

Review

# Prevalence of DSM/ICD-defined nicotine dependence

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## Abstract

We conducted a qualitative review to estimate for adults (1) the lifetime and current prevalence of DSM/ICD-defined nicotine dependence and (2) the prevalence of individual DSM/ICD dependence criteria. Systematic computer searches and other methods located eleven population-based surveys of adults ( $\geq 18$  year olds) and two of young adults (18–30 year olds). In the USA and Germany, about 25% of adults had been dependent on nicotine in their lifetime, including 15% who were currently dependent. Similar or higher rates were seen in Asian men but  $<5\%$  of Asian women had been dependent. About a third of ever-smokers and half of current smokers either had been or were currently dependent on nicotine and this did not consistently differ by age, country or sex. Impaired control over tobacco use was the most commonly endorsed criteria and giving up activities to use and spending lots of time with nicotine were the least commonly endorsed. Nicotine dependence is one of the most common mental disorders; however, about half of current smokers do not meet DSM/ICD dependence criterion.

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**Keywords:** Drug dependence; Epidemiology; Nicotine dependence; Substance-related disorders; Tobacco use disorder

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## 1. Introduction

The purpose of this paper is to estimate the prevalence of nicotine/tobacco dependence among adult smokers as defined by the American Psychiatric Association's (APA) Diagnostic and Statistical Manual (DSM) (American Psychiatric Association, 2000) or the World Health Organization's (WHO) International Classification of Diseases (ICD) (World Health Organization, 1993) classifications (N.B. Although DSM refers to "nicotine dependence" and ICD refers to "tobacco dependence" for brevity we will only use the former phrase). Nicotine dependence is measured in DSM/ICD using the same criteria as used for all substance dependencies (American Psychiatric Association, 2000; World Health Organization, 1992). These criteria focus on impaired control over drug use and physical dependence. Several non-DSM/ICD measures of nicotine dependence have been developed and focus on amount of tobacco use, craving, use of tobacco for pharmacological benefits, etc., (Piper et al., *in press*). DSM/ICD measures of nicotine dependence are not widely used in the tobacco research field, in part, because DSM/ICD measures have undergone much fewer validation tests than non-DSM/ICD measures (Hughes, *in press*; Piper et al., *in press*).

One important difference in DSM/ICD and non-DSM/ICD measures of nicotine dependence is that the former produces a present/absent decision on dependence, whereas the latter produce a continuous measure (the one exception is the Fagerstrom Test for Nicotine Dependence; however, that measure does not have a well-validated cutoff to use for dichotomous outcomes (Piper et al., *in press*)). There are many disadvantages to a dichotomous measure of dependence (Piper et al., *in press*). One advantage of a dichotomous measure is that, if one conceptualizes dependence not as a state or trait but as a disorder, then a dichotomous measure allows one to determine what proportion of a sample does or does not have the disorder, i.e., the prevalence of the disorder. A common question of clinicians, scientists and the lay public is what proportion of smokers are dependent on nicotine and only a dichotomous measure can answer this question. However, as with all disorders, prevalence is highly dependent on how stringent the dichotomous criterion is.

Knowing the prevalence of DSM/ICD nicotine/tobacco dependence is important for several reasons. First, several lines of evidence indicate many scientists and tobacco control advocates either explicitly or implicitly assume that almost all daily smokers are dependent on nicotine. For example, the UK Royal College of Physicians concluded "A small proportion of smokers, approximately 5%, do not appear to be addicted to nicotine" (Royal College of Physicians, 2000) (p. xiv). Also, the US Public Health Service Guidelines recommends pharmacotherapy for all smokers which implies all smokers are dependent on nicotine (Fiore et al., 2000). Finally, the earliest study of DSM/ICD nicotine dependence reported that 90% of smokers were dependent (Hughes et al., 1987). More recently, several lines of evidence have suggested a significant proportion of smokers may not be dependent (Shiffman, 1989). Determining the prevalence of DSM/ICD-defined nicotine dependence provides one estimate of how many current smokers meet an established threshold for clinically significant dependence.

Second, nicotine dependence is a clear barrier to smoking cessation that can be significantly mitigated by treatment (Fiore et al., 2000). Thus, knowledge of the prevalence of nicotine dependence is important for planning tobacco control programs. For example, if almost all smokers are dependent, then recommendations that all smokers receive treatment makes sense. Also, some evidence suggests tobacco control activities have mostly influenced less dependent smokers and that remaining smokers are more nicotine dependent than prior smokers (National Cancer Institute, 2003). To truly test this hypothesis requires a determination of the prevalence of nicotine dependence in a population and whether it changes over time. If this "hardening hypothesis" is true, then tobacco control programs will need to allocate more resources to treatment.

Although many studies have documented the prevalence of smoking, few have examined the prevalence of DSM/ICD nicotine dependence. This is probably due to two reasons. First, for reasons outlined elsewhere (Hughes, *in press*; Hughes and Howard, 1994), most epidemiologists studying "drug dependence" have excluded nicotine dependence. Second, most tobacco researchers have not used DSM/ICD instruments to measure nicotine dependence (Hughes, *in press*). We could locate only one prior review that discussed the epidemiology of DSM/ICD nicotine dependence and it cited only four studies (Giovino et al., 1995). Since that review a sufficient number of new surveys using DSM/ICD criteria have been published to permit (a) a better estimate of the prevalence of DSM/ICD nicotine dependence, (b) a test of the cross-study replicability of prevalence estimates, (c) analyses of possible causes for differences in prevalence across studies and (d) an estimate of the prevalence of individual DSM/ICD dependence criteria.

## 2. Methods

### 2.1. Data sources

We began with a search of the first author's own files and then searched Medline, PsychInfo and EMBASE databases through 12/05 for surveys of any type of drug dependence or abuse. We examined the Computer Retrieval of Information on Scientific Projects (CRISP) database of US National Institute of Health grants ([www.crisp.cit.nih.gov](http://www.crisp.cit.nih.gov)) and sent a request for publications to the principal investigators of the relevant grants. We examined abstracts of the 2001–2005 annual meetings of the College of Drug Dependence ([www.cpdd.vcu.edu](http://www.cpdd.vcu.edu)), the Research Society on Alcohol ([www.rsoa.org](http://www.rsoa.org)), the Society for Research on Nicotine and Tobacco (SRNT) ([www.srnt.org](http://www.srnt.org)), and the US National and World Conferences on Tobacco or Health in 2003–2005 ([www.nctoh2005.org](http://www.nctoh2005.org) and [www.wctoh2003.org](http://www.wctoh2003.org)). We also queried the SRNT listserve ([srntlist@tmahq.com](mailto:srntlist@tmahq.com)) and members of the DSM-IV Substance Use Disorders Research Planning Workgroup ([www.dsm5.org/conference4.cfm](http://www.dsm5.org/conference4.cfm)). When articles from the above searches cited references that might be relevant, we sought out these as well.

### 2.2. Study selection

The inclusion criteria were that the survey: (a) asked most of the DSM or ICD criterion items for substance dependence in regards to nicotine dependence, (b) was either population-based or used random selection and (c) reported on adults ( $\geq 18$ ). We did not include surveys of adolescents as these have been covered in prior reviews (Colby et al., 2000a,b; DiFranza et al., 2002; Kassel, 2000). We did include one unpublished analysis (L. Cottler, personal communication, 2/05) of data from one of the surveys included in this review.

### 2.3. Data extraction

We divided nicotine dependence into categories based on four attributes, i.e., (a) current dependence versus lifetime dependence, (b) dependence among all participants versus only among ever-smokers versus only among current smokers, (c) dependence among all participants versus only among men versus only among women or (d) dependence among all adults versus young adults (18–30 year olds).

Current dependence was usually defined in surveys as meeting the dependence criterion in the last 12 months. The large majority of those currently dependent are current smokers because <5% of smokers quit in a given year (National Cancer Institute, 2000; Royal College of Physicians, 2000) and conversion from dependent to non-dependent smoking while continuing to smoke is thought to be rare (US Dept Health and Human Services, 1988). Lifetime dependence was always defined in surveys as ever meeting dependence criteria, i.e., either current or past dependence. We did not report on past dependence, as only one study reported this (John et al., 2004a). Definitions of ever-smokers

ranged from those who smoked a single cigarette in their lifetime to those who smoked for  $\geq 4$  weeks or  $\geq 400$  cigarettes in their lifetime. The definition of current smoker in the studies ranged from those who smoked  $\geq 4$  weeks in the last year to current daily smokers. In two studies, ever and current smoking were not defined (Grant et al., 2004; Yoshimura, 2000). Three of the surveys included users of all tobacco products (Cottler, 1993; Hoch et al., 2004; Nelson and Wittchen, 1998) rather than just cigarette smokers; however, given that <5% of tobacco users use only non-cigarette tobacco (Giovino, 2002; Nelson and Wittchen, 1998), we will refer to these samples as smokers.

The information from the articles was entered into a spreadsheet by the first author and verified by the second and third authors. Discrepancies were reconciled via mutual agreement. Several of the data points in the tables were not from citations in the text but rather from our calculations of data in the article. A draft of the paper was sent to the authors of the articles included in the main analyses (see Table 1) to verify our citation or recalculation of their outcomes. Only six responded and only two suggested changes which were made.

Table 1  
Surveys of the prevalence of DSM/ICD nicotine dependence in adults<sup>a</sup>

Publications	Survey name	Year survey completed	Age, sex <sup>b</sup>	Sampling frame	Survey	Dx system
<b>Adults</b>						
<b>USA</b>						
Anthony et al. (1994), Breslau et al. (2001)	NCS	1992	15–54	National	CIDI	DSM-III-R
Cottler et al. (1995), Hale et al. (1993), Hughes et al. (2004)	DSM-IV Field Trial	1991	>18	Burlington <sup>c</sup> St. Louis <sup>c</sup>	CIDI-SAM	DSM-III DSM-III-R DSM-IV ICD-10
Grant et al. (2004)	NESARC	2002	$\geq 18$	National	AUDADIS	DSM-IV
Robins et al. (1985)	ECA	1982	>18	Baltimore Durham Los Angeles New Haven St. Louis	DIS	DSM-III
<b>Germany</b>						
Hoch et al. (2004)	SNICAS	2002	$\geq 16$	Medical practices	CIDI	DSM-IV
John, et al. (2004), Meyer et al. (2001)	TACOS	1996	18–64	Lubeck <sup>d</sup>	CIDI	DSM-IV
Schmitz et al. (2003)	GNHIES	1999	18–65	National	CIDI	DSM-IV
<b>Asia</b>						
Chen et al. (1993)	SMHS	1986	18–64	Hong Kong	DIS	DSM-III
Kawakami et al. (1998)		1993	$\geq 35$ men	Takayama, Japan	CIDI	DSM-III-R DSM-IV ICD-10
Lee et al. (1990)		?	18–65	Seoul, Korea <sup>c</sup>	DIS	DSM-III
Yoshimura et al. (2000)		1996	20–64	Nishime, Japan	CIDI	ICD-10
<b>Young adults (US)</b>						
<b>USA</b>						
Breslau et al. (1991), Breslau et al. (1994), Johnson, et al. (1996) <sup>e</sup>		1989	21–30	Detroit HMO	DIS	DSM-III-R
Nelson and Wittchen (1998)		1995	18–24	Munich, Germany	CIDI	DSM-IV

<sup>a</sup> AUDADIS, Alcohol Use Disorder and Associated Disabilities Interview Schedule; CIDI, Composite International Diagnostic Interview; CIDI-SAM, Composite International Diagnostic Interview–Substance Abuse Module; DIS, Diagnostic Interview Schedule; DSM, Diagnostic and Statistical Manual; Dx, Diagnostic; ECA, Epidemiological Catchment Area; GNHIES, German National Health Interview and Examination Survey; HMO, Health Maintenance Organization; ICD, International Classification of Diseases; NCS, National Comorbidity Survey; NESARC, National Epidemiologic Survey on Alcohol and Related Conditions; NHSDA, National Household Survey of Drug Abuse; SMHS, Shatin Mental Health Survey; SNICAS, Smoking and Nicotine Dependence Awareness and Screening Study; TACOS, Transitions in Alcohol Consumption and Smoking.

<sup>b</sup> Both men and women unless stated otherwise.

<sup>c</sup> Used only the two population-based sites.

<sup>d</sup> These surveys also included nearby towns.

<sup>e</sup> More than one article reported on the survey.

## 2.4. Data synthesis

We did not conduct a formal meta-analysis because the studies varied substantially in how the sample was collected, definitions of dependence, etc., (Egger et al., 2001; Rosenthal, 1995). However, we did attempt to follow the Quality of Reporting of Meta-analyses standards for reporting systematic reviews (Egger et al., 2001; Moher et al., 1999).

## 2.5. Methodological issues in assessing nicotine dependence

The DSM/ICD generic criteria for substance use/drug dependence were derived from formulations based on observations of alcohol dependence and appear to apply to dependencies on illicit drugs as well (Kosten et al., 1987); how well they apply to nicotine dependence is a subject of debate (Hughes, *in press*). The DSM/ICD criteria of compulsion to use, difficulty controlling use, use despite harm and withdrawal appear applicable to nicotine dependence, e.g., they are often endorsed. The criteria of spending large amounts of time obtaining, using or recovering from the substance and of foregoing activities to use the substance, do not appear applicable to smoking, e.g., they are less commonly endorsed. This is probably due to the ease of access to tobacco, the ability to use tobacco while engaging in other activities and the lack of behavioral intoxication from nicotine (Hughes, *in press*). Whether tolerance is applicable to nicotine dependence is debatable (Hughes, *in press*). Tolerance to aversive effects of tobacco clearly occurs but examples of tolerance in the DSM appear to refer to tolerance to rewarding effects (American Psychiatric Association, 2000) and it is debatable whether tolerance occurs to the rewarding effects of nicotine (Perkins, 2002). Using the substance more than intended might be applicable to nicotine dependence if the “more” refers to duration of use in a lifetime. However, the examples given for this criterion in the DSM (American Psychiatric Association, 2000) refer to greater use on a given occasion; whether this phenomena occurs with smoking has not been studied (Hughes, *in press*). Many of the diagnostic measures used in surveys either deleted some of the above criteria or used proxies, e.g., smoking >10 cigarettes/day has been used as a proxy for tolerance (Breslau, 1997; Hughes, *in press*). Whether such proxies are appropriate or cause false negatives or false positives is unknown.

This review will examine predictors of nicotine dependence. Unfortunately, many of the surveys examining predictors of nicotine dependence did not distinguish whether these predictors were predicting smoking onset or predicting dependence once smoking begins. Since the predictors of the onset of smoking are well-known (US Dept Health and Human Services, 1994), this review will focus only on the prediction of nicotine dependence among ever-smokers.

## 3. Results

### 3.1. Surveys of nicotine dependence

We located 19 articles that reported the prevalence of meeting versus not meeting the full criterion for DSM/ICD (Anthony et al., 1994; Breslau et al., 1991, 1994, 2001; Chen et al., 1993; Cottler et al., 1995; Grant et al., 2004; Hale et al., 1993; Hoch et al., 2004; Hughes et al., 2004; John et al., 2004a; Johnson et al., 1996; Kawakami et al., 1998; Lee et al., 1990; Meyer et al., 2001; Nelson and Wittchen, 1998; Robins et al., 1985; Schmitz et al., 2003; Yoshimura, 2000). These articles were based on 13 surveys (Table 1). Eleven were surveys of all adults ( $\geq 18$  years) and two of young adults (18–30 years) only. Among the adult surveys, four were of the USA, three of Germany and four of Asian countries. Among the two surveys of young adults, one was from the USA and one from Germany. Three surveys occurred in the 1980s, seven in the 1990s, two after 2000 and the date of one survey was unknown. One survey included only men.

The minimum age for most surveys was 18–21 years and the maximum was usually  $\geq 65$  year. Two studies included 15–17 year olds (Anthony et al., 1994; Hoch et al., 2004). Since 15–17 year olds represented a very small portion of participants in these surveys, they were included. One study did not include those 55 and older (Anthony et al., 1994). Since the onset of nicotine dependence after age 55 year is highly unusual (Breslau et al., 2001), it was included.

Three studies were population-based national surveys, eight were random samples of cities with or without surrounding rural areas, one was a random sample of medical practices and one a sample from an urban health maintenance organization. Six used the Composite International Diagnostic Interview (CIDI) (Skodol and Bender, 2000), four used the Diagnostic Survey Interview (DIS) (Skodol and Bender, 2000) and one used the Substance Abuse Module (SAM) of the CIDI (Cottler and Keating, 1990). Seven surveys reported DSM-IV (American Psychiatric Association, 2000), four DSM-III-R (American Psychiatric Association, 1987), four DSM-III (American Psychiatric Association, 1980) and three ICD-10 (World Health Organization, 1993) diagnoses. Two trials reported using more than one diagnostic system. Ten of the surveys had response rates of >70% and three had rates of 50–66% (Chen et al., 1993; Schmitz et al., 2003; Yoshimura, 2000).

We excluded reports based on the 1991–1993 US National Household Surveys on Drug Abuse because they reported on a combined sample of adults and adolescents (i.e.  $\geq 12$  years old) and their response options were not as well matched to the DSM/ICD criteria as the other surveys (Kandel et al., 1997; Kandel and Chen, 2000). We excluded an early survey of DSM-III criteria because, even though the sample recruited using a population based sample frame, only those who volunteered for a non-survey study were included (Hughes et al., 1987). We excluded results from sites of the DSM-IV Field Trials that examined those in treatment for alcohol/illicit drug problems (Cottler et al., 1995). We excluded a Japanese survey because it recruited solely from university and hospital personnel (Hashimoto et al., 2001).

Four surveys were conducted in the USA. One of the larger, most representative and most detailed surveys was the US National Comorbidity Survey (NCS); however, it assessed nicotine dependence in only 55% of the sample (Anthony et al., 1994; Breslau et al., 2001). The National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) reported on a very large, recent national USA sample and reported current rather than lifetime nicotine dependence (Grant et al., 2004). Two of the sites for the DSM-IV Field Trials examined population-based samples of current smokers in two USA cities (Cottler et al., 1995). One publication reported lifetime dependence among ever users at both of these sites (Cottler et al., 1995). Two other publications reported only current dependence in a small subsample of the Field Trials with little methodological detail and, thus, the results from these two articles were not included (Hale et al., 1993; Hughes et al., 2004). The above three surveys occurred when the prevalence of smoking in the USA was relatively low and tobacco control efforts relatively active (US Dept Health and Human Services, 1989). The fourth survey – the



Epidemiologic Catchment Area (ECA) survey – occurred over 20 years ago when smoking prevalence was higher (especially among men) and tobacco control activities were rare (Robins et al., 1985). This study used samples from five USA cities. Unfortunately, nicotine dependence rates are cited only in one table in one chapter with little detail.

Three recent surveys were conducted in Germany where the prevalence of smoking is fairly high and tobacco control efforts have been minimal (<http://apps.nccd.cdc.gov/nations>). The Smoking and Nicotine Dependence Awareness and Screening Survey (SNICAS) examined patients in a representative sample of primary care clinics (Hoch et al., 2004). The Transitions in Alcohol Consumption and Smoking study (TACOS) surveyed those in a large German city and surrounding areas (John et al., 2004b; Meyer et al., 2001). The German National Health Interview and Examination Survey (GNHIES) had participants undergo a physician interview of health problems plus complete self-report measures of mental disorders (Schmitz et al., 2003).

Four surveys were conducted in Asian countries in which the prevalence of smoking is very high in men and very low in women and very little tobacco control activities occur (<http://apps.nccd.cdc.gov/nations>). The Shatin Community Mental Health Survey examined residents of a new town developed by Hong Kong (Chen et al., 1993). One study invited all residents over age 35 years in a rural Japanese city (Takayama) to be surveyed but reported results only for male ever-smokers

(Kawakami et al., 1998). Another examined samples in Seoul and rural cities of South Korea (Lee et al., 1990). A fourth study invited all residents of a small Japanese town (Nishime) to be surveyed but included only those age 20–64 years (Yoshimura, 2000).

Two studies examined only young adults (18–30 year olds). One survey sampled from a health maintenance organization in a large USA city (Breslau et al., 1991, 1994; Johnson et al., 1996). The other used a population-based sample of 14–24 year olds from a large city in Germany but presented separate results for 18–24 year olds (Nelson and Wittchen, 1998).

The results of the above surveys are first grouped by their sample into all smokers or ever-smokers or current smokers. Then, within each of these groups, results are examined by type of dependence into current or lifetime dependence.

### 3.2. Dependence in the entire population

The prevalence of lifetime dependence among all participants varied across eight surveys from 12 to 36% (Table 2). This variability is probably because these rates are highly influenced by the prevalence of ever smoking. Higher rates of dependence occurred in surveys of USA and Germany which have higher smoking prevalences than in Asia. In fact, the highest rate of nicotine dependence was in a USA study done in 1980 when the prevalence of ever-smoking was significantly higher than more recently (Robins et al., 1985). The prevalence of current

Table 2

Prevalence (sample size) of DSM/ICD nicotine/tobacco dependence in men and women<sup>a</sup>

Study	Lifetime dependence in entire sample	Current dependence in entire sample	Lifetime dependence in ever-smokers	Lifetime dependence in current smokers	Current dependence in current smokers
<b>Adults</b>					
<b>USA</b>					
NCS	24% (4414)		32% (3337) <sup>b</sup>		
DSM-IV			66–71% (260) <sup>c</sup>		
NESARC		13% (43093)			53% (12238)
ECA	37% (3207)				
<b>Germany</b>					
SNICAS		14% (28707)			47% (?) <sup>c</sup>
TACOS	21% (4075)	11% (4075)		38% (1601) <sup>d</sup>	
GNHIES		9% (3293)			
<b>Asia</b>					
Hong Kong	13% (7229)				
Seoul	20% (3134)				
Takayama	12% (1491)				
<b>Young adults</b>					
Detroit, USA	20% (1007)	16% (1007)	51% (394) <sup>e</sup>	55% (292) <sup>c</sup>	
Germany	19% (3021)	15% (3021)	52% (1083) <sup>f</sup>		46% (967) <sup>d</sup>

DSMIII, DSMIII-R and DSM-IV rates.

<sup>a</sup> DSM, Diagnostic and Statistical Manual; ECA, Epidemiological Catchment Area; GNHIES, German National Health Interview and Examination Survey; ICD, International Classification of Diseases; NCS, National Comorbidity Survey; NESARC, National Epidemiologic Survey on Alcohol and Related Conditions; SNICAS, Smoking and Nicotine Dependence Awareness and Screening Study; TACOS, Transitions in Alcohol Consumption and Smoking; Parentheses = denominators.

<sup>b</sup> Smoked on  $\geq 1$  occasion.

<sup>c</sup> Daily smokers for  $\geq 1$  month.

<sup>d</sup> Smoked  $\geq 4$  weeks in last 12 month.

<sup>e</sup> Smoked  $\geq 1$  month in lifetime.

<sup>f</sup> Smoked  $\geq 4$  weeks in lifetime.

Table 3  
Prevalence of DSM/ICD nicotine dependence in adult men<sup>a</sup>

Study	Lifetime dependence in entire sample	Current dependence in entire sample	Lifetime dependence in ever-smokers	Lifetime dependence in current smokers	Current dependence in current smokers
<b>Adults</b>					
<b>USA</b>					
NCS	26% (~2097)		33% (~1650) <sup>b</sup>		
NESARC		14% (~21500)			
<b>Germany</b>					
SNICAS		16% (12167)			
TACOS	24% (~2000)				
	11% (~2000)				
<b>Asia</b>					
Hong Kong	27% (3443)				
Takayama			26–42% (170) <sup>c</sup>	38–48% (102) <sup>c</sup>	
Nishime	25% (673)				
Seoul	39% (1490)			42% (400) <sup>d</sup>	
<b>Young adults</b>					
Detroit, USA	20% (383)		50% (~150) <sup>d</sup>		
Germany	19% (1493)	16% (1493)	52% (545) <sup>e</sup>		47% (490) <sup>f</sup>

DSM-III-R, DSM-IV, ICD-10 diagnosis, smoked daily  $\geq 1$  month in lifetime.

<sup>a</sup> DSM, Diagnostic and Statistical Manual; ECA, Epidemiological Catchment Area; ICD, International Classification of Diseases; NCS, National Comorbidity Survey; NESARC, National Epidemiologic Survey on Alcohol and Related Conditions; SNICAS, Smoking and Nicotine Dependence Awareness and Screening Study; TACOS, Transitions in Alcohol Consumption and Smoking, Parentheses = denominators.

<sup>b</sup> Smoked on  $\geq 1$  occasion.

<sup>c</sup> Smoked  $\geq 400$  cigarettes in lifetime.

<sup>d</sup> Not defined.

<sup>e</sup> Smoked  $\geq 4$  weeks in lifetime.

<sup>f</sup> Smoked  $\geq 4$  weeks in last 12 month.

dependence among all participants was available for one USA and three German studies but no Asian studies and varied from 9 to 18%.

The prevalence of lifetime and current dependence was similar in men (Table 3) and women (Table 4) in the one USA and one German study. This is probably because the rates of ever-smoking in men and women were similar in these two countries (<http://apps.nccd.cdc.gov/nations>). The rates were much higher in men than women in the three Asian studies. This is probably because ever-smoking is common in men and uncommon in women in Asia (<http://apps.nccd.cdc.gov/nations>) (Tables 3 and 4). The prevalence of nicotine dependence in Asian men was similar to that in USA and German men.

### 3.3. Dependence among ever-smokers

Calculation of the prevalence of dependence among ever-users of a drug indicates the risk of developing dependence once one has been exposed to the drug (Anthony et al., 1994). Four studies have reported rates of dependence among ever-smokers and they only reported lifetime dependence, i.e., no surveys reported current dependence among ever-smokers (Tables 2–4). Among the USA studies, the prevalence of lifetime dependence among adult ever-smokers was much less in the NCS than the DSM-IV Field Trial (32% versus 66–77%). This is probably because the definition of ever-smoking in the NCS (use  $\geq 1$  occasion) was much more lenient than that for the Field Trial (daily

smoking for  $\geq 1$  month). The two studies among young adults found similar rates of dependence (52% each). Because of different definitions of ever-smokers, it is unclear if rates differ across studies of younger and older ever-smokers. Two of the studies in Table 1 have provided a more-rigorous within-study test of the association of age and dependence. Both found younger ever-smokers had higher rates of dependence (Anthony et al., 1994; Hoch et al., 2004).

The prevalence of dependence among ever smokers was similar between studies of male and female ever-smokers (26 and 33% for adult men versus 31% for adult women, and 52% for young adult men versus 51 and 53% for young adult women). Importantly, similar findings occurred in within-study comparisons of men versus women (Anthony et al., 1994; Breslau et al., 1991, 2001; Nelson and Wittchen, 1998).

### 3.4. Dependence among current smokers

Four studies have reported lifetime or current dependence among current smokers (Tables 2–4). One would think that, among current smokers, most lifetime dependence is current dependence because conversion from current to no dependence while continuing to smoke is thought to be unusual (US Dept Health and Human Services, 1988); however, this assumption has not been empirically tested. Lifetime and current dependence in current smokers in four studies ranged from 38 to 55%. The rates of dependence in adult versus young adult current

Table 4  
Prevalance of DSM/ICD nicotine dependence in adult women<sup>a</sup>

Study	Lifetime dependence in entire sample	Current dependence in entire sample	Lifetime dependence in ever-smokers	Lifetime dependence in current smokers	Current dependence in current smokers
<b>Adults</b>					
<b>USA</b>					
NCS	23% (~2313)		31% (1685) <sup>b</sup>		
NESARC		12% (~21500)			
<b>Germany</b>					
SNICAS		12% (16540)			46% (4418)
TACOS	18% (~2000) 12% (~2000)				
<b>Asia</b>					
Hong Kong	1% (3786)				
Seoul	3% (1644)				
Nishimiti	2% (818)			49% (39) <sup>c</sup>	
<b>Young adults</b>					
Detroit, USA	21% (621)		52% (~244) <sup>d</sup>		
Germany	19% (1528)	14% (1528)	53% (538) <sup>e</sup>		44% (478) <sup>f</sup>

<sup>a</sup> DSM, Diagnostic and Statistical Manual; ICD, International Classification of Diseases; NCS, National Comorbidity Survey; NESARC, National Epidemiologic Survey on Alcohol and Related Conditions; SNICAS, Smoking and Nicotine Dependence Awareness and Screening Study; TACOS, Transitions in Alcohol Consumption and Smoking, Parentheses = denominators.

<sup>b</sup> Smoked on  $\geq 1$  occasion.

<sup>c</sup> Not defined.

<sup>d</sup> Smoked daily  $\geq 1$  month in lifetime.

<sup>e</sup> Smoked  $\geq 4$  weeks in lifetime.

<sup>f</sup> Smoked  $\geq 4$  weeks in last 12 month.

smokers appeared similar. Although this suggests the development of nicotine dependence after age 24 is uncommon, the one within-study comparison found a not-trivial minority of smokers developed dependence after this age (Breslau et al., 2001). The rates of dependence among current smokers were similar in men versus women which is concordant with within-study comparisons (Breslau et al., 1991, 1994; Nelson and Wittchen, 1998).

### 3.5. Prevalence of individual dependence criteria

We located seven (Breslau et al., 1994; Hoch et al., 2004; John et al., 2004a; Johnson et al., 1996; Nelson and Wittchen, 1998; Strong et al., 2003; Yoshimura, 2000) population-based surveys that reported the prevalence of each DSM/ICD dependence criterion. Four of the population-based survey of adults in Table 1 published on individual criteria (Table 5). In addition, an unpublished analysis (L Cottler, personal communication, 7/05) used the two population-based samples of adults in the DSM-IV Field Trials (Cottler et al., 1995). Both of the population-based studies of young adults in Table 1 reported on individual items. Four other large surveys reported on individual dependence criteria but we did not include these because they were based on convenience samples (Cottler et al., 1995; Hughes et al., 1987; Lessov et al., 2004; Radzius et al., 2004).

As stated above, the definition of the sample can influence prevalence rates of dependence. Of the seven surveys on individual criteria included, four examined only ever-smokers; three examined only current smokers including one that examined

only current smokers who met DSM/ICD criterion for nicotine dependence. Sample sizes ranged from 394 to 3992. Few of the surveys reported the prevalence of the DSM criterion of (a) using nicotine to avoid withdrawal or (b) the ICD criterion of a strong desire to use nicotine, or (c) the DSM/ICD criterion of spending lots of time with the drug; thus, these were omitted from the formal analysis. The other six criteria used in DSM or ICD were reported in all but one study; this study reported on only four of the criteria. (Yoshimura, 2000).

The studies varied substantially in prevalence rates but the rank order of symptoms within a study was fairly consistent across studies. “Impaired control over use” was the most prevalent symptom, followed by “used more than intended” and “withdrawal” which were similar, followed by “use despite problems”, then “tolerance” and finally “giving up activities to use”. The Kendall W (Jar, 1999) – a measure of the consistency of rank order across samples – for all seven studies was 0.64 ( $P < 0.0001$ ), for the five adult studies was 0.69 ( $P < 0.001$ ) and for the two young adult studies was 0.97 ( $P = 0.01$ ) indicating excellent agreement. A similar ranking was found in the four surveys using convenience samples (Cottler et al., 1995; Hughes et al., 1987; Lessov et al., 2004; Radzius et al., 2004).

The rankings were similar for adults and young adults. The variability in the absolute rates of or rank order of endorsement did not appear to be consistently related to use of DSM/ICD versus proxy description of symptoms, diagnostic system (e.g., DSM-III versus DSM-IV), survey instrument (e.g., CIDI versus DIS), type of smoker (e.g., current versus ever-smoker) or country of survey.

Table 5

Prevalence (rank) of the more common individual DSM/ICD nicotine dependence criteria across different population-based samples<sup>a</sup>

	Smoking Status	<i>N</i>	Impaired control	Withdrawal	Use more than intended	Use despite problems	Tolerance	Give up activities to use
Adults								
USA								
NCS	Ever-smokers	2088	87% (1.5)	50% (4)	71% (3)	25% (5)	87% (1.5)	7% (6)
DSM-IV <sup>b</sup>	Ever-smokers	261	54% (5)	84% (1)	71% (3)	81% (2)	67% (4)	7% (6)
Germany								
SNICAS	Dependent current smokers	3992	87% (1)	80% (2)	61% (3)	60% (4)	29% (5)	25% (6)
TACOS	Current smokers	1601	73% (1)	41% (2)	30% (3)	27% (4)	19% (5)	1% (6)
Asia								
Nishime	Current male smokers	400	69% (1) <sup>c</sup>	46% (2) <sup>c</sup>	—	30% (5) <sup>c</sup>	—	1% (6) <sup>c</sup>
Mean for adults		1668	74% (1.9)	60% (2.2)	58% (3)	45% (4)	51% (3.9)	8% (6)
Young adults								
Detroit	Ever-smokers	394	60% (2)	31% (4)	69% (1)	44% (3)	27% (5)	7% (6)
Munich	Ever-smokers	1084	48% (3)	37% (4)	82% (1)	50% (2)	24% (5)	6% (6)
Mean for all studies		1403	68% (2.1)	53% (2.7)	64% (2.3)	45% (3.6)	42% (4.3)	8% (6)

<sup>a</sup> DSM, Diagnostic and Statistical Manual; ICD, International Classification of Disease; NCS, National Comorbidity Study, TACOS, Transitions in Alcohol Consumption and Smoking Study; SNICAS, Smoking and Nicotine Dependence Awareness and Screening Study.

<sup>b</sup> Unpublished paper (see text).

<sup>c</sup> This study only reported on four criteria. Given which criteria these were and how they occurred in other studies, we assigned them the ranks of 1, 2, 5 or 6 for this study.

## 4. Discussion

### 4.1. Prevalence of nicotine dependence versus other drug and mental disorders

The prevalence of lifetime (19–37%) and current (9–13%) nicotine dependence in the USA and German samples suggest nicotine dependence is one of the most common mental disorders. Among the studies that reported on both nicotine dependence and other common mental disorders, nicotine dependence was the most prevalent disorder in the three studies of adults (Chen et al., 1993; Grant et al., 2004; Lee et al., 1990) and was among the highest in the one study of young adults (Breslau et al., 1994).

Given this high prevalence, it is surprising that nicotine dependence is still not included in many self-report or interview-based surveys of psychiatric disorders (Hughes, *in press*) and in many reports on “drug dependence” (Hughes, 2004; Hughes and Howard, 1994). This may be because, unlike other psychiatric disorders, nicotine dependence rarely causes behavioral disruption or symptomatic distress; thus, few smokers seek treatment from behavioral clinicians (Hughes, *in press*). On the other hand, nicotine dependence is among the most fatal of the psychiatric disorders, e.g., one third of current smokers will die of a tobacco-related disorder (US Department of Health and Human Services, 2004) and smokers with nicotine dependence have greater mortality than smokers without nicotine dependence (Kubik et al., 2001).

Examining the prevalence of dependence in ever-users of a drug allows one to estimate the probability of developing dependence once exposed to the drug (Anthony et al., 1994). About a third to a half of those exposed to cigarettes became dependent on nicotine. In the two studies that examined several drugs, the

probability of developing dependence once exposed was at least 1.5 times greater for nicotine than any other drug (Anthony et al., 1994; Cottler et al., 1995). This contradicts the common lay notion that cocaine and opioids are the drugs most likely to lead to dependence once tried (US Dept Health and Human Services, 1988). There are several possible hypotheses for why nicotine exposure produces more dependence. For example, although debatable (Parrott, 2003), nicotine appears to produce several beneficial effects (e.g., relief of aggression, poor mood, difficulty concentrating and hunger) making it perhaps a more useful drug (Hughes, 2001c). In addition, nicotine use almost never causes intoxication and, thus, more drug can be imbibed without immediate adverse behavioral consequences. Alternatively, it may be non-pharmacological factors such as the ease of access, legality and wide promotion of cigarettes account for its ability to produce dependence once tried (Hughes, 2001c). None of these hypotheses have been empirically tested.

### 4.2. Prevalence of nicotine dependence in current smokers

Surprisingly, in most surveys only about half of current smokers fulfilled DSM/ICD criterion for nicotine dependence. This appears to directly contradict the common notion that all or almost all daily smokers are nicotine dependent (Fiore et al., 2000; Royal College of Physicians, 2000). One possible explanation for these lower-than-expected rates is that the DSM/ICD criterion is overly stringent. For example, it is probably harder to meet criterion for nicotine dependence than for other drug dependencies because two of the generic dependence criteria do not appear appropriate for nicotine dependence (see above). Thus, to fulfill DSM-IV criterion for nicotine dependence, one has to endorse, not 3 out of 7 criteria, but actually 3 of 5 criteria. A related possibility is that the DSM/ICD criterion are



not very valid measures when applied to nicotine (Hughes, *in press*).

Another possible explanation is that many smokers are “in denial” about their dependence in a manner similar to that thought to be typical of alcohol dependence (Morse and Flavin, 1992) and, thus, do not endorse dependence symptoms; however, most smokers state they are dependent (Hughes et al., 2004). A related explanation is that many smokers have never seriously tried to quit and, thus, are not aware of their dependence. Although this may be true of German (Boyle et al., 2000) or Asian smokers, in the USA, over 85% of smokers have tried to stop (Gallup Organization, 1999).

Another possibility is that the surveys included a large number of non-daily smokers who are less likely to be dependent (Okuyemi et al., 2002). None of the surveys reviewed reported the proportion of the sample that was non-daily current smokers; however, one survey of adults (Hoch et al., 2004) and one of young adults (Nelson and Wittchen, 1998) included only daily smokers and their prevalence rates were 46 and 47%.

A final possibility is that the 50% figure is not really surprising compared to what would be found in current daily users of other drugs. Unfortunately, we could not locate a population-based survey that reported the prevalence of dependence among current daily users of alcohol, cocaine, heroin, etc.

One interpretation of the finding that only half of current smokers meet DSM criterion for dependence is that it suggests there is substantial variability in predispositions to dependence. The fact that, apparently, many smokers can smoke cigarettes for decades and still not meet DSM/ICD criterion for dependence does suggest there must be some powerful genetic, environmental or intrapsychic factors that protect against the development of dependence.

Another interpretation is that our results indicate nicotine dependence is limited in what proportion of smoking behavior it can explain (Frenk and Dar, 2000); thus, perhaps alternate models such as the Health Belief Model, the Theory of Reasoned Action or the Theory of Planned Behavior (Schulze and Whittmann, 2003; Strecher et al., 1997) should be used to explain smoking. In rebuttal, some would state either (a) the ICD/DSM measure is a poor measure of nicotine dependence or (b) dependence theory never claimed to explain all of smoking behavior and as long as it accounts for a significant amount of the behavior (just like genotype) it should be utilized. In terms of the former, although several studies have suggested the validity of the DSM/ICD as applied to nicotine is less than that for non-DSM/ICD measures of nicotine dependence (Hughes, *in press*; Piper et al., *in press*), the issue is still in doubt. If the DSM/ICD criterion were less valid, this would not necessarily suggest nicotine is not a dependence, but it would suggest that nicotine dependence is different from other drug dependencies, i.e., some facets of alcohol and other drug dependencies do not apply to nicotine. This, in turn, would suggest the drug dependence model cannot be uniformly applied to smoking (Hughes, *in press*). Perhaps a better appreciation of what dependence facets can and cannot be applied to smoking would further understanding more than simple tests of whether smoking is or is not a DSM/ICD-defined dependence phenomena.

#### 4.3. Prevalence of individual dependence criteria

There was a large variance in the absolute rates of endorsement of individual DSM/ICD generic dependence criteria when applied to nicotine; however, the rank of order of criteria was quite consistent across studies. The rank order analysis suggested the most common symptom was “impaired control”, followed by “use more than intended” and “withdrawal”, followed by “use despite problems”, then “tolerance” and finally “giving up activities to use.” “Spending lots of time with drug” was not assessed in the studies; suggesting it is a rare symptom. Item-response analyses is another method to examine rank order of symptoms. The one study using this method found a different ranking (Strong et al., 2003). In this study the rank order of symptoms was tolerance > using more than intended > withdrawal = impaired control > use despite harm.

The rank orders of dependence symptoms for non-nicotine drug dependencies differ across drugs of dependence (Kosten et al., 1987; Langenbucher et al., 1995, 2004; Morgenstern et al., 1994); thus, it is difficult to state whether the rank order for nicotine dependence is similar to that with other drugs. Also, comparison of the prevalences of endorsement of individual criteria across drugs and studies must be made cautiously due to differences in denominators. For example, studies have used all participants, those who used the drug >5 times, those who were dependent on the drug, and those who were in treatment for problems with the drug, as the denominator. In the one direct comparison of the rank order between nicotine and non-nicotine dependencies, withdrawal was the second most common symptom for nicotine dependence but was the least common symptom for cocaine dependence; also, giving up activities to use was common in all dependences except nicotine dependence (L. Cottler, personnel communication 7/05).

Among ever-smokers the probability of being dependent did not differ between men and women. This finding occurred in both across-study and within-study comparisons. This finding is actually unexpected as there are several lines of evidence that women smoke less for nicotine dependence than men (Perkins et al., 1999). In both sets of analyses, younger ever-smokers were more likely to be dependent than older ever-smokers, suggesting a secular cohort effect (Hughes, 2001a). One possible explanation for this is that with public pressure to not smoke increasing over time, young adults who do choose to experiment and persist in tobacco use are more and more likely to be those who have some historical or genetic predisposition to develop nicotine dependence (Hughes, 2001b). In both between-study and within-study analyses, Black ever-smokers were more likely to develop dependence than White ever-smokers. One possible explanation for this is that Blacks tend to metabolize nicotine slower and this increased exposure to nicotine increases the probability of dependence (Perez-Stable et al., 1998).

Finally, this review did not examine the psychometrics of measurement of nicotine dependence using the DSM/ICD (Colby et al., 2000a; Piper et al., *in press*). Prior studies have examined the reliability (Cottler et al., 1989; Hughes et al., 2004; Shiffman et al., 2004; True et al., 1999), validity (Breslau et al., 1994, 2001; Breslau and Johnson, 2000; John et al.,

2004a; Kawakami et al., 1998; Shiffman et al., 2004) and cross-system agreement, e.g., DSM-IV versus ICD-10 (Cottler et al., 1991, 1995; Hughes et al., 2004; Kawakami et al., 1998) of DSM/ICD nicotine dependence measures. Also several studies have examined whether DSM/ICD nicotine dependence is a uni-dimensional or multi-dimensional construct (Hughes et al., 2004). This review also did not discuss non-DSM/ICD measures of nicotine dependence (Etter et al., 2003; Fagerstrom and Schneider, 1989; Hudmon et al., 2003; Piper et al., 2004; Shiffman et al., 2004) or the concordance between DSM/ICD and other scales (Hughes et al., 2004).

In summary, our major conclusions are: (a) nicotine dependence is one of the most common mental disorders; however, (b) the rates of nicotine dependence among ever-smokers and current smokers are lower than anticipated.

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