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A Review of the Prevalence and Co-occurrence of Addictions in US Ethnic/Racial Groups: Implications for Genetic Research

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Abstract

Background and Objectives—We conducted a review of the prevalence and co-occurrence of 12 types of addictions in US ethnic/racial groups and discuss the implications of the results for genetic research on addictions.

Methods—We utilized MEDLINE and PsycINFO databases to review the literature on alcohol, tobacco, marijuana, illicit drugs, gambling, eating/food, internet, sex, love, exercise, work, and shopping. We present results for each addiction based on total US prevalence, prevalence within ethnic groups, and co-occurrence of addictions among ethnic groups when available.

Results—This review indicates very little research has examined the interrelationships of addictive behaviors among US ethnic groups. The studies that exist have focused nearly exclusively on comorbidity of substances and gambling behaviors. Overall findings suggest differences among US ethnic groups in prevalence of addictions and in prevalence of addiction among those who use substances or engage in gambling. Almost no ethnic group comparisons of

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other addictive behaviors including eating/food, internet, love, sex, exercise, work, and shopping were identified in the literature.

Conclusions—Despite large-scale research efforts to examine alcohol and substance use disorders in the US, few studies have been published that examine these addictive behaviors among ethnic groups, and even fewer examining co-occurrence and co-morbidity with other addictions.

Scientific Significance—Even with the limited studies, these findings have implications for genetic research on addictive behaviors. We include a discussion of these implications, including issues of population stratification, disaggregation, admixture, and the interplay between genetic and environmental factors in understanding the etiology and treatment of addictions.

Keywords

addictive behaviors; ethnicity; race; prevalence; comorbidity; co-occurrence; genetics

Sussman, Lisha, & Griffiths[1] investigated prevalence and co-occurrence of 11 types of addictions. These included alcohol, tobacco, illicit drugs (including marijuana), gambling, eating/food, internet, love, sex, exercise, work, and shopping. The most research is available on these 11 addictions, which appear to account for about 90% of addictions experienced[2]. The review found that approximately half of the US adult population had signs of addictive behaviors in the past year, with a 23% co-occurrence of the addictions on average but substantial variability of co-occurrence among addictions (10–50% overlap). There has yet to be a review of the prevalence and co-occurrence of these addictions as a function of race or ethnicity. In the present paper, we conduct this review for US ethnic/racial groups.

The PACE model provides a framework to examine the specificity and co-occurrence of addiction[3]. In the PACE model, pragmatics (P; availability, acquisition), attraction (A; vulnerability, reactivity), communication (C; socialization, experience), and expectation (E; beliefs, anticipated effects) all play a role in the likelihood that an individual will develop an addiction to one behavior (specificity), to multiple behaviors simultaneously (comorbid, concurrent), or to multiple behaviors consecutively (substitution). Addiction co-occurrence is thought to involve the interplay of biological, environmental, situational, and learning factors. Applying this framework to racial/ethnic groups, addictive behaviors and their co-occurrence may vary across groups due to multiple factors. There may be differential accessibility or attractiveness of different substances for different groups. For example, increase usage of menthol cigarettes by Blacks in the US has been linked to tobacco company marketing campaigns and accessibility[4]. There may also be variations in biological factors that make addictive behaviors more or less attractive. For example, genetic variants in Asians that reduce alcohol metabolism and increase adverse physical effects from alcohol are associated with lowered risk for alcohol addiction[5]. Finally, there may be differences across groups in socialization processes (e.g., approval of marijuana use by family and friends, gambling as a culturally accepted activity, experience with drug-related arrests) or expectations (e.g., body image associated with exercise addiction, the expectancy that either drinking or smoking will relieve anxiety, but only drinking will provide an excuse for casual sex). Examining the interplay among such factors is important for revealing underlying

processes in the development of addictive behaviors, including their specificity and comorbidity. Difference may be due not only to different prevalence of risk/protective factors (e.g., baserates), but also to how these factors relate to the development of addictions (e.g., mechanistic pathways).

Differing prevalence rates of addictions and their co-occurrence across racial/ethnic groups have implications for genetics research. When conducting genetic research, variations in genotype distributions across groups must be accounted for in data analyses, which is typically done by either stratifying or covarying for group differences in allele prevalence. If not taken into account, this issue of population stratification can lead to spurious findings due to ethnic group differences in both genotype distributions and phenotype prevalences. Thus, understanding ethnic differences in prevalence and co-occurrence of addictive behaviors, as well as the prevalence of genetic variants (e.g., allelic distributions of genes), is an important step in conducting genetic research across groups.

In this study, we examined the 12 addictions, with marijuana split from illicit drugs when data are available. We present results for each addiction based on total US prevalence, prevalence within ethnic groups, and co-occurrence of addictions for each ethnic group when available. For the remainder of this study, we refer to "ethnic" groups rather than "racial" groups since the studies we review 1) rely on self-reported identity instead of ancestral markers, 2) typically categorize participants using a combination of race, ethnicity, and origin (e.g., Asian, Black, Hispanic), and 3) in some studies further delineate participants by nationality (e.g., Cuban, Mexican)[6]. We end with a discussion of implications for genetics research, including issues of population stratification, sample size, disaggregation, admixture, and the interplay of genetic and environmental factors in understanding the etiology and treatment of addictions.

Method

The search involved use of Proquest, including two databases (PsycINFO and MEDLINE) to examine articles published by April, 2016. Search terms included: (ethnic OR race OR Black OR "African American" OR "Asian American" OR Caucasian OR White OR "Native American" OR Hispanic OR Latino) AND (prevalence OR incidence) AND (co-occurrence OR comorbidity OR "co-occurring disorders" OR "co-occurring addictions"). In addition, we included terms for each addiction used in Sussman et al. (2011)[1] plus relevant terms from the *Diagnostic Statistical Manual of Mental Disorders—Fifth Edition* (DSM-5)[7]: 1) Alcohol: "alcohol dependence," "alcohol use disorder," alcoholism, 2) Tobacco: "tobacco addiction," "tobacco use disorder," "nicotine addiction," "nicotine dependence," 3) Marijuana: "marijuana abuse," "marijuana dependence," "marijuana use disorder," "cannabis dependence," "cannabis use disorder," 4) Illicit Substances: "illicit drug abuse," "drug abuse," "drug dependence," "drug addiction," "substance use disorder," 5) Gambling: "gambling addiction," "compulsive gambling," "pathological gambling," "gambling disorder," 6) Eating: "overeating addiction," "food addiction,'' "eating addiction," "binge eating disorder," "overeating dependence," "eating disorder," "feeding disorder," 7) Internet: "internet addiction," "web addiction," "pathological internet use," "video game addiction," 8) Love: "love addiction," "pathological love," "sexual dependency," 9) Sex: "sex

addiction," "sexual compulsivity," 10) Exercise: "physical activity addiction," "exercise addiction," 11) Work: "workaholic," "workaholism," "work addiction," and 12) Shopping: "shopping addiction," "compulsive shopping."

Titles were examined first to screen potential articles, followed by abstracts and then manuscripts. The reference sections of manuscripts were examined for additional references not located in the searches. If few relevant articles were found, other terms were attempted (e.g., ethnic subgroups like "Mexican American" or "Chinese American") or only the addictive behavior was searched without pairing it with the prevalence or co-addiction terms.

We established a set of inclusion and exclusion criteria to retain a variety of studies but also to permit some type of comparability across studies. First, all publications had to be peer-reviewed articles. Second, we attempted to include only studies that reported a sample size of at least 500 participants to avoid the most selective, convenient samples[8]. If few studies were found for a particular addictive behavior, however, we included studies with smaller sample sizes. Third, we focused our age range predominantly on adults of 18+ years of age to better capture prevalence of addictions from the start of emerging adulthood into middle/older adulthood. Fourth, we included only prevalence studies that examined both males and females, and removed studies with particularly selective samples (e.g., inpatients). Fifth, we focused on more recent studies of addictive behaviors (i.e. those since the DSM-IV was published in 1994), given the revisions to diagnostic criteria for addictions over the past several decades and the availability of recent large national studies that have examined ethnic differences in addictions.

Results

Alcohol

We located a total of 206 articles through the initial database search. From these, 14 articles were retained, and an additional six were included from reference sections and additional searches.

Prevalence—The most recent prevalence data for alcohol addiction among US ethnic groups have come from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), a study sponsored by the National Institute of Alcohol Abuse and Alcoholism (NIAAA) that has interviewed a nationally representative sample of adults (18+ years of age) at three time points: between 2001–2002 on 43,090 individuals (Wave I), in 2004–2005 in a replication study on 35,653 of the original Wave I participants (Wave II), and in 2012–2013 on an additional 36,309 adults (Wave III). NESARC publications have primarily reported racial/ethnic results stratified into five groups: Asian (including Asian, Native Hawaiian, and Pacific Islander), Black, Hispanic, Native American (American Indian and Alaska Native), and White. In the total sample of NESARC-III, past-year and lifetime prevalence of DSM-5 alcohol use disorder (AUD) were 13.9% and 29.1%, respectively, and past-year and lifetime DSM-IV AUDs (abuse or dependence) were 12.7% and 43.6%, respectively[9]. These numbers indicate an increase in DSM-IV AUDs from those found in NESARC-I of 8.5% and 30.3%, respectively, which is consistent with increased rates of heavy alcohol consumption found also during that 11-year period[10,11]. The relative pattern

among ethnic groups, however, was consistent across the two NESARC waves. Among the five ethnic groups, DSM-5 past-year and lifetime AUD in NESARC-III were highest in Native Americans (19.2%, 43.4%) and lowest in Asian (10.6%, 15.0%), with Whites (14.0%, 32.6%), Hispanic (13.6%, 22.9%), and Blacks (14.4%, 22.0%) in between. When adjusted for sociodemographic variables and compared with Whites as the reference group, Native Americans were approximately 1.3 and 1.5 times more likely, whereas Blacks were one fifth and one half less likely, Hispanics were one third and one half less likely, and Asians were one half and one third less likely to have past-year and lifetime DSM-5 AUD, respectively[9]. In NESARC-I, DSM-IV past-year and lifetime AUD were also highest in Native Americans (12.1%, 43.0%) and lowest in Asians (4.5%, 11.6%). Past-year DSM-IV AUD did not differ among the other ethnic groups, but lifetime AUD was higher in Whites (6.9%, 34.1%) than Hispanics (7.9%, 21.0%) and Blacks (6.9%, 20.6%). When adjusted for sociodemographic variables and compared with Whites as the reference group, Hispanics were 30% and 60% less likely, Blacks were about half as likely, and Asians were 60% and 80% less likely to have past-year and lifetime DSM-IV AUD, respectively; Native Americans did not significantly differ from Whites in adjusted models[10].

Grant et al[12] (2006) compared NESARC-I findings for past-year AUDs with data collected a decade earlier in the 1991–1992 National Longitudinal Alcohol Epidemiological Survey (NLAES, N = 42,862), a nationally representative sample of adults also conducted by NIAAA. Rank order among ethnic groups remained the same in these studies, with similar increases in past-year DSM-IV abuse in Whites (3.3% to 5.1%), Hispanics (2.5% to 3.9%), and Blacks (1.5% to 3.3%), but only significant decreases in dependence in Whites (4.4% to 3.8%), not in Hispanics (5.8% to 4.0%) or Blacks (3.8% to 3.6%). The ethnic group rank order is slightly different from data from the National Household Survey on Drug Use and Health (NSDUH, formerly the National Household Survey on Drug Abuse, NHSDA), which is series of cross-sectional annual surveys conducted by the Substance Abuse and Mental Health Services Administration on approximately 70,000 12+ year-old individuals each year. In the 2008 NSDUH survey, past-year DSM-IV AUD was 8.0% in Hispanics, 7.5% in Whites, and 6.6% in Blacks, with almost no change in past-year DSM-IV AUDs found in NSDUH total sample from 2002–2008[13]. In the 2005–2007 NSDUH surveys, past-year DSM-IV AUD prevalence was significantly different between Whites and Blacks, and Blacks and Hispanics[14]. Similarly, in the 2001 NHSDA survey, past-year DSM-IV AUD was 9.7% in Hispanic, 8.0% in Whites, and 6.0% in Blacks[15]. In the National Comorbidity Survey-Replication (NCS-R), a nationally representative sample of 9,282 adults interviewed in 2001–2003 by the Institute for Social Research at the University of Michigan, lifetime prevalence of DSM-IV AUD was significantly higher in Whites (13.4%, n = 4,180) compared with Blacks (9.5%, n = 717), with Hispanics at 15.0% (n = 527)[16]. Overall these data indicate lower prevalence of AUDs in Blacks compared with Whites and Hispanics, with similar rates among Whites and Hispanics that differ in rank order across national studies.

Several studies have examined US ethnic subgroups of Asian, Hispanic, and Native Americans. Using data from the 1991–1992 NLAES to examine Asian American subgroups, Price et al.[17] reported lifetime DSM-IV alcohol dependence was 12.8% in Japanese (n = 314), 10.1% in Filipino (n = 185), 9.7% in Korean (n = 123), 4.5% in Chinese (n = 230), and

3.4% in Vietnamese ($n = 89$) adults. The finding that Koreans were twice as likely to have lifetime dependence as Chinese is consistent with results in a college student sample that found 10% of Chinese ($n = 179$), 20% of Korean ($n = 194$), and 33% of White ($n = 305$) college students had a lifetime DSM-IV AUD[18]. Using NSDUH data from 1999–2002, Sakai et al.[19] found that among US lifetime alcohol users, past-year DSM-IV dependence was approximately 4% in full (single race) Native Hawaiian and Pacific Islanders, 3% in Koreans, 2% in Indians, Japanese, and Vietnamese, and 1% in Chinese and Filipinos, with higher prevalence in those who indicated multiple races compared with single race for Filipinos and Native Hawaiians. In the 2002–2003 National Latino and Asian American Study (NLAAS), frequency of lifetime DSM-IV AUDs in 2,095 Asian Americans varied by Filipino (4.2%), Chinese (1.5%), and Vietnamese (0.9%) ethnicity as well as by other Asian single ethnicity (4.4%) and mixed ethnicity (8.4%)[20].

In the Hispanic American Baseline Survey (HABLAS), a 2006 study of 18+ year-olds, differences were found in drinking patterns and problems among Mexican ($n = 1,288$), Puerto Rican ($n = 1,335$), Cuban ($n = 1,327$), and South/Central ($n = 1,274$) Americans[21]. For example, Mexican American men had higher rates of past-year dependence (15.1%) than South/Central American men (9.0%), with Puerto Rican men more similar to Mexican Americans at 15.3%, and Cuban Americans lowest at 5.3%. In women, Puerto Rican women (6.4%) had higher past-year dependence than Mexican (2.1%), Cuban (1.6%) and South/Central (0.8%) American women[22,23]. These relative differences are consistent with data from NESARC-I for lifetime prevalence of DSM-IV dependence in Mexican (9.8%, $n = 4,558$), Puerto Rican (7.0%, $n = 997$) and Cuban (4.0%, $n = 450$) Americans[12,22,24], as well as data from the NLAAS ($n = 2,554$ Hispanic) that find Puerto Rican Americans are at higher risk than Cuban Americans for lifetime substance use disorders including AUDs[23].

Native American tribes are diverse and show variation in AUD prevalence. Data collected from 1,660 individuals from seven tribes in 1998–2001 as part of the Ten Tribes study found past-year and lifetime rates of DSM-IV ranged substantially across the tribes[25]. For example, lifetime dependence was 21–56% in men and 17–30% in women in six of the tribes and only 1–2% in one tribe. In a study comparing DSM-IV AUDs in Southwest ($n = 1,446$) and Northern Plains ($n = 1,638$) tribes, past-year (4.5% vs. 9.8%) and lifetime (9.8% vs. 16.6%) prevalence of dependence significantly differed for the tribes[26].

Co-occurrence—We found two studies that examined past-year prevalence of co-use and co-morbidity of alcohol with nicotine and illicit drugs (10 classes including cannabis) among ethnic groups using NESARC-I data[27,28]. Past-year alcohol use was 74.3% in Whites, 70.0% in Hispanics, 66.5% in Native American, and 61.5% in Asian. Co-use of alcohol with nicotine was 34.0% in Native Americans, 29.4% in Whites, 24.8% in Blacks, 20.6% in Hispanic, and 18.1% in Asians, which indicates past-year nicotine use in 51.9% of Native American, 39.6% of White and Black, and 29.4% of Asian and Hispanic alcohol users[27]. Co-use of alcohol with drugs was 9.0% in Native Americans, 7.9% in Blacks, 7.4% in Whites, 5.5% in Hispanic, and 5.1% in Asians; this indicates drug use in 13.7% of Native American, 12.6% of Black, 10.0% of White, 8.3% of Asian, and 7.9% of Hispanic alcohol users[28]. When examining DSM-IV use disorders, past-year comorbidity of AUD with nicotine dependence was 7.0% in Native Americans, 4.6% in Whites, 3.2% in Blacks, 3.1%

in Asians, and 2.2% in Hispanics; this indicates nicotine dependence in 45.6% of Asians, 44.0% of Native Americans, 35.7% of Whites, 29.6% of Blacks, and 18.2% of Hispanics with a past-year AUD[27]. Past-year comorbidity of AUD with drug use disorders was 3.5% in Native Americans, 1.1% in Whites, Blacks, and Hispanics, and 0.7% in Asians, which indicates a drug use disorder in 28.9% of Native Americans, 15.9% of Blacks, 12.4% of Whites, 15.6% of Asians, and 13.9% of Hispanics with a past-year AUD[28].

Other studies have examined alcohol use and problems within those who have a drug use disorder (DUD)[14,29] or gambling problem[18,30,31], which we review in those sections. Other studies have examined both AUDs and DUDs, but have not reported their co-use or comorbidity[11,32–34]. We found no studies that examined co-occurrence of AUDs with eating, internet, love/sex, exercise, working, or shopping addictions.

Nicotine

We located a total of 191 articles through the initial database search. From these, five articles were retained, and one additional article was included from additional searches.

Prevalence—In the total US population, NESARC-I data indicated a past-year DSM-IV nicotine dependence prevalence of 12.8% in US adults[35], which was higher in Native Americans (33.6%) than in Whites (23.2%), Blacks (13.3%), Hispanics (7.1%), and Asians (7.0%)[36]. Within lifetime cigarette users, the pattern was similar, with 58.2% of Native Americans, 48.9% of White, 41.1% of Black, 35.5% of Hispanic, and 31.8% of Asian lifetime smokers being dependent[36]. These estimates also are consistent with earlier studies. In the 1991–1993 NHSDA surveys ($N = 87,915$), past-year DSM-IV nicotine dependence among past-month smokers was significantly higher among Whites (29.5%) than Blacks (23.1%) and Hispanics (21.6%)[37].

We found only one study that examined nicotine dependence among US ethnic subgroups. In a sample of smokers in Hawaii ($N = 919$), Native Hawaiians (5.6%) had higher rates of past-year nicotine dependence as indicated by the Fagerstrom Test of Nicotine Dependence than East Asians (4.9%), with Whites (5.2%) and Filipinos (4.9%) in between[38]. In a review of 39 studies published as of 2005 that disaggregated Asian American subgroups, great variability was found in smoking prevalence across groups, but prevalence of dependence was not examined[39].

Co-occurrence—In NESARC-I, among those who had past-year nicotine dependence, 22.8% also met criteria for an AUD and 8.2% for a drug use disorder in the past-year[40]. Among past-year tobacco users, co-use of alcohol in the past year was 81.7% of Whites, 81.5% of Asians, 81.3% of Hispanics, 79.2% of Blacks, and 68.5% of Native Americans[27]. Among those with past-year nicotine dependence, 37.3% of Asians, 31.4% of Hispanics, 29.3% of Whites, 27.1% of Blacks, and 26.5% of Native Americans also had a past-year AUD[27].

Cannabis

We located a total of 146 articles through the initial database search. From these, seven articles were retained, and an additional two were included from reference sections and additional searches.

Prevalence—In NESARC-III, past-year DSM-IV cannabis use disorder (abuse and dependence) prevalence was 2.9%, almost twice the prevalence in NESARC-I of 1.5%[41]. However, these rates represented 31% of past-year users in NESARC-III and 36% of past-year users in NESARC-I. Additionally, past-year and lifetime DSM-IV cannabis dependence in NESARC-I were 0.3% and 1.3%, respectively, and lifetime cannabis use disorder was 8.5%[29]. These NESARC-I rates are higher than those reported in the 1991–1992 NLAES that found past-year DSM-IV cannabis use disorders was 1.2%[42].

By ethnicity, DSM-IV prevalence of past-year and lifetime cannabis use disorder in NESARC-I were highest in Native Americans (3.4%, 15.4%), followed by Blacks (1.8%, 7.4%), Whites (1.4%, 9.3%), Hispanics (1.2%, 5.5%), and Asians (1%, 2.8%, respectively), with significant differences between Native Americans and Whites[29,43]. Between NESARC-I in 2001–2002 and NESARC-III in 2012–2013, DSM-IV past-year cannabis use disorders increased in most ethnic groups across the decades, but increases were only significant for Blacks and Hispanics[41]. Rates of past-year use disorders in NESARC-III were in similar rank order as in NESARC-I for Native Americans (5.5%), Blacks (4.6%), Hispanics (2.8%), Whites (2.7%), and Asians (1.3%). However, within past-year users, past-year cannabis use disorder was 35.8% in Black, 33.3% in Hispanic, 31.9% in Native American, 28.9% in White, and in 26.0% Asian users[41]. In the 2005–2011 NSDUH surveys ($N = 394,400$), Native Americans had the highest prevalence of past-year cannabis use disorders (3.7%), followed by Black (2.5%), Hispanic (1.8%), White (1.5%), Native Hawaiian/Pacific Islander (1.3%), and Asians (0.8%)[44]. In the 2008 NSDUH sample, among past-year adult marijuana users ($n = 6,917$), Hispanics (13.4%) and Blacks (12.3%) had higher rates of dependence than Whites (8.5%) and others (8.1%)[44]. These data also are consistent with earlier studies, including 1991–1993 NHSDA data, which estimated DSM-IV past-year cannabis dependence in 9.4% of Hispanics, 8.2% of Whites, and 7.8% of Blacks[45].

Prevalence of cannabis dependence also has been found to vary within Native American subgroups. Lifetime DSM-IV cannabis use disorder for Southwest (12.2% men, 4.5% women) and Northern Plains Indians (14.1% men, 9.4% women)[46] were only significantly different for Southwest females. In another sample of 525 Southwest California Indians, 33% met DSM-III-R criteria for lifetime cannabis dependence[47].

Co-occurrence—We found one article that examined comorbidity of cannabis use disorders with AUDs among ethnic groups. In the 2005–2007 NSDUH surveys, 8.8% of adult substance users met criteria for past-year co-occurring DSM-IV cannabis use disorder and AUD. The overlap between the two was significantly higher for Blacks (14.5%) compared with Whites (7.9%) and Hispanics (8.9%)[14].

Illicit Substances

We located a total of 200 articles through the initial database search. From these, 11 articles were retained, and an additional four were included from reference sections and additional searches.

Prevalence—Prevalence of DSM-5 past-year and lifetime illicit drug use disorder (DUD, based on amphetamine, cannabis, club drug, cocaine, heroin, other opioids, hallucinogen sedative/tranquilizer, and inhalants/solvent use disorders) in NESARC-III were 3.9% and 9.9%, respectively[49]. By ethnicity, past-year and lifetime rates were 6.9% and 17.2% in Native Americans, 5.9% and 9.9% in Blacks, 3.7% and 10.8% in Whites, 3.9% and 7.2% in Hispanics, and 1.4% and 4.0%, respectively, in Asians. Rates were lower in Hispanics and Asians for DUD compared with Whites[49], similar to rates for non-medical opioid use disorders when examined alone[50]. DSM-IV prevalence of past-year illicit drug use disorder (DUD, abuse and dependence) in NESARC-I was 2.0% in the total population. Rates in ethnic groups generally followed a similar pattern for past-year DUD as those in NESARC-III at 4.9% in Native Americans, 2.4% in Blacks, 1.9% in Whites, 1.7% in Hispanics, and 1.4% in Asians. Native Americans were significantly higher than all other ethnic groups studied[28]. Lifetime DUD in the total population was 10.3% and was highest in Native Americans at 18.4%, followed by Whites at 11.3%, Blacks at 8.7%, Hispanics at 7.2%, and Asians at 3.8%[51].

In the 2004 NSDUH, past-year prevalence of DSM-IV DUD was higher overall, but followed a similar pattern of 7.3% in Native Americans, 3.6% in Blacks, 3.0% in Hispanics, and 2.6% in Whites, with no statistical differences between 2002 and 2003 or 2003 and 2004 data[52]. After adjusting for sociodemographic variables, Hispanics were 10% less likely and Blacks were 37% more likely than Whites to have a DSM-IV DUD in the 2002 NSDUH survey[52]. When each drug was examined individually in the 2005–2007 NSDUH surveys, only DSM-IV cocaine disorders were significantly different among ethnic groups, with Whites (2.0%) having higher rates of past-year cocaine abuse and dependence than Hispanics (0.8%) and Blacks (0.6%)[10]. In the 2001–2003 NCS-R, lifetime prevalence of DSM-IV DUD was significantly higher in Whites (14.8%) compared with Blacks (10.8%), with Hispanic at 16.1%[16].

Several studies have examined ethnic subgroups. In the 1999–2002 NSDUH surveys among lifetime alcohol users, past-year DSM-IV illicit drug dependence was approximately 1.5% in full (single race) Native Hawaiian and Korean, 1% in Pacific Islander and Vietnamese, and 0.5% in Chinese, Filipino, Indian, and Japanese Americans[19]. Wu & Blazer's[53] review of population-based studies published between 2010–2015 found Asian Americans as a whole have a lower prevalence of DUDs compared with other ethnic groups, but sample sizes were too small to compare rates of DUDs within Asian American subgroups. Among Hispanics in NESARC-I[22,24], lifetime DSM-IV drug dependence was significantly higher in Puerto Rican (3.3%) than in Mexican (1.8%) and Cuban (1.0%) Americans. Lipsky and Caetano[52] reviewed national survey data on Hispanic American drug use through 2009, but did not examine DUDs. We found only one study that examined Black subgroups. In the 2001–2003 National Survey of American Life, a similar prevalence of lifetime DSM-IV alcohol and

drug dependence combined was found in Black (4.9%, *n* = 3,570) and Caribbean Black (4.1%, *n* = 1,621) American adults[54]. In Native Americans, lifetime DSM-IV DUD was similar for Southwest (14.0% men, 5.4% women) and Northern Plains Indians (15.4% men, 10.9% women), with only Southwest females significantly lower than the other three groups[46].

Co-occurrence—We found two studies examining co-use and comorbidity of DSM-IV DUDs with other addictions among ethnic groups. In NESARC-I, past-year comorbid AUD and DUD was highest in Native Americans at 3.5% and lowest in Asians at 0.7%, with Whites, Blacks, and Hispanics in between at 1.1%[55]. In the 2005–2007 NSDUH, of those who had a past-year DUD, 87% also had an AUD, including 89% of Hispanics, 88% of Whites, and 78% of Blacks[14]. Nine percent of those with a DUD had both AUD and cannabis use disorder, including 14% of Blacks, 9% of Hispanics, and 8% of Whites, which indicates that 18.6% of Blacks, 9.9% of Hispanics, and 8.9% of Whites with a past-year AUD also had a cannabis use disorder[14].

Pathological Gambling

We located a total of 22 articles through the initial database search. From these, five articles were retained, and an additional three were included from reference sections and additional searches.

Prevalence—Data from the NESARC-I sample estimated the lifetime prevalence of DSM-IV pathological gambling as 0.4%[37], which was found to vary across racial and ethnic groups[23]. Lifetime prevalence of pathological gambling Blacks was 0.9%, which was significantly higher than among Whites at 0.4% and Hispanics was 0.3%[23]. The lifetime prevalence among Native Americans and Asians combined was 0.6%, which did not differ from any of the other ethnic groups. Lifetime prevalence of disordered gambling (defined as 3 or more DSM-IV criteria) in Native Americans/Asians (2.3%) and Blacks (2.2%) was almost twice the rate in Whites (1.2%) and Hispanics (1.0%)[30]. Past-year prevalence of disordered gambling also was significantly higher among Blacks (1.0%) than Whites (0.5%), and Whites than Hispanics (0.4%)[56,57]. These NESARC-I estimates are generally consistent with data from the 2001–2003 NCS-R, which estimated the lifetime prevalence of DSM-IV pathological gambling as 0.6% and found Blacks were 8.4 times more likely to have pathological gambling than non-Hispanic Whites[58].

Data from a community sample of 718 Native American and 510 Hispanic veterans in the southwest and north central regions of the US estimated a lifetime prevalence of DSM-IV pathological gambling as 9.9% in the Native American veterans and as 4.3% in the Hispanic veterans[59]. In a study of 161 Northern Plains Native Americans compared with 102 non-Native Americans from the same region, 2.8% of the Native Americans and 1.6% of the non-Native Americans met lifetime DSM-III-R criteria for pathological gambling[60]. Using a cutoff score of 5 on the South Oaks Gambling Screen (SOGS[57]) to indicate lifetime probable pathological gambling, 9.6% of the Native Americans were identified as problem gamblers compared to 5.6% of the non-Native Americans. One other study estimated the prevalence of pathological gambling in ethnic subgroups. Luczak and Wall[18] assessed

gambling behavior among 179 Chinese, 194 Korean, and 305 White college students from one university in California. Lifetime probable pathological gambling as indicated by the SOGs was significantly higher in Chinese (6%) and Koreans (7%) compared with Whites (2%).

Co-occurrence—Three studies were identified that examined the comorbidity of pathological gambling and DUDs among ethnic groups[18,56,57]. Barry and colleagues[56] found risk for comorbid past-year pathological gambling was not significantly different for Blacks and Whites for AUD (odds ratios, OR, of 4.3 for Blacks vs. 6.2 for Whites), DUD (3.4 vs. 2.9), nicotine dependence (3.1 vs.7.1), and any substance use disorder (AUD or DUD, 4.2 vs. 6.7), although Blacks had a significantly stronger relationship between subsyndromal gambling and any substance use disorder than Whites. Similarly, Barry and colleagues[57] found ORs that were not significantly different for Hispanics and Whites for past-year pathological gambling with AUD (6.81 for Hispanics vs. 6.21 for Whites), DUD (1.75 vs. 2.90), nicotine dependence (7.13 vs. 7.14), and any substance use disorder (3.67 vs. 6.74), although Hispanics had a significantly stronger relationship between subsyndromal gambling and any substance use disorder as well as nicotine dependence than Whites. Luczak and Wall[18] found lifetime probable pathological gambling was significantly related to DSM-IV AUDs among Chinese men (OR =13.33) and White men (OR = 9.36), but not among Korean men (OR = 2.53), but no associations were significantly different for women.

Food Addiction

We located a total of 24 articles through the initial database search. From these, four articles were retained, and no additional articles were included from reference sections or additional searches.

Prevalence—Prevalence of DSM-IV lifetime binge eating disorder (BED), a proxy for food addiction, has been estimated at 1–3%[62,63]. In a St. Louis community sample of 18+ year-olds (55% female) assessed in 2001–2002, past-year prevalence of probable DSM-IV BED did not significantly differ for Whites (6.9%, $n = 739$) and Blacks (4.5%, $n = 133$)[64]; associations of AUD and tobacco dependence with BED also were assessed, but not reported by ethnicity. Smith et al.[65] examined current (past 3–6 month) DSM-IV BED in a biracial epidemiologic study of 3,948 individuals (55% women, 48% Black) aged 28–40 years in 1995–1996. The total sample BED prevalence was 1.5%, and Black men (0.4%) had significantly lower BED rates than Black women (2.2%), White women (2.0%), and White men (1.2%). In the 2007 National Institutes of Mental Health Collaborative Psychiatric Epidemiology Surveys (NIMH CPES), prevalence of DSM-IV BED was 2.7% in Asians ($n = 972$) and 1.0% in non-Hispanic Whites ($n = 7,487$), which were not significantly different[66]. The 2009–2011 Nurses' Health Study II (NHS-II) examined DSM-IV BED in a national sample of 73,289 45–64 year-old women using the Yale Food Addiction Scale[67]. BED prevalence was 8.4% in the total sample and was significantly higher in Whites (8.5%) than Blacks (6.3%), with Hispanics similar to Whites at 7.6% and Asians at 2.9%[68].

We found only one study that examined BED within ethnic subgroups. In 972 Asian Americans in the 2007 NIMH CPES, the adjusted odds ratio for DSM-IV BED was 0.9 in

Chinese, 2.0 in Filipinos, and 0.6 in Vietnamese when using other Asians as the reference group, but group differences were not significant[66].

Co-occurrence—We found no food addiction studies examining its comorbidity with other addictions across ethnic groups.

Internet

We located only one article through the initial database search, which was not retained. Through additional searches we found one empirical study that examined ethnic differences in internet addiction in adults.

Prevalence—In a systematic review of 68 empirical papers published between 2000–2013 on internet addiction[67], only one study was found that reported ethnicity was associated with internet addiction in adults. This study of 1,470 college students (63% female, mean age 19.1 years) found a higher prevalence of internet addiction among Asians (8.6%; 46% of the sample) compared with non-Asians (3.8%)[70].

Co-occurrence—We found no internet addiction studies examining its comorbidity with other addictions among ethnic groups.

Sex

We located only one article through the initial database search, which was not retained. Through additional searches we found only one empirical study that examined ethnic differences in sex addiction.

Prevalence—In their 2000 review of sexual addictions, Ragan and Martin[71] noted that ethnic and cultural differences in sexual addictions are almost totally unknown. In a study of online sexual addiction in college men ($N = 1,441$; 9.6% response rate), a multiple regression analysis found being Black ($n = 165$) was a significant predictor of at-risk behaviors for online sexual addiction, but ethnicity only accounted for less than 1% of the variance[72]. In this study, 8.6% were categorized as at-risk for online sexual addiction and 8% for compulsive sexual behavior, but these rates was not reported by ethnicity.

Co-occurrence—We found no love/sex addiction studies examining its comorbidity with other addictions among ethnic groups.

Love

We located no articles through the initial database search or through additional searches. We found no love addiction studies examining its comorbidity with other addictions among ethnic groups.

Exercise

We located no articles through the initial database search or through additional searches. We found no exercise addiction studies examining its comorbidity with other addictions among ethnic groups.

Work

We located no articles through the initial database search. Through additional searches we found one study that examined ethnic differences in work addiction.

Prevalence—There has been almost no discussion of workaholism as a function of ethnicity[73]. In a convenience sample study of employees in North Carolina (88% response rate), no mean differences in workaholism were found for 79 Black ($M = 59$) and 108 White ($M = 61$) employees using the Work Addiction Risk Test[74]. Prevalence of workaholism based on a cut score was not reported.

Co-occurrence—We found no work addiction studies examining its comorbidity with other addictions among ethnic groups.

Shopping/Buying

We located only one article through the initial database search, which was retained. Through additional searches we found one additional meta-analysis study.

Prevalence—Koran estimated the prevalence of compulsive buying to be 5.8% in a national household survey conducted in 2004 on 2,513 18+ year-old adults[75]. In logistic regression analyses, ethnicity was not a significant predictor of compulsive buying status. In a meta-analysis examining 63 empirical studies of consumer impulse buying from 1978 through 2012, six studies investigated ethnic differences and the results were inconclusive[76]. These six individual studies were not specified, however, and could not be located.

Co-occurrence—We found no shopping/buying addiction studies examining its comorbidity with other addictions among ethnic groups.

Discussion

This review indicates very little research has examined the interrelationships of addictive behaviors among US ethnic groups. We summarize the overall findings in Table 1. In Table 2, we show results from NESARC-I, which has provided the most comprehensive recent set of publications on addictions and their comorbidities in US ethnic groups. Overall, our findings from this review suggest differences among US ethnic groups in rates of use, in prevalence of addictions, and in prevalence of addiction among those who use substances or engage in gambling.

The majority of the studies that exist have focused nearly exclusively on comorbidity of substances and gambling behaviors. In these studies, both past year and lifetime rates of alcohol, nicotine, and drug use disorders were consistently higher in Native Americans and lower in Asians, with Blacks, Hispanics, and Whites in between and varying by rank order across studies, timeframes, and the inclusion of covariates in analyses. The small amount of data on overlap suggested variability in the co-occurrence and comorbidity of addictive behaviors across ethnic groups, including higher comorbidity of some addictions for Asians (e.g., gambling and alcohol) and lower comorbidity for Native Americans (e.g., nicotine and drug) than found in other ethnic groups. Importantly, studies have largely focused on

concurrent addictions rather than lifetime comorbidity, making it difficult to examine substitution of addictions, which may represent different addictive phenotypes than do concurrently overlapping addictive behaviors. Taking into account rates of use, addiction, and the temporal pattern of co-occurrence and comorbidity of addictive behaviors across ethnic groups is important for understanding the etiology of addiction and warrants additional research.

We identified almost no ethnic group comparisons of addictive behaviors including eating/food, internet, sex, love, exercise, work, and shopping in the literature. Despite large-scale research efforts to examine addictive behaviors in the US, few studies have been published that examine these addictions by ethnicity, and even fewer examining co-occurrence and co-morbidity with other addictions among US ethnic groups. With the exception of eating disorders, most of these addictive behaviors are often overlooked or even not accepted as "addictions" by researchers and practitioners. The DSM-5, however, supports the conceptualization of these as behavioral addictions (e.g. sex, shopping, internet)[7], which calls for the need for more research on these behaviors, including neurobiological and epidemiologic studies, to validate their similarities and differences with other addictive behaviors. It is important to acknowledge that there is large literature on substance addiction overlap with other psychiatric disorders such as anxiety and mood disorders[77], but additional research is required to gain a more complete picture of the broader range of addictive behaviors and their overlap. We expect that forthcoming NESARC-III publications will provide updated prevalence of addictive behaviors in the US, and hope that these publications will include studies of ethnic group differences and multiple addictions.

Even with the limited studies, these findings have implications for genetic research on addictive behaviors. Population stratification is a critical issue in genetics research, which means that smaller racial/ethnic groups are often not assessed in genetic studies that require separation of groups when allele prevalences vary. Careful attention must be paid to differentiating genetic effects within and across ethnic groups. The research indicates not only variation in addiction prevalence and comorbidity across the five major US ethnic/racial categories, but also within ethnic subgroups categorized broadly as Asian, Hispanic, and Native American, and indicates the need to further disaggregate ethnic groups when researching the genetics of addictions. The typically smaller sample sizes for ethnic minority groups result in lower power to detect significant relationships in these groups, but the consistency of effect sizes across ethnic groups can serve as indicators of the stability of the relationships across groups and suggest potentially different etiologies. When effect sizes are consistent across groups, this provides support for the generalizability of the genetic-phenotypic relationships. When effect sizes differ across groups, this suggests the possibility of additional genetic and environmental explanations for the relationship, including gene-environment effects; furthermore, in the case of candidate genes when the function of the gene is not established, group differences may be due to ethnic group differences in linkage disequilibrium of the initially identified gene with an actual functional gene.

In addition, the issue of admixture within ethnic groups has been identified as an increasingly important factor to consider in US ethnic groups including Native Americans[78] and Blacks[79], but admixture rates also vary across other ethnic groups and studies also differ

in their inclusion criteria for ethnic group membership (e.g., 50%, 75%, full heritage required). Both sample and study characteristics have been shown to moderate gene effect sizes[80], and as ethnic groups become less homogeneous, the issue of admixture may further affect ability to detect genetic-phenotypic relationships. The use of ancestral identification markers to estimate admixture proportion allows admixture to be used as a covariate to reduce genetic heterogeneity and enhance detection of genetic associations[79].

Genetic research provides the opportunity to examine how both genetic and environmental factors are associated with the etiology of addictions. As shown in several of the studies reviewed[10,52], adjusting for sociodemographics altered the patterns of relationships, for example with Whites no longer having significantly lower likelihood of AUDs than Native Americans and instead having higher likelihood than Blacks and Hispanics. This highlights the importance of examining the role of environmental factors on prevalence and co-occurrence of addictive behaviors. Testing models like the PACE framework, which incorporates genetic, biological, environmental, situational, and learning factors that may vary across ethnic groups, will improve our understanding of the complex interplay among risk and protective factors involved in the development of addictive behaviors. Elucidating how these factors are related to addictive phenotypes based on patterns of use and comorbidity, including their similarity and differences across ethnic groups, will further our understanding of common and unique mechanistic pathways in the etiology of addictions.

This research also has clinical implications for treating individuals who have developed one addiction, multiple addictions, or a series of addictions. Having a better understanding of factors involved in the development of addictions, such as the function an addictive behavior serves for the individual, variations in physical responses to substances, and the negative consequences within the individuals' broader context/environment, can assist clinicians in designing individualized, targeted treatment plans.

Given this review's findings that there are variations in both the co-occurrence of use and the comorbidity of addictions among ethnic groups, it is clear that genetic research on these relationships will be complicated to tease apart. Examining genetic-phenotypic relationships within and across ethnic groups is a crucial step toward improving our understanding of gene, gene-environment, and gene-gene effects on addictive behaviors.

Acknowledgments

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Table 1

Summary of Prevalence and Co-occurrence of Addictions Among Ethnic Groups

Addiction	Number of Studies	Relative Prevalence Among Ethnic Groups	Relative Co-occurrence Among Ethnic Groups
Alcohol	20	- Asians typically have lower prevalence of alcohol use disorders and Native Americans have higher prevalence, with Whites, Blacks, and Hispanics between - Across studies, diagnoses, time frames, and inclusion of model covariates, rank order of Whites, Blacks, and Hispanics vary, with some indication of Blacks having lower prevalence than Whites and Hispanics - Within Asian Americans, Chinese and Vietnamese have lower rates than Japanese and Koreans - Within Hispanic Americans, Cubans and South Americans have lower prevalence than Mexicans and Puerto Ricans - Within Native Americans, prevalence ranges vary substantially across tribes	- Co-use of alcohol with nicotine and with drugs is lower in Asians and higher in Native Americans, with Whites, Blacks, and Hispanics between - Co-morbidity of alcohol use disorders with nicotine dependence and with drug dependence was higher in Native Americans than the other four main US ethnic groups
Nicotine/tobacco	6	- Hispanics and Asians have lower prevalence of nicotine dependence and Native Americans have higher prevalence, with Whites and Blacks between - Within Hawaiian smokers, Native Hawaiians have higher levels of dependence than White, Filipino, Asian, and other ethnicities	- Among tobacco users, co-use of alcohol was high in all five ethnic groups, but was lower in Native Americans - Among those with tobacco dependence, comorbidity of alcohol use disorders was similar in all ethnic groups, but was higher in Asians
Marijuana/cannabis	9	- Asian Americans typically have lower prevalence of cannabis use disorders and Native Americans have higher prevalence - Across studies, diagnoses, and time frames, rank order of Whites, Blacks, and Hispanics vary, with some indication more recently of Blacks having higher prevalence than Whites and Hispanics	- Co-morbidity of cannabis and alcohol use disorders was higher in Blacks than Whites and Hispanics
Drugs/illicit substances	15	- Asian Americans typically have lower prevalence of drug use disorders and Native Americans have higher prevalence - Rank order of Whites, Hispanics, and Blacks vary, with some indication Whites have higher prevalence than Hispanics - Among Hispanic Americans, drug dependence was higher in Puerto Rican than Mexican and Cuban Americans	- Comorbidity of drug and alcohol use disorders was lower in Asians and higher in Native Americans, with Blacks, Whites, and Hispanics between
Gambling	8	- Blacks typically have higher prevalence of pathological gambling than Whites and Hispanics, with Whites having higher prevalence than Hispanics in some studies - Native Americans have higher rates than non-Native Americans and than Hispanics - Asians have higher probable pathological gambling than Whites	- Compared with Whites, no differences were found for Blacks and for Hispanics in pathological gambling comorbidity with alcohol use disorder, drug use disorder, nicotine dependence, or any substance use disorder - Probable pathological gambling was more strongly associated with alcohol use disorders in Chinese

Addiction	Number of Studies	Relative Prevalence Among Ethnic Groups	Relative Co-occurrence Among Ethnic Groups
			men compared with Korean men, with White men between
Food/eating	4	- Whites have higher prevalence of binge eating disorder than Blacks in some but not all studies, with Hispanics between - Asians have lower prevalence of binge eating disorder than Whites in some but not all studies, with similar prevalence among Asian subgroups	- No ethnic-specific data for co-occurrence with other addictions
Internet	1	- One study found Asians have higher prevalence of internet addiction than non-Asians	- No ethnic-specific data for co-occurrence with other addictions
Sex	1	- One study found being Black compared with non-Black was a risk factor for online sexual addition, but had low predictive value	- No ethnic-specific data for co-occurrence with other addictions
Love	0	- No ethnic-specific data for prevalence was located	- No ethnic-specific data for co-occurrence with other addictions
Exercise	0	- No ethnic-specific data for prevalence was located	- No ethnic-specific data for co-occurrence with other addictions
Work	1	- One study found no difference between Blacks and Whites	- No ethnic-specific data for co-occurrence with other addictions

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Table 2

NESARC-I Past-Year and Lifetime Prevalence and Comorbidity of DSM-IV Addictions Among Ethnic Groups

	Past Year						Lifetime					
	Asian	Black	Hispanic	Native American	White	Total	Asian	Black	Hispanic	Native American	White	Total
Alcohol use disorder	4.5	6.9	7.9	12.1	6.9	8.5	11.6	20.6	21.0	43.0	34.1	30.3
-comorbid with nicotine dependence	3.1	3.2	2.2	7.0	4.6							
-comorbid with drug use disorder	0.7	1.1	1.1	3.5	1.1							
Nicotine dependence	7.0	13.3	7.1	33.6	23.2	12.8						
-comorbid with alcohol use disorder	2.6	3.6	4.2	8.9	6.8							
Cannabis use disorder	1.0	1.8	1.2	3.4	1.4	1.5	2.8	7.4	5.5	15.4	9.3	8.5
Drug use disorder	1.4	2.4	1.7	4.9	1.9	2.0	3.8	8.7	7.2	18.4	11.3	10.3
Disordered gambling		1.0	0.4		0.5			2.2	1.0		1.2	