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An Exploratory Analysis of Psychological and Genetic Based Outcomes Related to Binge Drinking and Binge Eating Behaviors in a College-Age Population

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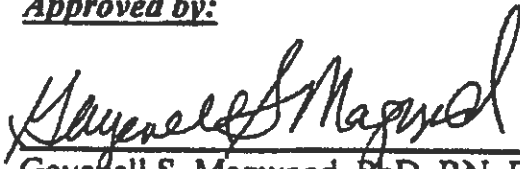Follow this and additional works at: https://medica-musc.researchcommons.org/theses

**An Exploratory Analysis of Psychological and Genetic Based Outcomes
Related to Binge Drinking and Binge Eating Behaviors
in a College-Age Population**

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A dissertation submitted to the faculty of the Medical University of South
Carolina in partial fulfillment of the requirements for the degree of Doctor of
Philosophy in the College of Nursing.

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ABSTRACT

Purpose

The purpose of this dissertation was to explore psychological and genetic associations of binge drinking and eating in college-age individuals, and to assess if overlap exists across phenotypes. Key contributing factors of binge drinking and binge eating informed the development of a hypothesized biobehavioral conceptual framework for binge behavior. Next, an integrative review of existing instruments that measure binge eating was conducted to observe concepts related to binge eating as applied clinically. Finally, a secondary analysis was carried out to investigate the phenotypes of interest in a study aim that focused on key concepts in the framework from survey data as well as an aim that investigated physiological concepts by way of genetic data.

Problem

Binge drinking and eating are prevalent behaviors in our society and within the college-age population. Binge eating rates are increasing, and binge eating disorder (BED) was included as a primary diagnosis in the current edition of the Diagnostic and Statistical Manual of Mental Disorders, the DSM-5. Little is known about the etiology of binge eating; however, binge eating is regularly equated to substance use disorders in the literature.

The specific aims of the dissertation study were to determine:

Aim 1: If binge behaviors are associated with stress, impulsivity, and health outcome risks of obesity, anxiety, and depressive symptoms.

Aim 2: If shared single nucleotide polymorphisms (SNPs) present for binge drinking and binge eating from a Genome-Wide Association Study (GWAS) and a candidate gene approach.

Design

A secondary analysis of cross-sectional self-report data was conducted to achieve aim one within the framework of a mediation analysis, while a Genome-Wide Association Study (GWAS) was conducted to achieve aim two.

Findings

Binge as a mediator applied to binge eating but not to binge drinking. Females demonstrated higher rates of binge eating, anxiety, and depressive symptoms than males. Overweight and obese participants were more likely to binge eat than binge drink. Racial differences showed that more Whites binge drink compared to Asians, Blacks, and Hispanics. No racial differences were noted among binge eating outcomes.

No genetic overlap was noted among phenotypes nor was statistically significant output noted for the binge drink GWAS. Gene-based significance for binge eat included the following: *PURG, LYPD5, SKAP2, TRAPPC1*, and *NCOA2*.

Conclusions

While binge drinking and binge eating are prevalent behaviors in college-age youth, binge eating shows heightened associations to pathologies without taking frequency into account. For the GWAS, preliminary analyses suggest that the binge drinking phenotype was oversaturated. It is probable that risky drinking behaviors were inseparable from problem drinking at this age by forming the phenotype from a binary approach assessing binge drinking within a month.

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Introduction

The primary research goal of this study was to determine if there is evidence of shared genetic variation for binge drinking and binge eating and to determine whether binge drinking and binge eating are associated with identified psychological and health risk outcomes in college-age individuals. Researchers performed a secondary analysis of data from fall and spring cohorts in years 2011-2013 of the *Spit for Science* database, consisting of 4107 individuals, to test psychological-based variables common to binge drinking and binge eating behaviors in order to inform future prospective studies and to enhance understanding surrounding the etiology of binge drinking and binge eating. They also conducted a Genome-Wide Association Study (GWAS) using fall participant data consisting of 2386 individuals to assess phenotypes from a hypothesis-free and hypothesis-directed genetic approach.

The aims of this secondary data analysis of the *Spit for Science* project at Virginia Commonwealth University were to determine:

1. If binge behaviors are associated with stress, impulsivity, and health outcome risks of obesity, anxiety, and depressive symptoms.

2. If shared single nucleotide polymorphisms (SNPs) present for binge drinking and binge eating from a Genome-Wide Association Study (GWAS) and a candidate gene approach.

Binge eating and binge drinking are common behaviors in the college-age population, and the onset of lifetime problems associated with these behaviors is likely to occur during college years (Dakanalis et al., 2014; Kessler et al., 2007; Kessler et al., 2013; Kuntsche, Kuntsche, Thrul, & Gmel, 2017). Binge Eating Disorder (BED) has

become the most prevalent eating disorder in society, with 3.5% of females and 2.0% of males demonstrating a lifetime prevalence for the disorder (American Psychiatric Association, 2013; Blackburn, Johnston, Blampied, Popp, & Kallen, 2006; Hudson, Hiripi, Pope, & Kessler, 2007), and binge eating continues to increase rapidly in the population in industrialized countries (da Luz et al., 2017; Mitchison, Touyz, Gonzalez-Chica, Stocks, & Hay, 2017). Research indicates that binge eating is associated with an increased risk for obesity and poor outcomes from treatment for weight loss as well as multiple adverse health conditions (Dakanalis et al., 2014; Goldschmidt, Wall, Zhang, Loth, & Neumark-Sztainer, 2016; Tanofsky-Kraff et al., 2013).

Approximately 40% of undergraduate youth report binge drinking in the last month in the 2013 National Survey on Drug Use and Health conducted by the Substance Abuse and Mental Health Services Administration. Research designates that for 40% of individuals, alcohol dependence is established between ages 17 and 23, and alcohol misuse patterns in early adulthood are a strong predictor for emerging problems with alcohol abuse later in life (Adams, Milich, Lynam, & Charnigo, 2013; Dick et al., 2014).

Significant gaps exist regarding the etiology of Binge Eating Disorder (BED), which gained a diagnostic code and unique behavioral criteria in the most recent edition of the Diagnostic and Statistical Manual of Mental Disorders' Fifth Edition (DSM-5) largely due to the increasing prevalence of diagnosis for BED. An integrative review of existing instruments that measure binge eating was conducted to survey concepts related to binge eating as applied clinically in order to inform if the key concepts under study in the hypothesized Biobehavioral Model of Binge Behavior (Figure 1) are included in clinical evaluations for the behavior. Over the last two decades, a vast amount of

literature on BED has quickly assimilated. The rising state of the science on BED warranted a focused reassessment of BED measures, as accurate diagnosis and subsequent treatment cannot be made if the utilized measure does not capture the diagnostic criteria unique to the disorder. Given the inclusion of BED in the DSM-5 as a distinct diagnosis, and the availability of numerous self-report measures to assess disordered eating behaviors that include the component of BE, the integrative literature review (manuscript 1) aimed to provide a starting point for this dissertation study. The goal of this review was to synthesize the evidence of self-report measures that assess for BE behavior in adults and evaluate their utility as applied to the DSM-5 diagnostic criteria of BED as well as to support the overarching concepts under study as depicted in the Biobehavioral Model for Binge Behavior (Figure 1).

Addiction scientists have investigated the genetic influence of binge behaviors, and though evidence suggests that binge eating may be similar to alcohol abuse in that there are genetic addiction pathway associations to the disorder, limited studies exist that compare binge eating to binge drinking outcomes (Volkow, Wang, Fowler, Tomasi D, & Baler, 2011; Volkow et al., 2010). Binge eating and drinking behaviors are also linked to marked psychological distress and are thought to originate from a disruption in impulse control (Bauer & Ceballos, 2014; Coskunpinar, Dir, & Cyders, 2013; Eichen, Chen, Schmitz, Arlt, & McCloskey, 2016; Ferriter & Ray, 2011; Kane, Loxton, Staiger, & Dawe, 2004; Kessler, Hutson, Herman, & Potenza, 2016; Racine et al., 2013; Rush, Becker, & Curry, 2009; Stojek, Fischer, Murphy, & MacKillop, 2014). Common in college-age youth, binge eating and binge drinking are incipient disorders that place one at risk for an increase in secondary adverse health concerns such as substance use

disorder (SUD), obesity, anxiety, and depression in adulthood (Goldschmidt et al., 2016; Kessler et al., 2007; Kuntsche et al., 2017).

Spit for Science is a university-wide descriptive and cross-sectional study currently underway at a large, urban four-year university in the mid-Atlantic region of the United States (Dick et al., 2014). The research aims to understand pathways related to substance use and mental health outcomes. Substances of study include food, alcohol, drug use, and nicotine use. The research also collects genetic material to investigate how genes and/or environments affect behavior and substance use during the developmental phase of young adulthood. Participants complete a baseline survey and provide a genetic contribution in the fall or spring of their freshman year, and are invited to complete a follow-up survey in the spring of each subsequent year of their undergraduate education. Incoming freshmen age 18 years or older are invited to participate by completing an online survey that takes approximately 30 minutes, as well as providing a one-time contribution of a four-mL saliva sample for DNA processing that is collected after completion of the baseline survey. Approximately 70% of eligible students enrolled in this project in their freshman year, and of those, 98% of the participants provided a DNA sample (Dick & Hancock, 2015; Dick et al., 2014). Compensation in the amount of ten dollars is provided for the completion of each survey and the saliva sample. Baseline surveys during the fall and the spring from cohorts in years 2011-2013 were utilized for aim one of this secondary data analysis. This sample included 4107 participants after excluding those who did not have a genetic sample, did not endorse the questions of study, and/or had never ingested alcohol. Fall participants from this total were used for the genetic analysis (N = 2386).

The dissertation study aimed to investigate a hypothesized biobehavioral conceptual framework model of binge behavior as applied to the population of college-age youth (Figure 1). The genetic variation between binge eating and binge drinking was investigated, as were associations of binge to impulsivity, stress, and health outcome risks of obesity, anxiety, and depressive symptom indicators as graphically depicted in Figure 1. Covariates of sex, self-reported race/ethnicity, age, and fall/spring survey administration time were measured in the analyses. Maternal or paternal history of anxiety/depression or problem drinking was also reported.

For the primary study, the UPPS-P Impulsive Behavior Scale developed by Lynam, Smith, Cyders, Fischer, & Whiteside (2007) was included to measure five-factors of impulsivity domains: lack of perseverance, lack of premeditation, negative urgency, positive urgency, and sensation seeking. Lifetime stress was measured by a Stressful Life Events Scale (Kendler, Karkowski, & Prescott, 1999) that includes twelve event-based items on the overarching categories of "personal" or "network" based stressful events.

A mediation was conducted where impulsivity and perceived stress were treated as predictors of binge, with binge drinking and binge eating serving as mediators; and anxiety, depression and body mass index (BMI) serving as health outcome indicators. Heightened perceived stress as well as decreases in inhibitory control are common associations to binge eating and binge drinking (Adam & Epel, 2007; Annagur, Orhan, Ozer, Yalcin, & Tamarn, 2015; Bauer & Ceballos, 2014; Lyu, Zheng, Chen, & Jackson, 2017; Meule, de Zwaan, & Muller, 2017; Parylak, Koob, & Zorrilla, 2011; Sinha, 2012; Steiger & Thaler, 2016). Negative urgency, the tendency to act impulsively when

distressed, is predicted to influence binge eating (Hunt, Forbush, Hagan, & Chapa, 2017; Racine & Martin, 2016, 2017; Wolz, Granero, & Fernandez-Aranda, 2017); while sensation seeking is predicted to primarily influence binge drinking (Adan, Navarro, & Forero, 2016; Doumas, Miller, & Esp, 2017; Lac & Donaldson, 2016). Moreover, shared adverse psychological risks of heightened anxiety and depressive symptoms are demonstrated in the literature as consequences associated with binge eating and binge drinking. (Adam & Epel, 2007; Alexander, 2017; Becker & Grilo, 2015; Eichen, Chen, Boutelle, & McCloskey, 2017; Farstad, McGeown, & von Ranson, 2016; Kiecolt-Glaser et al., 2015; Koob et al., 2014; Laghi, Liga, Baumgartner, & Baiocco, 2012; Pedrelli, Collado, Shapero, Brill, & MacPherson, 2016; Raman, Smith, & Hay, 2013; Sehm & Warschburger, 2016; Stewart, Brown, Devoulyte, Theakston, & Larsen, 2006).

Psychological and physiological health concerns are common to both binge behaviors, however more research is needed to advance understanding about the association that these factors have with binge behaviors in college students (Kessler et al., 2013). This research investigated perceived stress, inhibitory control, anxiety, and depressive symptoms of college students who self-reported binge behaviors compared to students who did not self-report binge drinking and/or binge eating (aim 1) to address the observed research gap in the literature.

The genetic focus (aim 2) of the study was inspired by addiction theory as well as the state of the evidence related to binge eating and binge drinking as comorbid disorders, indicating that almost one-quarter of individuals with BED demonstrate a SUD within their lifetime, and approximately 2.7% of those with BED demonstrate the presence of a SUD simultaneously (Schreiber, Odlaug, & Grant, 2013). Moreover, in relatives of those with

BED, heightened levels of SUD have been demonstrated (Fortuna, 2010; Lilenfeld, Ringham, Kalarchian, & Marcus, 2008). Alcohol use disorders have been linked to genetic risk factors that predispose one to addiction of the substance (Awofala, 2013; Kendler et al., 2015).

The obesity epidemic led to research investigating physiological conditions that support the motivation of individuals to consume calorically dense foods. One branch of inquiry involves the reward circuitry system as supported in addiction science, illustrated by lay terms that emerged in connection to eating, such as "craving", "comfort foods" and "chocoholic". Addiction theorists argue that increased environmental availability of calorically dense foods interacts with individual biological make-up, predisposing some to be more susceptible to obesogenic influences (Baik, 2013; Johnson & Kenny, 2010; Stice, Yokum, Bohon, Marti, & Smolen, 2010; Volkow et al., 2010; Volkow, Wang, Tomasi, & Baler, 2013a; Volkow, Wang, Tomasi, & Baler, 2013b; Wise, 2013; Ziauddeen & Fletcher, 2013). However, research that investigates a human genetic predisposition to binge eating and the contested term "food addiction" is still in the early stages (Fortuna, 2010; Munn-Chernoff & Baker, 2016; Westwater, Fletcher, & Ziauddeen, 2016). This presents an opportunity to nurse scientists who are well positioned in holistic thinking to conduct such research within interdisciplinary teams.

Genetic research indicates that a polymorphism in the *Taq*IA allele of the dopamine 2 receptor (*D2R*) gene moderates responsively of reward circuitry and contributes to compensatory reward seeking behaviors, increasing the risk for substance misuse as well as maladaptive eating behaviors (Avena, Rada, & Hoebel, 2008; Benton, 2010; Fortuna, 2010; Stice et al., 2010). Those with one or two copies of the A1 allele have 30-40% less *D2R* than those without an A1 allele (Baik, 2013). Suggestion of associations of the A1 allele

predisposing risk for substance misuse and obesity remains a topic of debate in addiction literature (Baik, 2013). However, addiction literature widely supports that dopamine plays a key role in reward and associated behaviors that lead to reward gratification (Baik, 2013; Hebebrand et al., 2014; Volkow et al., 2013b). Studies also indicate that the *DRD4, OPRM1, 5-HTT* and *FTO* receptor genes have implications in a variety of addictive disorders grounded in impulsive behavior patterns, showing concurrent evidence of association to binge eating behavior (Calati, De Ronchi, Bellini, & Serretti, 2011; Castellini et al., 2017; Lichenstein et al., 2014; Smith & Robbins, 2013; Volkow et al., 2010; Volkow et al., 2013b; Volkow & Wise, 2005). The intention behind the genetic focus of the present research as stated in aim two was to investigate evidence for shared genetic variants among those who endorse binge behaviors compared to those who do not.

To date this is the first known study that investigates shared genetic variation in college-age individuals who self-report binge eating and/or binge drinking utilizing both a GWAS and a candidate gene approach. Alcohol is a food-based substance that demonstrates a genetic predisposition towards substance abuse for some individuals (Schreiber et al., 2013). Binge eating disorder and SUD share similar phenomenology including urges to engage in binging episodes that result in distress (Awofala, 2013). Moreover, because of similar neurobiology found in both food and alcohol based binge disorders, the same medications based on shared neurobiology have been examined and are used for treatment in both disorders (Schreiber et al., 2013). The study also has implications for obesity research in that those who binge eat are more likely to have an elevated body mass index. Interventions to counteract obesity have been largely ineffective, and obesity rates have grown to an epidemic proportion in the United States (U.S.), with one in three U.S. adults being obese; moreover,

the Centers for Disease Control and Prevention (2011) report that obesity rates continue to rise worldwide (CDC, 2011; Volkow, Wang, & Baler, 2011). Once exposed to a palatable food substance, some individuals may have more difficulty controlling their intake of highly palatable foods partly due to factors related to the motivation-reward based pathway, thought to be similar to that seen in binge drinking and SUD with alcohol ingestion. This study explores and helps clarify the shared etiology that contributes to binge eating and binge drinking in a college-age population. Findings may aid in the refinement of future studies and interventions by shedding light on physiological and psychological contributors to binge behaviors in college-age youth.

The manuscripts that follow capture the breadth of binge eating and the research aims as they pertain to binge drinking and binge eating. Again, manuscript one is an integrative review that focuses on existent measurements for binge eating disorder as a point of departure to gain understanding about the clinical definition and application of binge eating. The measurements are presented in a manner that speaks to those qualities that are unique to binge eating disorder, as opposed to binge eating as a component of bulimia nervosa or anorexia nervosa, binge type. Manuscript two is a report of findings of the biobehavioral conceptual framework that is under study in aim one, while manuscript three is a report of the genetic findings of aim two.
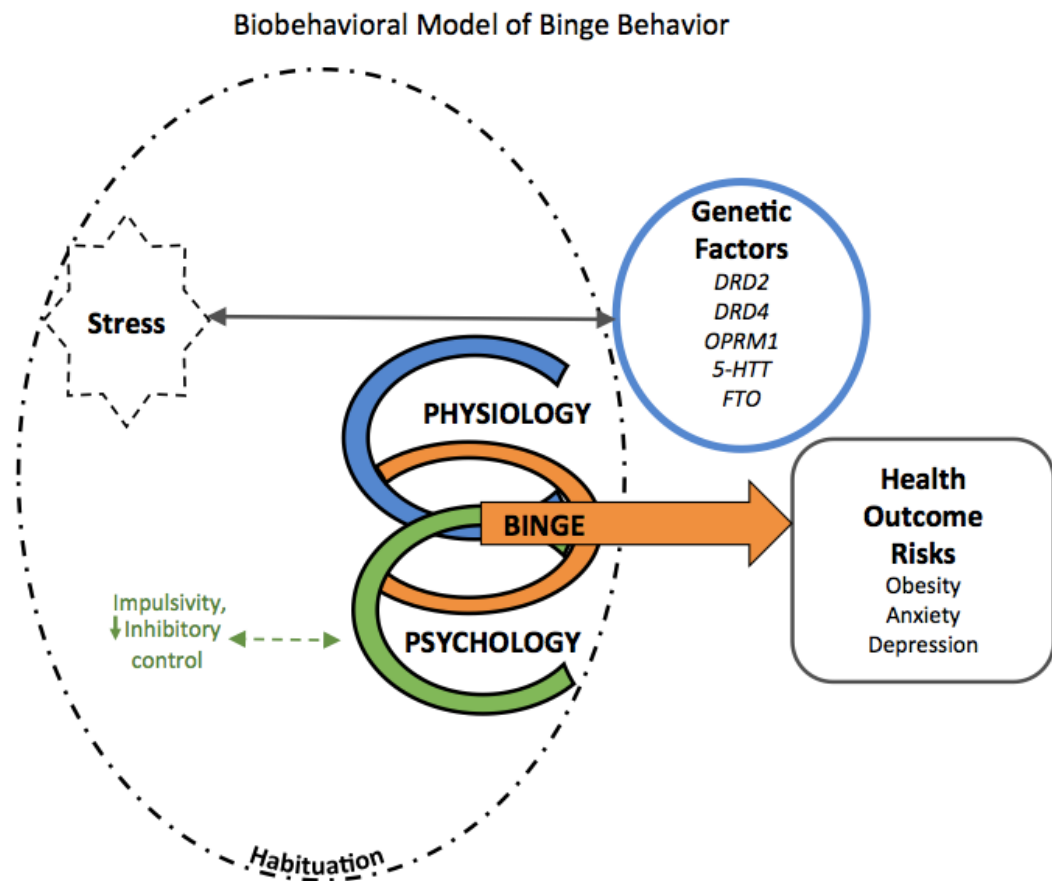
Figure 1: Biobehavioral Model of Binge Behavior

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Manuscript 1

Measurements for Binge Eating and Considerations Unique to

Binge Eating Disorder: An Integrative Review of the Literature

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Abstract

Objective: Binge eating disorder is linked with marked psychological distress and associated health problems, including a heightened risk for obesity. Binge eating disorder is now included in the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-5) as a distinct eating disorder diagnosis, and there are various self-report measures to assess disordered eating behaviors that include the component of binge eating. The aim of this integrative literature review is to synthesize the evidence of original self-report measures that assess for binge eating and evaluate their utility as applied to the DSM-5 diagnostic criteria for binge eating disorder.

Method: A systematic multi-stage search process was used to review the literature.

Results: A total of 945 manuscripts were identified with eleven meeting inclusion criteria for the final review.

Discussion: Many existing measures include diagnostic criteria for binge eating disorder but lack exclusive assessment of substrates unique to the disorder. Binge eating disorder measured within the context of instruments assessing alternate eating disorders that involve binge eating behavior may be problematic, complicating the establishment of accurate prevalence rates of binge eating disorder among the general population. Many measures of the disorder have been tested among treatment-seeking samples, further obscuring accurate assessment of prevalence rates of binge eating disorder in the general population. Measures to address these gaps may refine treatment planning and knowledge underlying the distinct eating disorder.

Key Words: Binge eating, binge eating disorder, eating disorder, measurement, psychometrics

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1. Introduction

Binge eating (BE) behavior is linked with marked psychological distress and associated health problems, including a heightened risk for obesity (Bulik, Sullivan, & Kendler, 2002; Striegel-Moore & Franko, 2008; Villarejo et al., 2012). In 2013, binge eating disorder (BED) received its own standing diagnosis in the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (APA, 2013). The process of ensuring accurate diagnosis of BED is complicated by multifaceted diagnostic factors that limit understanding of criteria associated with BED, and by measurement tools that incorporate diagnostic criteria related to BED as well as other eating disorders. Consensus on the best screening method for BED has not been reached (Mustelin, Karkkainen, Kaprio, & Keski-Rahkonen, 2016).

The operational definition of BE as applied to BED and bulimia nervosa (BN) is "…eating, in a discrete period of time, an amount of food that is definitely larger than most people would eat in a similar period of time under similar circumstances…and a sense of lack of control over eating during the episode" (APA, 2013, p. 345, 350). The operational definition of BE becomes complex, however, when quantified under different subsets of application. An objective binge episode (OBE) exists when there is loss of control and the amount of food is objectively large, whereas a subjective binge episode (SBE) exists when there is a loss of control but the amount of food consumed is not objectively large (Birgegard, Clinton, & Norring, 2013). The former is a defining characteristic of BED and BN, and the latter applies to diagnostic criteria of anorexia nervosa (AN) binge-eating purging type. Various eating disorders contain BE as a primary symptom for diagnostic criteria, including BN and the binge-purge type of AN.

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Thus, BE has been studied in the context of such eating disorders, and its measures

reflect the myriad ways that the behavior is applied.

The language "definitely larger" in the diagnostic criteria of BED and BN

complicates the diagnosis because studies indicate that gender, food-type consumed, and

social context may predicate what one considers the threshold for "definitely larger"

(Arikian et al., 2012; Forney, Holland, Joiner, & Keel, 2015, p. 15). Measures of eating

disorders often contain blended variables that assess defining characteristics of the binge

to determine whether it is an objective or a subjective binge (Birgegard, Norring, &

Clinton, 2014). The incorporation of various aspects that define a binge based upon the

perspective of the individual may be problematic in a measure, reducing its content

validity and ability to capture an accurate diagnosis.

Another defining characteristic that distinguishes BED from BN and the AN

binge-eating purging type is that persons diagnosed with BED do not engage in

"inappropriate compensatory behavior" (APA, 2013, p. 350) such as purging behavior or

excessive exercise after the binge episode. Language about engagement in inappropriate

compensatory behaviors within a measure for BED may have the potential to decrease

construct validity for the disorder. Key criteria for BED are that persons also

demonstrate loss of control over their eating as well as experiencing negative emotions

and guilt after the binge (Montano, Rasgon, & Herman, 2016).

Many tools that assess for the presence of an eating disorder blend diagnostic

criteria of multiple disorders within one instrument. Fairburn and Cooper's Eating

Disorder Examination (EDE) is a semi-structured interview that is in its seventeenth

edition and is considered by most to be the "gold-standard" to diagnose eating disorders

(Black & Wilson, 1996; Brewin, Baggott, Dugard, & Arcelus, 2014, p. 299; Cooper, Cooper, & Fairburn, 1989; de Man Lapidoth, Ghaderi, Halvarsson-Edlund, & Norring, 2007). The Eating Disorders Assessment for DSM-5 (EDA-5) is a semi-structured interview designed to diagnose feeding and eating disorders in the DSM-5, and its psychometric properties were tested against the EDE (Sysko et al., 2015). The EDE and the EDA-5 had a kappa of 0.90 for BED, and the EDA-5 appears to be a useful instrument for diagnosing BED and other eating disorders in clinical and research settings. The Structured Clinical Interview for DSM-IV (SCID-I) is another semi-structured interview that shows good psychometrics to obtain diagnoses for BED, AN, and BN (Mustelin et al., 2016). However, semi-structured interviews are time consuming and require substantial training, leading many providers and researchers to use the more common employment of self-report to form an initial assessment of behavior. Although interviews are advised as a complementary diagnostic measure to self-report, a debate remains as to whether interviews will illicit truthful responses over self-report measures in diagnostic evaluation, due to the shame-based characteristic of many who binge eat (Birgegard et al., 2013; Birgegard et al., 2014). Various self-report measures commonly used to assess BE demonstrate adequate reliability and validity and may serve as useful measurements to identify the presence of BE (Celio, Wilfley, Crow, Mitchell, & Walsh, 2004; Vander Wal, Stein, & Blashill, 2011). Accurate diagnosis is important to facilitate insurance coverage, treatment planning, and further development of the state of the science surrounding each unique disordered eating condition.

Over the last two decades, a vast amount of literature on BED has quickly assimilated. In this literature, BE has emerged within tenets of a biobehavioral addiction

framework that incorporates a physiological-based desire for palatable food options (hedonic hunger) to reward-based eating behavior among some BE types (Dalton, Blundell, & Finlayson, 2013; Epel et al., 2014; Manasse et al., 2015). The DSM-5 echoes literature that indicates an overlap between characteristics of BED and other eating disorders with patterns seen in addiction, yet also reports that "the relative contributions of shared and distinct factors in the development and perpetuation of eating and substance use disorders remain insufficiently understood" (APA, 2013, p. 329). BE also overlaps with addictive behaviors in that BED describes excessive consumption of a substance that is associated with temporary relief, followed by unwelcomed delayed consequences of psychological distress often manifesting as negative self-evaluation, social embarrassment, shame, guilt and depression (Birgegard et al., 2013; Raman, Smith, & Hay, 2013). Figure 1 describes the proposed theory underlying the biobehaviorally driven process of BED that manifests as a cycle, and looks very similar to addiction when applied to alternate known substances of abuse.

The rising state of the science on BED warrants a focused reassessment of BED measures. Accurate diagnosis and subsequent treatment cannot be made if the utilized measure does not capture the diagnostic criteria unique to the disorder. Given the recent inclusion of BED in the DSM-5 as a distinct diagnosis, and the availability of numerous self-report measures to assess disordered eating behaviors that include the component of BE, the aim of this integrative literature review is to synthesize the evidence of self-report measures that assess for BE behavior in adults and evaluate their utility as applied to the DSM-5 diagnostic criteria of BED.

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2. Methods

PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Science, and PsychINFO databases were utilized to search for literature reporting psychometric evaluation of self-report measures of BE using combinations of the following key terms: *binge eating, binge eating disorder, bulimia, instrument validation, questionnaires, reliability, reliable, reproducibility of results, self-assessment, self-report, statistical reliability, test validity, validation studies, and validity.* Databases were searched from 1980 to present. All studies that described a form of measurement related to BE were originally included. Studies were excluded if there was no full text English version, no strength of association specifically with BE, no psychometrics reported, no primary source of the measure available, or the sample was younger than 18 years of age. A summary of the systematic search of literature is described in Figure 2. Results were compared with the self-report measures for BE from the *Handbook of Assessment Methods for Eating Behaviors and Weight-Related Problems: Measures, Theory, and Research* (Tasca, 2009) to ensure inclusion of prominent measures and protection against selection bias.

3. Results

Based on evaluation and search criteria, eleven primary measurement instruments that assessed for BE were reviewed and included in Table 1. Reliability was assessed by review of internal consistency using Cronbach's alpha and test-retest measures in most reports. Validity was assessed diversely across measures including outcomes of concurrent validity, construct validity, and reported sensitivity and specificity measures.

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No original studies clearly outlined underlying theoretical frameworks as a composite of the measure.

The Binge Eating Scale (BES) was not originally developed to assess BED, but it appears to have value to predict binge-eating severity, and is largely used as an assessment of BE in bariatric surgery candidates (Grupski et al., 2013; Marek, Tarescavage, Ben-Porath, Ashton, & Heinberg, 2014). It has also been used to measure preoperative BE since the presence of BE has been shown as predictive of negative outcomes post surgery (Marek, Tarescavage, Ben-Porath, Ashton, & Heinberg, 2015). A limitation of the BES is that it does not assess the amount of food consumed nor the time frame in which the binge occurred, both of which are defining characteristics of BED as stated within the DSM-5 criteria as consuming an "unusually large" amount of food within a two-hour time period. Grupski et al. (2013) also reported that the BES, while viewed as a useful screening instrument for bariatric surgery candidates, also yielded a high false positive rate; and other researchers challenged sensitivity and specificity of the BES, with values at 85% and 20% reported in the literature (Celio et al., 2004). Yet the BES demonstrated promising sensitivity (81.8%) and specificity (97.8%) in a sample of 1008 Portuguese female college students (Duarte, Pinto-Gouveia, & Ferreira, 2015). This is worthy of mention since most screens for BE are tested in treatment seeking samples or in samples that contrast clinically ill patients to healthy participants.

Scales such as the Eating Disorder Diagnostic Scale (EDDS), the Eating Disorder Examination-Questionnaire (EDE-Q), and the Questionnaire of Eating and Weight Patterns (QEWP) appear to be valid and reliable measures of symptom composites for eating disorders with moderately encouraging psychometrics for specific

diagnostic criteria of BED (Aardoom, Dingemans, Slof Op't Landt, & Van Furth, 2012; Jacobi, Abascal, & Taylor, 2004; Stice, Fisher, & Martinez, 2004). The EDDS is a relatively new measure, and debate remains concerning discriminate validity in terms of a valid cut-off score to distinguish non-eating disordered behaviors from clinical eating disorder diagnoses (Krabbenborg et al., 2012). Stice et al. (2004) reported sensitivity and specificity of 88% to 98% in a follow-up study assessing psychometrics of the EDDS, though these values were condensed across all eating disorder diagnoses, making it difficult to distinguish specific psychometric characteristics for BED. Although the literature indicates that the EDDS is psychometrically sound, sensitivity, specificity, positive predictive value and negative predictive value for BED were lower than those for AN and BN, though still psychometrically acceptable (>.74) (Stice et al., 2000).

The QEWP (Spitzer et al., 1993) was examined because it was initially intended to identify persons with BED. Initial studies by Spitzer et al. (1993) demonstrated encouraging findings related to persons with a diagnosis of BED; however, subsequent studies showed mixed reviews of the instrument. Nangle, Johnson, Carr-Nangle, and Engler (1994) utilized the QEWP to measure three-week test-retest reliability in a sample of self-referred binge eaters and a comparison sample. Results showed moderate stability of the BED diagnosis (kappa = 0.58). An alternate study assessing the Questionnaire for Eating and Weight Patterns–Revised (QEWP-R) version of the measure showed moderate sensitivity (0.74) and specificity (0.35) among a sample where 79% held the diagnosis of BED (Celio et al., 2004). Elder et al. (2006) compared the QEWP-R and the EDE-Q among 249 bariatric surgery candidates and found that the two self-report

measures were both useful in identifying those with recurrent BE occurring once weekly,

but the convergence was moderate as evidenced by a kappa coefficient of 0.26.

The EDE-Q is an established instrument based upon Fairburn and Cooper's

Eating Disorder Examination semi-structured interview that is considered the gold

standard to detect the presence of an eating disorder; yet researchers debate the self-

report EDE-Q measure's ability to discriminate between individuals with BED from

those with another disordered eating diagnosis. Berg, Peterson, Frazier, and Crow (2012)

conducted a systematic review of the literature to evaluate psychometric evaluations of

the EDE and EDE-Q. Within 10 studies that examined the psychometrics of the EDE-Q,

multiple samples on which the EDE-Q was tested were convenience samples from

participants already enrolled in treatment. Based on these findings, Berg et al. (2012)

warned that the generalizability of the psychometric findings on the EDE-Q is limited.

Bardone-Cone and Boyd (2007) echo this finding in their evaluation of the psychometric

properties of the EDE-Q in Black and White women using the Spearman's correlation

coefficient, demonstrating significant differences between objective and subjective BE

descriptions in White women versus Black women, with subjective BE showing

instability in Black women (r_s = .20, p = .106), while White women demonstrated

stability across assessment of objective (r_s = .56) and subjective (r_s = .47) BE.

The Eating Loss of Control Scale (ELOCS) (Blomquist et al., 2014) and The Loss

of Control over Eating Scale (LOCES) (Latner et al., 2014) are measures published in

2014. Neither measure is intended to diagnose BED specifically; yet because loss of

control (LOC) is a defining characteristic of BED, they are included for review. The

samples upon which the two scales were tested were different. The ELOCS was tested

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on obese persons seeking treatment with the diagnosis of BED, and the LOCES was

tested with college-age persons with a mean age of 20.4 years, who had a mean body

mass index of 22.8 kg/ m^2, and were primarily Asian (54.5%). The LOCES was a

significant predictor of binge episode frequency in 261 undergraduate men and women,

demonstrating that it may be a useful measure to predict pathology of BE (Stefano,

Wagner, Mond, Cicero, & Latner, 2016). While each measure showed good internal

reliability (ELOCS α = 0.90; LOCES α = 0.96), future studies are needed to aptly

determine if these results can be generalized to other populations.

　　　BE is rarely assessed in primary care and BED is thought to affect an even larger

percentage of the population seeking primary care related treatments (Dorflinger, Ruser,

& Masheb, 2017). The Patient Health Questionnaire eating disorder module (PHQ-ED)

assesses bulimia nervosa and recurrent BE and is a component of the Patient Health

Questionnaire (PHQ) that was designed by Striegel-Moore and her colleagues (2010) to

allow selective use of modules to assess common mental disorders. They recommend the

PHQ-ED for testing in the general population, but only if objective bulimic episodes are

ruled out with follow up questions since the positive predictive values for persons

meeting criteria for the conditions were low at 15% to 19% using criteria assessed by the

EDE, 14th edition semi-structured interview. The VA Binge Eating Screener (VA-BES)

is a single item assessment for BE tested in a Veteran population with a mean age of 61.7

years that asks about the presence and frequency of experiencing loss of control while

eating extremely large amounts of food (Dorflinger et al., 2017). A cut point of ≥ 2

binge episodes per week indicated significant agreement with the QEWP-R (χ^2 = 24.8,

p < 0.001) for BE (Dorflinger et al., 2017).

The Eating Disorders Inventory-3 (EDI-3) (Garner, 2004) is a tool that is not

included in Table 1 because this assessment was created to identify individuals from

clinical and nonclinical adult and adolescent populations who may meet criteria for

bulimia. Because BE is also a criterion for BN, this instrument assesses one's thoughts

and tendency surrounding BE. No version of this assessment was obtainable without

purchase because of a copyright held by Psychological Assessment Resources; however,

the tool is widely used with extensive national and international normative data. Clausen,

Rosenvinge, Friborg, and Rokkedal (2011) report that the EDI-3 holds excellent

reliability based upon high Cronbach's alpha (0.90-0.97) and test-retest outcomes ($r =$

0.98). Clausen et al. (2011) revealed the ability of the EDI-3 to significantly discriminate

between those with an eating disorder and those without ($p < 0.001$); however, BED was

not addressed directly in the analysis. Mustelin et al. (2016) show that the utilization of

the Bulimia, Drive for Thinness, and Body Dissatisfaction subscales of the EDI

demonstrate sensitivity of 87% and specificity of 76% for BED at a cutoff of ≥ 21 in a

sample of 2825 Finnish twin women age 22-27 years. Validity and reliability of the

original measure of the EDI as it applies to BED are not included in this analysis since no

primary full-text materials were obtained, which is a limitation of the present study.

The Binge Eating Disorder Test (BEDT) is a subscale of an existing measure

originated by Thelen et al. in 1991 to assess bulimia called the Bulimia Test-Revised

(BULIT-R). The BULIT-R was not included in this analysis because it is a measure of

bulimia; however the BEDT subscale is comprised of 23-items specific to BED criteria.

Mention of the BEDT was limited to one study by Vander Wal, Stein and Blashill (2011);

and the BEDT is not included in Table 1 because original studies of validity and

reliability measures of the BEDT were not identified in the literature. Vander Wal et al.

(2011) compared the self-report measure composite of the EDE-Q, the BUILT-R and

BEDT to assess their diagnostic utility among 15 obese participants with BED and 26

obese participants without BED. The BEDT outperformed the other measures, achieving

100% sensitivity, specificity and positive/negative predictive value outcomes. Results

indicate that the BEDT is potentially a valuable measure of BED, warranting further

analysis.

4. Discussion

As indicated in this review, multiple instruments with valid and reliable statistical

properties are currently available to assess the presence of various eating disorders.

However, many of these measures present limitations surrounding construct validity and

their ability to accurately depict objective BE as it is described in the DSM-5 diagnosis of

BED. Furthermore, validity of a measure is ideally assessed among different sample

populations, and the majority of measures presented primarily assessed psychometrics

within a treatment-seeking sample. Knowledge regarding generalizability and the

capacity of the tools to assess the presence and spectrum of BED within the general

population is limited. Given the sensitive nature surrounding the topic of BED, and the

guilt and shame that is associated with the behavior, attaining a random sample to yield

valid and reliable self-report results remains a challenge. However, the presence of the

disorder may be more or less prevalent than is currently assumed if the sample is not

representative of the general population.

Striegel-Moore and Franko (2008) recount that the prevalence of BED exceeded

other eating disorders in studies looking at the occurrence of eating disorders across

racial and ethnic groups. Now that BED is a distinguishable disorder from the other

eating disorders, it seems appropriate that measurement tools need to be reevaluated to

determine if they serve as a valid clinical diagnostic for BED and its unique symptoms.

Scales that are specific to BED and its clinical correlates are lacking.

As Di lorio (2005) notes, "Validity is not an all-or-none principle; rather, it is an

evolving property….evidence is never complete; thus, the process of validation is

continual" (p. 236). It is encouraging that BED earned status as its own diagnosis in the

DSM-5, and that the state of the science on the disorder is growing. Yet because the act

of BE overlaps across BN, AN binge-purge type, and BED, predominant measurement

tools collapse symptoms of various eating disorders into a composite, making it difficult

to distinguish defining characteristics of BED from other disorders in various tools that

are available. BE studied within the context of AN binge-purge type and BN is

problematic because it makes it difficult to establish accurate rates of the behavior and

the prevalence of BED among the general population. Moreover, many existing

measures capture binge-eating behavior in relation to AN binge-purge type or BN,

limiting the ability to learn more related to the unique etiology of BED. Since the

majority of the existing measures lack assessment of substrates exclusive to BED,

development or refinement of existent scales that reflect this gap are warranted to

improve treatment planning and knowledge underlying the disorder.

Many measures have claimed correlations with BE and/or BED that are not

typically considered able to capture the diagnosis of BED, such as The State Urge to

Binge Scale (Swenson, 2007), The Emotional Eating Scale (Arnow, Kenardy, & Agras,

1995), the Body Checking Questionnaire (Reas, White, & Grilo, 2006), the Eating

MEASUREMENTS FOR BINGE EATING

Pathology Symptoms Inventory (Forbush et al., 2013), the Food Thought Suppression

Inventory (Barnes, Fisak, & Tantleff-Dunn, 2010; Barnes & White, 2010), the

Three-Factor Eating Questionnaire (Stunkard & Messick, 1985), the Reward-Based

Eating Drive Scale (Epel et al., 2014), the Palatable Eating Motives Scale (Boggiano,

2016), the Disordered Eating Questionnaire (Lombardo, Cuzzolaro, Vetrone, Mallia, &

Violani, 2011), the Cognitive Fusion Questionnaire – Food Craving measure (Duarte,

Pinto-Gouveia, Ferreira, & Silva, 2016) and the Yale Food Addiction Scale (Gearhardt,

Corbin, & Brownell, 2009). Multiple scales specifically assess food craving and its

association with BE behavior (Innamorati et al., 2014; White et al., 2002). Scales such as

the Eating Loss of Control Scale (Blomquist et al., 2014) and The Loss of Control over

Eating Scale (Latner et al., 2014) show promise to better understand the defining

construct of loss of control in eating disorders and BED, but they are both new scales that

warrant further testing to determine their utility to identify those with BED.

Research indicates that these tools may reveal additional information about BE

and BED because they are able to correctly identify binge-eating behavior by

discriminating between subclinical and clinical BE groups. This discrimination may

allow identification and treatment of individuals who exhibit signs that are on a lower end

of the spectrum of the disorder before clinical manifestations increase. Moreover,

multiple newly emerging self-report measures are available to assess similar facets of the

one aspect associated with BED, such as loss of control (Blomquist et al., 2014; Latner et

al., 2014). These various measures may assist in refining understanding of the etiology

and symptomology associated with BED, and may present alternate ways of sharpening

classification for the disorder, thus allowing the state of the science to move forward.

However, it also appears that researchers may be using alternate constructs to describe a phenomenon, such as the term *disinhibition* to capture criteria for loss of control or "eating addiction" rather than "food addiction" (Bohrer, Forbush, & Hunt, 2015; Hebebrand et al., 2014, p. 295; Stunkard & Messick, 1985). Therefore, further clarity surrounding the tenets and concept of BED within its measures appears warranted.

5. Conclusion

From the perspective of a practitioner, assessment of the various measures of BE and/or BED is needed to further understand the facets of the unique disorder and phenomenon. Many of the measures that are utilized to assess BE are also employed to assess other eating disorders or potentially related concepts of interest. Evaluating the presence or absence of BE is available in multiple measurements; yet practitioners are not able to diagnose BED unless the measure includes the diagnostic criteria for BED as presented in the DSM-5. As the science surrounding BED grows stronger, researchers and practitioners may need to revisit the diagnostic tools that are used for confirmation of reliability and validity within this population to ensure clinical utility.

A screening approach for BED and other eating disorders that involves a symptom composite of various eating disorders has strengths and limitations; and researchers warn that a single self-report measure should be followed up with an alternate diagnostic tool (Berkman et al., 2105; Jacobi et al., 2004; Marek et al., 2014; Tanofsky-Kraff et al., 2013). The measurement of the general pathology of eating disorders appears psychometrically sound with established self-report measures that are in use. However, assessing the specific psychopathology of BED as it relates to possible psychosomatic and biobehavioral etiologies, as well as the shared and distinct factors of

eating disorders, remains an evolving area of study as evidenced by the myriad of

measures that were reviewed and are being used among researchers and practitioners.

Acknowledgments

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Manuscript 1

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
Binge Eating Scale (BES); (Gormally, Black, Daston, & Rardin, 1982)	Two independent samples of overweight adults seeking behavior-based treatment for obesity. N=112 Male=15 Female=97 Primarily White/middle class	Aim: To measure degree that obese persons experience problems with binge eating. 16-item self-report.	8 items assess behaviors; 8 items assess thoughts/feelings; Total scores range from 0 to 46 on a 0 to 3 scale per item; Cut-off scores established by Marcus, Wing, and Lamparskil (1985): Severe: ≥ 27 Moderate: 18-26 Mild or None: ≤ 17	Cognitive framework: The abstinence violation effect (AVE)	Internal consistency: Compared participants' scores on each item to total score with a Kruskal-Wallis test of ranked data. Significant chi-squares 9.1 or above ($p < .01$). Cronbach's alpha 0.89 for Portuguese version (Freitas, et al., 2006)	Concurrent: Two independent samples of overweight adults. BES scores compared with individual assessments of binge eating severity by trained interviewer. The BES did not correlate with no BE, and the BES differentiated between no BE and moderate and severe BE levels.	15 minutes self-administration tool; Portuguese version with like psychometrics; Does not assess amount of food consumed.	Level 3b Quasi-experi-mental study

MEASUREMENTS FOR BINGE EATING

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
Binge Scale Questionnaire (BSQ); (Hawkins & Clement, 1980)	College-age men and women at a U.S. university. Initial sample: N=247 Male=65 Female=182. Replication sample: N=118 Male=45 Female=73. Additional sample: 26 overweight females in treatment.	Aim: To measure binge eating and vomiting based upon parameters of associated behaviors and attitudes to assess severity of binge eating. 19-item self-report.	9 of 19 multiple choice items yield score and are scored from 0 to 3, with 3 indicating greater severity.	Framework not discussed. Theoretical assumptions stated: One's subjective definition is warranted as to what constitutes a binge episode. Severity of binge behaviors will correlate with degree of psychopatho-logy	Internal consistency: Cronbach's alpha = 0.68. One month test-retest: Pearson Correlation Coefficient $r = 0.88$ in 1-month test-retest stability.	Construct: principal components analysis yielded 2 components: Guilt and concern about binge eating = explained 71% of variance in item loadings. Duration and satiety = contributed to 16% variance in item loadings.	Administration and scoring are quick. Not widely used at present.	Level 3b Observa-tional study with control

MEASUREMENTS FOR BINGE EATING

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
Eating Disorder Diagnostic Scale (EDDS); (Stice, Telch, & Rizvi, 2000)	367 females; 17 with diagnosis of BED. Diverse in age, location and socioeconomic status.	Aim: To develop a tool to enable brief screening for eating pathology including AN, BN and BED based upon diagnostic criteria for each disorder within DSM-IV. Diagnostic scale for AN, BN and BED and symptom composite scale. 22-item self-report	4 items assess attitudinal based symptoms of AN and BN on 7-point scale from 0 to 6. 4 items measure frequency of uncontrolled consumption over time. 4 items assess frequency of compensatory behaviors. Open-ended questions.	Not discussed	Internal consistency: Cronbach's alpha = 0.91 for total symptom composite Test-retest agreement: 1-week test-retest kappa coefficient for BED using the EDDS was .75 with an accuracy rate of .89.	Criterion: Agreement of EDDS and structured psychiatric interview diagnoses for BED category findings: $K = .74$ Sensitivity = .77 Specificity = .96 Positive Predictive Value = .80 Negative Predictive Value - .95	Scale can be scored by hand or with computer algorithm. Scale based upon DSM-IV criteria. Psychometrics primarily conducted by original authors.	Level 4 Observational study without control

MEASUREMENTS FOR BINGE EATING

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
Eating Disorder Examination-Questionnaire (EDE-Q); (Fairburn & Beglin, 1994)	285 females from a community sample. 36 female patient sample BN=23 AN=13	Aim: To develop a self-report version of the "gold standard" Eating Disorder Examination (EDE). EDE measures range of psychopathology in eating disorders. 36-item self-report.	Subscales: Restraint, Eating Concerns, Weight Concerns, Shape Concerns based on timeframe within last 28 days. 7-point Likert scale with scores of 4 or higher per item indicating pathology.	Not discussed	Not reported in EDE-Q study. Test-retest agreement: Reported by Reas, Grilo, & Masheb (2006) for BED between EDE and EDE-Q with 86 patients with BED. EDE-Q subscales Spearman rho correlations 0.66 - 0.77, EDE-Q items Spearman's rho correlations 0.54 to 0.78.	Concurrent: Binge eating agreement in EDE and EDE-Q measures Kendall's tau correlation coefficient 0.60 ($p < 0.001$)	Can be completed in less than 15 minutes. Overeating with loss of control, loss of control without overeating, and overeating with no loss of control differentiated. Definitions of loss of control or amount of food are not provided.	Level 3b Cross sectional observa-tional study with control

MEASUREMENTS FOR BINGE EATING

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
Eating Disorders in Obesity questionnaire (EDO); (Lapidoth, Ghaderi, Halvarsson-Edlund,Norring, 2007)	97 patients seeking weight-loss treatment at four surgical and one non-surgical facility in Sweden: M=27 F=70 Ages = 19-62 years.	Aim: To assess eating disorder symptoms and binge eating in patients in a weight loss treatment setting. 11-item self-report.	8 questions apply only to persons who self-report binge eating. Modified from the Survey for Eating Disorders.	Not discussed	Test-retest agreement: Cohen's kappa = 0.65 for binge eating. Cohen's kappa = 0.65 for eating disorders,	Concurrent: Between EDE and the EDO - Identifying participants with eating disorders (Cohen's kappa=0.67) Identifying binge eating (Cohen's kappa=0.63)	Fast and easy administration. Binge eating is defined according to DSM-IV definition. Questions referring to AN are not included due to context.	Level 4 Cross sectional observa-tional study without control

MEASUREMENTS FOR BINGE EATING

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
Eating Disorder Questionnaire-Online (EDQ-O); (ter Huurne et al., 2014)	134 new patients in treatment for eating disorder in the Netherlands M=16 F=118.	Aim: To develop an on-line self-report questionnaire to diagnose AN, BN, BED, and EDNOS with no face-to face interview.	Patients only receive questions according to their situation based upon answers provided. AN and BN questions derived from Mini-International Neuropsychiatric Interview and BED questions taken from diagnostic criteria in DSM-IV. AN- A1 to A8b BN- B1a to B7 BED- C1a to C5f	Not discussed	Not discussed	Agreement between EDQ-O and DSM-IV diagnosis determined by LEAD standard. AUC (area under receiver operating characteristic curve) values 0.72 to 0.83. Sensitivity for BED 0.66.	5 minutes to administer and on-line. New measure with limited psychometrics.	Level 4 Cross sectional observa-tional study without control

MEASUREMENTS FOR BINGE EATING

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
Eating Loss of Control Scale (ELOCS); (Blomquist et al., 2014).	168 obese to morbidly obese males and females seeking treatment for weight-loss with DSM-IV- based diagnosis of BED present. Aged 21 to 65 M=48 F=120 Caucasian non-Hispanic = 69.64%	Aim: To develop an instrument that measures different aspects of loss of control (LOC) eating among individuals with an eating disorder. 18-item 1 factor scale.	Likert-type scale from 0-10 to determine degree of feelings, behaviors and experiences related to LOC eating within the past 28-days. Modeled after EDE-Q. Higher scores yield more LOC	Not discussed	Cronbach's alpha = 0.90 for the scale	Construct: Principal component analysis factor loadings for 18-items ranged from $r = 0.45$ to $r = 0.78$. Convergent with EDE-Q measures of LOC: Pearson correlations - Objective episode: $(r = 0.40, p <0.001)$ Subjective episode: $(r = 0.22, p <0.005)$	Ease of administration and scoring. Only measures one LOC domain. May be used as initial screening tool for BED, but not diagnostic.	Level 4 Observa-tional study without control

MEASUREMENTS FOR BINGE EATING

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
Loss of Control over Eating Scale (LOCES); (Latner et al., 2014)	Study 1 Sample: 34 eating disorder experts and 22 persons with previous diagnosis of eating disorder. Study 2 Sample: n = 476 college-aged from U of Hawaii Asian = 54.5% English is 1st language = 83.4% Female = 73.8%	Study 1 Aim: To establish content validity of the measure of LOC eating. Study 2 Aim: Validate the psychometric properties of the resulting scale within a non-clinical sample and reduce the 74-item measure.	Study 1: Rate each of original 56 items twice on Likert scale of 1 to 5 and recommend those that indicate LOC eating; rate relevance of 13 facets of construct on Likert scale 1 to 5; open-ended responses. Study 2: Rated 74 items (28 added and 10 deleted from original sample) on frequency of experience from 1 to 5; completed eating disturbance, general distress, functional impairment, and general self-control measures.	Not discussed	Study 1: Not reported Study 2: Cronbach's alpha = 0.96 for the 24-item scale	Study 1: Focus was content validity by establishment of construct definition for loss of control eating (qualitative) and ratings on 1-5 point Likert scale for question and construct clarity (quantitative). Study 2: 24-item measure. Internal consistency: Cronbach's alpha = .96 Test-retest reliability with Pearson correlation: ($r = 0.86$, $p <0.001$)	5-point Likert scale with option of 24-item or 7-item LOCES. May be used as initial screening tool for BED, but not diagnostic. Tested in non-clinical population. EFA: 3 factors of LOC-eating emerged: 1. Behavioral aspects 2. Cognitive/ dissociative 3. Positive euphoric	Study 1: Level 4 Observa-tional study without control Study 2: Level 4 Observa-tional study without control

MEASUREMENTS FOR BINGE EATING

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
Patient Health Questionnaire Eating Disorder module (PHQ-ED); (Striegel-Moore et al., 2010).	348 participants from a random sample: (259 screen positive cases; 89 screen negative cases). White = 87% Women = 82% With at least some college = 80% Average age = 28.18 (SD = 5.38)	Aim: To use the PHQ-ED in a community sample to identify bulimia nervosa/binge eating disorder (BN/BED) or recurrent binge eating (RBE) in comparison to Eating Disorder Examination14 (EDE) semi-structured interview outcomes, and to examine individuals who screen positive for an eating disorder with the PHQ-ED but do not meet diagnostic criteria against those that screen positively and do meet diagnostic criteria.	The PHQ-ED consists of six yes/no response items on binge eating and compensatory behaviors, plus two additional questions if binge eating or purging was previously endorsed.	Not discussed	Not discussed	Sensitivity for both diagnostic outcomes = 100%. Specificity for BN/BED = 91.7%. Specificity for RBE = 92.4%. Positive Predictive Value (PPV) of meeting EDE interview assessed criteria: BN/BED = 15% RBE = 19%.	May be useful to rule out BN/BED and RBE in the general public but the researchers advise to follow-up with an alternate measurement for clinical validation.	Level 3b Observa-tional with controls

MEASUREMENTS FOR BINGE EATING

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
Questionnaire of Eating and Weight Related Patterns (QEWP); (Spitzer et al., 1993)	1785 participants in treatment for weight control (29% = BED). 942 community sample. 75 patients with BN.	Aim: To validate BED as a diagnosis using the QEWP to better understand its unique clinical components	QEWP was originally a seven-page questionnaire with questions that operationalized variables associated with BED on a 5-point Likert scale. QEWP- Revised is comprised of 28 items with a 5-point Likert-scale and open-ended question of food choices. Presented within 6-month frame and considers weight loss history.	Not discussed	Not discussed	Not directly stated. Validity was stated as supported by odds ratios for BED vs. community sample on variables associated with BED at the time of development.	Developed to identify presence of BED and associated variables. Also compares groups across psychopathologies and BED showed higher rates in all categories.	Level 3b Observational with controls

MEASUREMENTS FOR BINGE EATING

Table 1: Data Extraction and Psychometric Analysis of Self-Report Measures

Instrument Reference	Research Sample/ Participants	Instrument Description and Study Aim	Item Description and Scoring	Theoretical Framework	Reliability	Validity	Feasibility & Considerations	Level of Evidence
VA Binge Eating Screener (VA-BES); (Dorflinger, Ruser, & Masheb, 2017).	116 veteran participants who were referred to primary care treatment for weight control. Mean age = 61.66 years (SD = 8.73). Average BMI = 37.90. Male = 88% White = 75% Black = 20.9%	Aim: To investigate a single-item screening tool for binge eating, the VA-BES, for use in a primary care setting.	"On average, how often have you eaten extremely large amounts of food at one time and felt that your eating was out of control at that time?" Options: "Never"; "<1 time/week"; "1 time/week"; "2-4 times/week"; "5+ times/week".	Not discussed	Not discussed	Binging ≥2 times/week showed significant agreement of the VA-BES when compared to the QEWP (χ^2 = 24.79, p < 0.001).	Developed to identify presence of BED and associated variables. Also compares groups across psychopathologies and BED showed higher rates in all categories.	Level 4 Observa-tional without controls
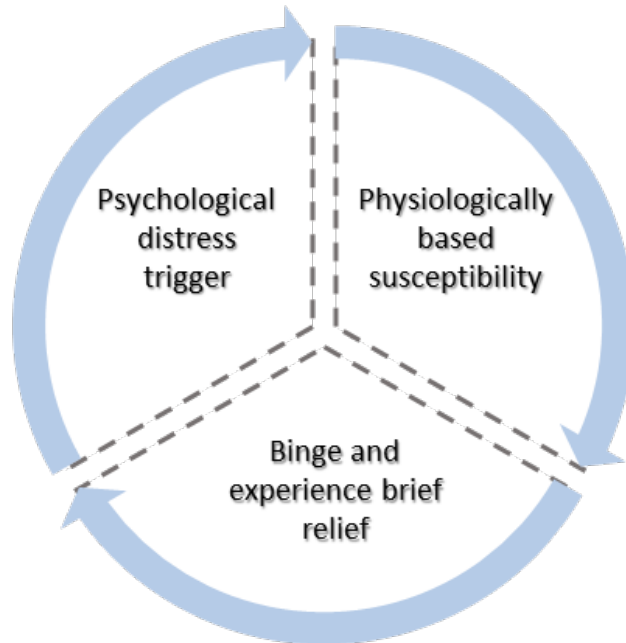
Figure 1: Biobehavioral Model Applied to Binge Eating Disorder

The proposed cycle of binge eating is an interrelated process that is biobehavioral in its origin. Binge behaviors are physiologically and psychologically driven and are sustained by each component influencing the other.
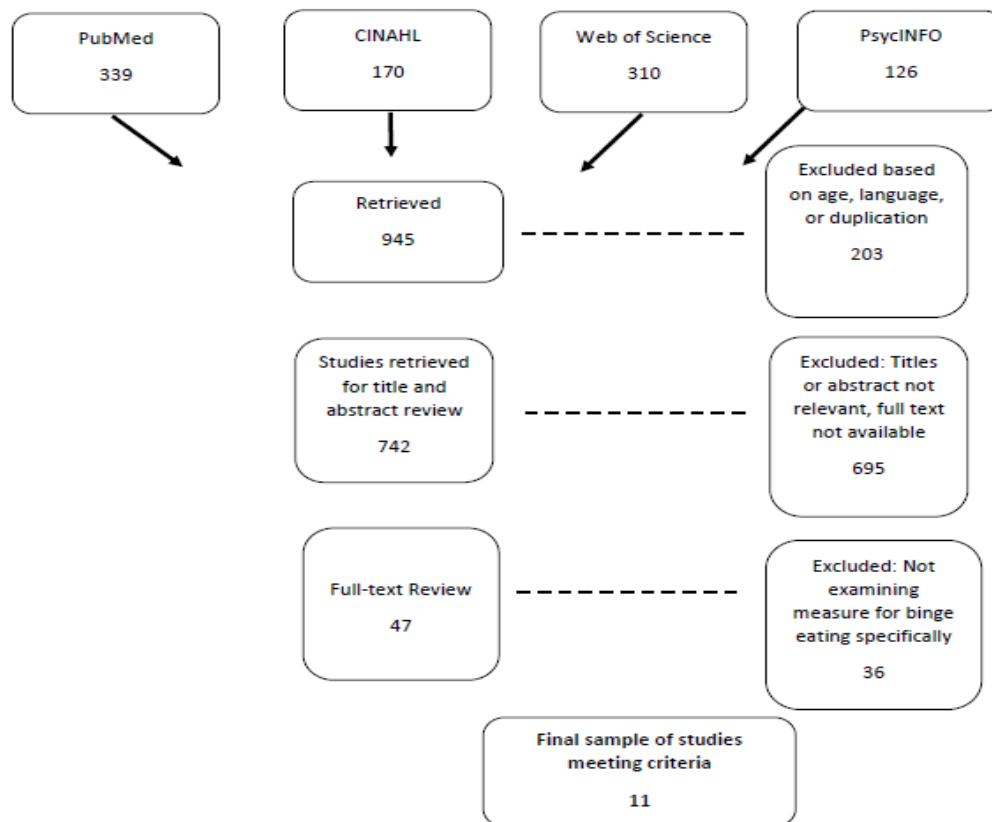
Figure 2. Search strategy results

Manuscript 2

Association of Binge Drinking and Eating with Perceived Stress, Impulsivity, and Health

Outcomes of Anxiety, Depressive Symptoms, and Obesity in College-Age Youth:

A Mediation Model

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Abstract

Background and Purpose: Binge drinking (BD) and binge eating (BE) are associated with adverse health outcomes of anxiety and depression. Among American college students, BD and BE are prevalent behaviors and can lead to long-term health consequences. This study examined BD and BE in a college population to test binge behavior as a mediating effect between stress and impulsivity, and their impact on outcomes of anxiety, depression symptoms, and increased body mass index.

Methods: A secondary analysis examined associations of impulsivity and stress with BD and BE mediators and health outcomes. Participants were 4107 college students at a public university who completed an on-line survey about mental health and high-risk health behaviors.

Results: BE but not BD was found to partially mediate anxiety and depression and fully mediate BMI outcomes, and stress and impulsivity predictors were partially mediated by BE in multivariable models with anxiety and depression as health outcomes. BE, anxiety and depression were more prevalent in females than males. Overweight and obese participants were more likely to BE than BD. Racial differences showed more Whites BD. No racial differences were noted among BE outcomes.

Conclusion Implications for Practice: While BD and BE are prevalent behaviors in college youth, BE shows heightened associations to pathologies. Authors discuss considerations of BE as compared to BD in the college population and highlight the

benefit of open discourse about BE with patients since BE is often privatized and stigmatized.

Keywords: Binge drink, binge eat, college-age, mediator, comorbidity

I. Introduction

      Binge drinking (BD) and binge eating (BE) are common behaviors in the undergraduate college-age population that include ages from the late teens to the early twenties, and the onset of lifetime problems and long-term stressors associated with these behaviors is likely to occur during college years (Martin, Groth, Longo, Rocha, & Martens, 2015; Dakanalis et al., 2014; R. C. Kessler et al., 2007; Ronald C. Kessler et al., 2013). Characterized by loss of control eating of large amounts of food in a short period of time and experiencing significant distress over the episode, Binge Eating Disorder (BED) has become the most prevalent eating disorder in society, with 3.5% of females and 2.0% of males demonstrating a lifetime prevalence (Association, 2013; Blackburn, Johnston, Blampied, Popp, & Kallen, 2006; Hudson, Hiripi, Pope, & Kessler, 2007). While studies convey that BE affects as many as 1:20 (Mitchison, Touyz, Gonzalez-Chica, Stocks, & Hay, 2017), approximately 30% of the general population report engaging in BD as defined by the consumption of four or more drinks for females and five or more drinks for males in a two-hour period and (NIAAA, 2017).

      Binge drinking is even higher among undergraduate youth with approximately 40% reporting BD in the last month in the 2013 National Survey on Drug Use and Health conducted by the Substance Abuse and Mental Health Services Administration. Research designates that for 40% of individuals alcohol dependence is established between ages 17 and 23, and alcohol misuse patterns in early adulthood are a strong predictor for emerging problems with alcohol abuse later in life (Adams, Milich, Lynam, & Charnigo, 2013; Dick et al., 2014; Hasselgard-Rowe, Broers, & Haller, 2017; Kuntsche, Kuntsche, Thrul, & Gmel, 2017; Morris, Dowell, Cercignani, Harrison, & Voon, 2017).

BD has long been a frequent occurrence on college campuses and BE is increasing at alarming rates (Mitchison, Hay, Slewa-Younan, & Mond, 2012; Mitchison et al., 2017). Impulsivity and stress are predictors attributed to BD (Kuntsche et al., 2017) and BE (Eichen, Chen, Schmitz, Arlt, & McCloskey, 2016; Lyu & Jackson, 2016) and have also been linked to anxiety, depression and overweight/obesity (Becker & Grilo, 2015; Javaras et al., 2008; Racine & Martin, 2017; Hunt, Forbush, Hagan, & Chapa, 2017; Steiger & Thaler, 2016). There is a clear connection between the rise in BE and the rise in the prevalence of obesity (da Luz et al., 2017; Mustelin, Bulik, Kaprio, & Keski-Rahkonen, 2017). A pronounced increase in psychological distress in those with BE exists (Mustelin et al., 2017) with many who recurrently binge eat meeting criteria for a disorder other than binge eating disorder (BED), such as anxiety, depression, post-traumatic stress disorder and/or substance abuse (Javaras et al., 2008; Ling, Rascati, & Pawaskar, 2017; Mitchison et al., 2017; Pawaskar et al., 2016).

Since both binge behaviors are prevalent in the college-age population and contribute to long-term stressors, the present study tested a hypothesized biobehavioral conceptual model of binge behavior with BD and BE serving as mediators between predictors of perceived stress and impulsivity and outcomes of anxiety, depressive symptoms and body mass index (BMI) (See Figure 1). We examined this research question using a parent data source called *Spit for Science* that includes participants seeking their undergraduate degree. Binge was tested as a mediator because of its association to variables of interest in the model as well as the overall objective of this study to advance understanding of psychological associations to BD and BE, and to contribute to the design of effective prevention and intervention strategies for binge behaviors for college youth.
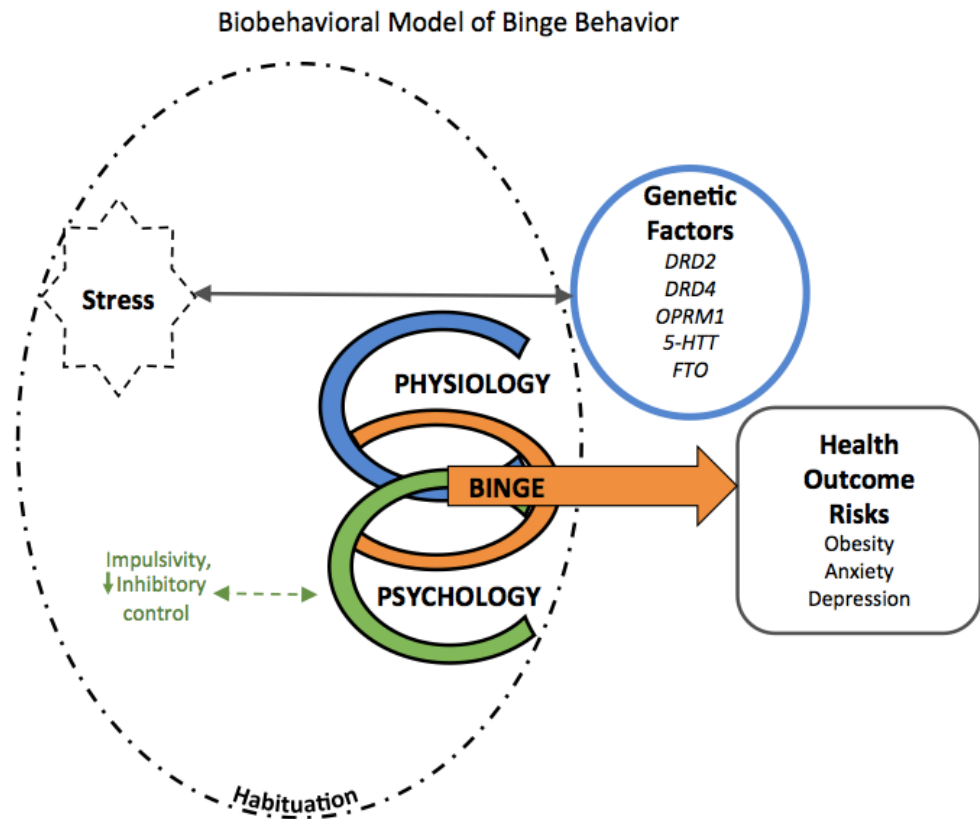
Figure 1. Biobehavioral Model of Binge Behavior

2. Methods

2.1 Participants and Dataset

A secondary analysis of cross-sectional data from years 2011-2013 of the *Spit for Science* dataset was used to investigate the biobehavioral model with binge behavior as a mediating variable among predictors and health outcomes applied to the population of college students in the fall or spring of their freshman year. The study takes place at a large, urban four-year university in the mid-Atlantic region of the United States. *Spit for Science* is a university-wide study that commenced in the fall of 2011 and investigates how genes and environments contribute to behavior and substance use during the developmental phase of

young adulthood. Incoming freshmen age 18 years or older are invited to participate.

Participants are asked to complete a baseline survey and to provide a four-mL saliva sample

for DNA processing in the fall or mid-spring semester of their freshman year. They are

invited to complete a follow-up survey mid-spring semester of each subsequent year of their

undergraduate education, and survey data are collected using a university-hosted electronic

data organization tool, Research Electronic Data Capture (REDCap) (Harris et al., 2009).

Participants receive ten dollars for the completion of each survey, as well as for contributing

the one-time saliva sample (Dick & Hancock, 2015; Dick et al., 2014).

Baseline surveys during the fall and the spring in years 2011-2013 were utilized for

this secondary data analysis, yielding an N of approximately 4107 participants after excluding

those who had never been exposed to alcohol, those who were not exposed to the impulsivity

variables in the baseline survey, and those that were missing a DNA sample. The current

study includes participant demographics of age, sex, ethnic self-identification and

maternal/paternal education histories and considers sex, race, nicotine use, and semester of

survey administration as confounders.

2.2 Measures

Binge Drinking: Binary BD groups were formed based on the National Institute on

Alcohol Abuse and Alcoholism (NIAAA) definition for BD, which includes the

consumption of four or more alcoholic drinks for females and five or more alcoholic

drinks for males during one time period on at least one day out of the past month

(NIAAA, 2017). 1473 who responded "no" to the question "Have you ever had at least

one drink of any kind of alcohol?" were excluded from the study. BD and NBD groups

were formed based upon responses to questions about the number of drinks consumed on

a typical day when they drank. Responses were based upon answers to the following frequency-based consumption questions from the Alcohol Use Disorders Identification Test, "How many drinks containing alcohol do you have on a typical day when you drink? or "During the past 30 days on the days that you drank how many drinks did you have each day?" (Babor et al., 2001). Those who were exposed to alcohol but did not meet binge drinking criteria were controls for the binge drink group.

Body Mass Index (BMI): BMI was determined by self-report height (inches) and weight (pounds), and was measured according to clinical BMI parameters: underweight (less than 18.5), normal weight (18.5 to 24.9), overweight (25 to 29.9) and obese (30 or greater) (World Health Organization, 2017).

Eating Disorder Examination-Questionnaire: Endorsement of BE was determined based on binary responses to a question derived from the Eating Disorder Examination-Questionnaire (EDE-Q), which has been incorporated into the DSM-5 diagnostic criteria for binge eating disorder (BED) (Dick et al., 2014; Fairburn & Beglin, 1994). To assess for the presence of BE, the EDE-Q, and the correspondent DSM-5, ask individuals whether there have been times during the last four weeks when they consumed what most people would consider an unusually large amount of food given the circumstances (Fairburn & Beglin, 1994).

Nicotine Use: Past-month cigarette use was based on seven response options in *Spit for Science* and was recoded and categorized according to no use, moderate use, and daily/almost daily use. Nicotine use was included as a confounder in the study since nicotine may have a role in neuroendocrine function, and stress is a variable of interest. (Steptoe & Ussher, 2005, Dick et al. 2014).

SCL-90: The Symptom Checklist-90 (SCL-90) is a measure of anxiety and depression and is a widely utilized measure in research and clinical practice to assess anxiety and depressive symptoms (L. E. Derogatis, Cleary, P.A., 1977; L. R. Derogatis, Lipman, & Covi, 1973). Eight items from the SCL-90 were used to measure anxiety and depression in participants. Müller, Postert, Furniss, & Achtergarde, (2010) did a comparison of eleven short versions of the symptom checklist 90-Revised and found nearly equal internal consistency and validity indices as the full version.

Anxiety ($Cronbach's\ alpha = 0.85$) and depression ($Cronbach's\ alpha = 0.87$) subscales used in the current study were pro-rated by "averaging the responses for those with non-missing answers for more than half of the anxiety and depression questions respectively" (Dick et al., 2014, p. 4). Items related to anxiety included feeling nervous or shakiness inside, being suddenly scared for no reason, feeling fearful, and experiencing spells of terror or panic; while items related to depression ranged from feeling blue, excessive worry, feeling no interest in things, and feeling hopeless about the future. Response options range from "not at all" to "extremely" for anxiety and depression on an ordinal scale with a minimum of four and a maximum of twenty.

Stressful Life Events Scale: Using this scale, twelve stressful events were rated by *Spit for Science* participants as having experienced or not having experienced the event in their lifetime, yielding a sum score for each individual based on his or her total exposure. Events include broken engagement or steady relationship, separation from a loved one or close friend, serious illness or injury, being burglarized or robbed, trouble with police, being laid off or fired from a job, major financial problems, serious housing problems, serious difficulties at school, the passing of someone close, the serious injury of a mother or father,

and serious illness or injury of someone close (Kendler, Karkowski, & Prescott, 1999).

Rating response options for stressful life events were ordinal based upon a 0-12 response

level.

UPPS-P Impulsive Behavior Scale: The UPPS-P Impulsive Behavior Scale measures

impulsivity within five subscales of rash action. The UPPS-P was developed by Lynam,

Smith, Cyders, Fischer, & Whiteside (2007; Lynam, Smith, Whiteside, & Cyders, 2006) who

validated the instrument in the young adult population as a measure of impulsive behavior

within the following five domains: Negative **U**rgency, Lack of **P**remeditation, Lack of

Perseverance, **S**ensation Seeking, and **P**ositive Urgency. The Cronbach's alpha for the five

subscales ranged from 0.69 to 0.79. Subscales were pro-rated by averaging the responses for

participants with non-missing answers for more than half of the impulsivity questions

respectively. Thus, individuals who answered fewer than 50% of the items were excluded,

and scores were calculated from those participants with less than 50% of missing data, thus

yielding an ordinal variable ranging from three to twelve for each of the five impulsivity

domains.

2.3 Statistical analysis

A step approach to evaluate the mediation model proposed by Baron and Kenny

(1986; MacKinnon, Fairchild, & Fritz, 2007) as depicted in Figure 2 was used to determine

the significance of the coefficients within a cross-sectional design. Multiple potential

predictors (X) exist that include Stressful Events and the following impulsivity domains:

Negative Urgency, Lack of Premeditation, Lack of Perseverance, Sensation Seeking, and

Positive Urgency, and multiple outcome variables (Y) including Anxiety, Depression, and

BMI. Binge Drinking and Binge Eating were hypothesized as mediating the effect of stressful

events and impulsivity components on anxiety, depression and BMI. Four steps for

determination of mediation as described by Barron and Kenny (1986) occurred as follows:

Step 1. linear regression with X predicting Y; Step 2. logistic regression between X predicting

the potential mediator M; Step 3. linear regression with the potential mediator M predicting

Y. The purpose of steps 1-3 was to establish if a significant relationship among variables

existed. If 1 or more of these regressions failed to be significant, then the conclusion was that

mediation was not possible or likely. If the regression in steps 1-3 was significant, then in

step 4 a multivariable regression model with both X and M predicting Y was tested. In step 4,

if the relationship between X and Y was no longer significant the findings supported full

mediation. If both X and Y remained significant the findings supported partial mediation.
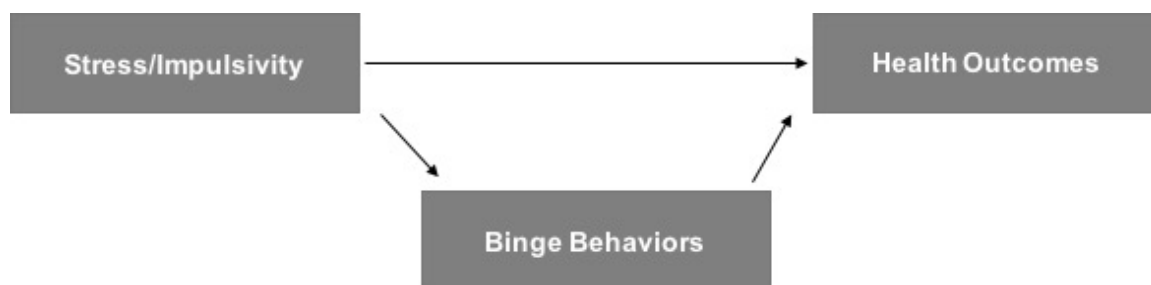
Figure 2. Hypothesized mediation model

Individual mediation models were formed with variables significant at $p \leq 0.05$ from

this series of regression analyses. In an additional step, multivariable regression was used

including all predictors simultaneously as well as the confounders age, sex, ethnicity, nicotine

use, and fall or spring survey administration time during the freshman year. and backwards

elimination was applied at $p = < 0.05$ in the first of two multivariable models. Backwards

elimination was applied at $p < 0.05$ in the multivariable models.

3. Results

3.1 Demographics

The average age of participants was 18.5 (IQR: 18.3, 18.8). The racial distribution of the sample included Asian 11%, Black 19%, White 56%, Hispanic/Latino (7%) and Other (9%). The breakdown for participants according to sex was 63% female, which is close to overall university demographics for sex (Dick et al., 2014). Parental education status was collected as a socioeconomic indicator. The majority of participants reported mothers with a college degree or beyond (57%) and fathers with a college degree or beyond (54%).

Descriptives for BD/BE: 1968 (48%) reported BD in the past month and 982 (24%) reported at least one instance of BE in the past month. 1673 (41%) had neither BD nor BE; 1449 (35%) had BD only; 463 (11%) had BE only; and 519 (13%) had both BD and BE. There were no significant differences in BD rates between males and females. Sex did have a relationship to BE in the sample, with females more likely to be binge eaters. There was a statistically significant difference between BD/NBD among self-reported ethnicities, with Whites drinking more than the expected norm and Blacks drinking less than the expected norm ($p < 0.0001$). There were no statistically significant differences noted among Asian and Hispanic/Latino self-report ethnicity groups for BD. There were also no statistically significant differences noted among ethnicities for the BE/NBE outcomes.

BD/NBD rates demonstrated statistically significant differences for the maternal education status but not for the paternal education status. There was more BD (59% vs. 57%: $p = 0.0115$) in the sample for those students who reported a maternal education of college degree or beyond compared to the other education groups. No statistically significant differences were noted in parental education status for the BE/NBE groups.

Body mass index outcomes were statistically different among BD/NBD groups (p = 0.0091), with BD showing 69% at normal weight compared to 65% in the NBD sample, though underweight (7% vs 10%), overweight (16% vs 18%) and obese (7% vs 7%) groups were not higher for BD. Statistically significant differences were also noted in the BE versus NBE groups (p < 0.0001) where BE was higher in overweight groups (21% vs. 15%) and obese groups (11% vs. 6%). Normal weight (62% vs. 68%) and underweight groups (5% vs. 9%) were lower among binge eaters.

Table 2 includes means and standard deviations of the health outcome variables as well as the stress/impulsivity predictor variables. With the exception of anxiety (p = 0.4041) all health outcomes and stress/impulsivity variables differed statistically significantly between the BD/NBD groups. With the BE/NBE groups, with the exception of sensation seeking (p = 0.2585), all health outcomes and stress/impulsivity variables differed statistically significantly between the two groups.

3.2 Anxiety
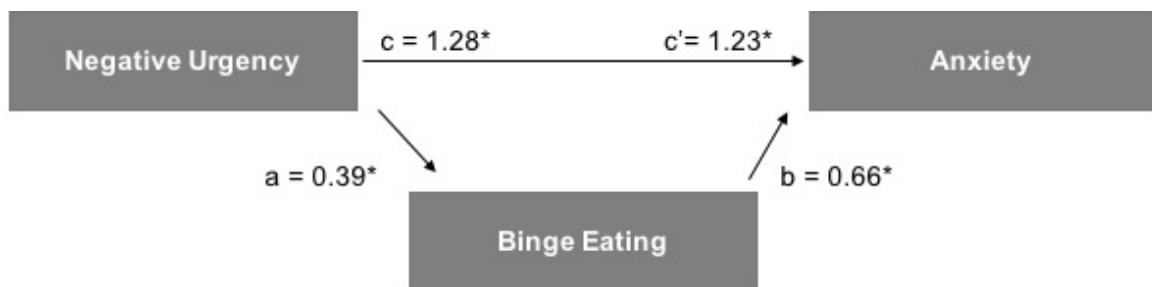
*p < .0001

Figure 3.   Mediation Model for the Relationship Between Negative Urgency: Binge Eating: Anxiety

Mediation Analysis. Figure 3 shows the mediation model for the relationship between negative urgency, binge eating and anxiety as an illustration. The relationship of

negative urgency with anxiety was statistically significant (c = 1.28, p = <0.0001; Table

1a) and remained statistically significant when controlling for binge eating (c'= 1.23, p =

<0.0001; Table 4a). Binge eating was significantly related to anxiety when controlling

for negative urgency (b = 0.66, p = <0.0001; Table 4a) and negative urgency was

significantly related to binge eating (a = 0.39, p = <0.0001; Table 3). Since predictor,

mediator and outcome variables remained statistically significant for all models, Baron

and Kenny's (1986) criteria for partial mediation of binge eating was met for the

relationship between negative urgency, binge eating and anxiety. Results from the

subsequent mediation models for depression and BMI outcomes can be found in

Appendix A for depression and Appendix B for BMI.

Overall, the mediation approach showed that stress and impulsivity predictors were

significantly related to anxiety at $p < 0.05$ (Table 1a). Impulsivity variables were significant at

predicting the potential mediator of BD but stress was not predictive of BD (p = 0.0845) and

was excluded from all subsequent modeling, while sensation seeking was excluded from

subsequent models since it did not demonstrate a relationship with BE (p = 0.2946) as shown

in Table 2b.   BD was eliminated from further evaluation for mediation of the effect of stress

and impulsivity on anxiety since BD did not predict anxiety (p = 0.4037), however BE

remained in the model as a mediator since it did predict anxiety (p = <0.0001). Significant

remaining outcomes indicated that Partial mediation was indicated for BE and lack of

perseverance (0.39, p = <0.0001), lack of premediation (0.23, p = <0.0001), negative urgency

(as described above: 1.23, p = <0.0001), positive urgency (0.84, p = <0.0001) and stressful

events (0.25, p = <0.0001) on anxiety.

Multivariable Modeling. Backwards elimination was used to arrive at the

multivariable model when significance was at $p = < 0.05$ (Table 4b). The final multivariable

model showed that all predictor variables were positively related to anxiety with the exception

of lack of premeditation, which demonstrated a slight negative relationship with anxiety

(-0.47). For all models age had no impact. Sex had a significant impact with Females on

average scoring 0.86 higher on anxiety than Males, holding all other variables constant. There

was a significant difference between the race/ethnicity groups ($p < 0.0001$). Blacks on

average had a 0.21 lower anxiety score than Whites, while Hispanics had an anxiety score that

was 0.64 lower on average, all other variables held constant. Asians and Others were not

different from Whites. There was a significant effect for nicotine use ($p < 0.0001$) with

individuals who smoke moderately having, on average, an anxiety score 0.33 higher and daily

smokers having, on average, a 0.75 higher anxiety score than non-smokers, all other things

being held equal. That is, both daily use ($p < 0.0001$) and moderate use were significantly

different from no use ($p = 0.0061$). See Table 4 for the results of the final multivariable

model.

3.3 Depression

Mediation Analysis. Stress and impulsivity predictors were significantly related to

depression at $p < 0.05$ (Appendix A: Table 1a). Impulsivity variables were significant at

predicting the potential mediator BD but stress was not predictive of BD ($p = 0.0845$) and was

excluded from all subsequent modeling. Similarly, sensation seeking was excluded from

subsequent models since it did not demonstrate a relationship with BE ($p = 0.2946$) as shown

in Appendix A: Table 2b. BD and BE each predicted depression (BD: $p = 0.0086$; BE: $p =$

<0.0001) (Appendix A: Table 3b). BD partially mediated the relationships of lack of

perseverance (0.65, *p* = <0.0001), lack of premediation (0.48, *p* = <0.0001), and sensation

seeking (-0.50, *p* = <0.0001), with depression (Table 4a in Appendix A). Sensation seeking

was negatively related to depression with BD as a partial mediator, while the impulsivity

variables demonstrated positive relationships with depression. Partial mediation of BE was

established for relationships of lack of perseverance (0.61, *p* = <0.0001), lack of premediation

(0.44, *p* = <0.0001), negative urgency (1.58, *p* = <0.0001), positive urgency (0.83, *p* =

<0.0001), and stressful events (0.34, *p* = <0.0001), with depression (Appendix A: Tables 5a).

Multivariable Modeling. BD and BE remained in the multivariable model after

backwards elimination (Appendix A: Tables 4b and 5b) however BD was not a mediator for

depression in the final multivariable model in this college-age population that included

confounders (*p* = 0.8251) (Table 6). BE remained as a partial mediator for depression and

relationships between lack of perseverance, lack of premeditation, negative urgency, and

stressful events in the final multivariable model for BE (Table 7).

For BD and the mediation for depression, sex had a significant impact with Females

on average scoring 1.23 higher on depression than Males, holding everything else the same.

For categorical confounding variables, there was a significant difference between the

race/ethnicity groups for depression (*p* = 0.0415) where Blacks were significantly less

depressed than Whites (*p* = 0.0268). There is a significant effect for nicotine use (*p* < 0.0001)

with individuals who smoke moderately having, on average, a 0.86 higher depression score

and daily smokers having, on average, a 1.93 higher depression score than non-smokers, all

other things being held equal. That is, both daily use (*p* < 0.0001) and moderate use were

significantly different from no use (*p* < 0.0001). Spring survey participants scored 0.79 points

higher on depression than fall participants, with a statistically significant difference (*p* <

0.0001), thus depression was significantly higher in the spring participants within this analytic

subsample.

Though BD was not found to be significant in terms of mediation of depression, BE

met criteria for partial mediation for depression even after adjustment for confounders (See

Table 7). Since predictors remained significant in the BE mediation model partial mediation

of BE existed. All variables were positively related to depression with the exception of lack

of premeditation, which demonstrated a slight negative relationship with depression (-0.39)

indicating that students with higher depression showed more premeditation. Lack of

perseverance, negative urgency and stressful events remained in the final multivariable model

and negative urgency was positively related to depression with the largest effect of the final

predictor variables (1.47, $p < 0.0001$). Sex had a significant impact with Females on average

scoring 1.0 higher on depression than Males, holding other variables the same. No significant

difference between the race/ethnicity groups was observed for depression ($p = 0.4128$). A

significant effect for nicotine use was noted where both daily cigarette use and moderate

cigarette use were significantly different from no use. ($p < 0.0001$). Individuals with

moderate smoking showed an average of 0.59 higher depression scores than non-smokers on

average and daily smokers show an average of 1.17 higher depression score than non-

smokers, all other things being held equal. Spring survey participants scored 0.78 points

higher on average levels of depression than fall participants ($p < 0.0001$) within this analytic

subsample.

3.4 Body Mass Index

Mediation Analysis. Mediation models to establish relationships between predictors,

potential mediators and BMI showed full mediation for BE but not for BD. Sensation seeking

was the only significant predictor with a statistically significant relationship with BMI at $p <$ 0.05 (Appendix B: Table 1a). As was the case in the previous models, impulsivity variables were significant at predicting the potential mediator BD but stress was not predictive of BD ($p = 0.0845$) and was excluded from all subsequent modeling, while sensation seeking was excluded from subsequent models since it did not demonstrate a relationship with BE ($p = 0.2946$) (Appendix B: Tables 2a and 2b). BD did not predict BMI ($p = 0.7779$), but BE remained in the model since it predicted BMI (p = <0.0001) (Appendix B: Table 3). All predictors emerged as non-significant for BMI in Appendix B: Tables 4a while BE remained significant, thus satisfying Baron and Kenny's criteria for full mediation between the relationship of BE and BMI.

Multivariable Modeling. The only variable that remained in the final model for BMI after backwards elimination was BE (1.40, $p = < 0.0001$) (Appendix B: Table 4), again showing that stress and impulsivity had no relation to BMI, and BE fully mediated the relationship between BMI and BE. For categorical confounding variables, there was a significant difference between the race/ethnicity groups ($p < 0.0001$), with Asians having lower BMI levels than Blacks, Hispanic/Latino, Whites and Other race/ethnicity categories. On average, Blacks scored highest on BMI out of the significant race/ethnicity categories as compared to Whites (1.79, $p < 0.0001$), while Hispanics were 0.91 higher on average, all variables held the same, and the Other race/ethnicity category was 0.71 higher on average than Whites. There was not a significant effect for nicotine use ($p = 0.1151$) for BMI but there was a significant effect of survey administration time with spring survey participants scoring 0.58 points higher on average levels of BMI than fall participants, ($p = 0.0007$) in this analytic subsample.

4. Discussion

The goal of this paper was to explore the applicability of variables in a hypothetical bio-behavioral model of BD and BE behaviors among college-age individuals, with binge serving as the mediator between predictor and outcomes in the models to explore the impact of binging on health outcomes. BE was a significant partial mediator of anxiety and depression and full mediation was seen with BE and BMI in the present study. Negative urgency was a particularly salient predictor of BE when considering anxiety and depression, while stressful events fell out of the model for BD and sensation seeking fell out of the model for BE for the health outcomes.

No mediation was noted for BD in the current sample and BD did not show strong commonalities with BE among this college-age population. Depression was the only outcome for which BD carried over to the final model, and in this model BD was not statistically significant. Despite BD having many adverse outcomes in the college-age population, it is difficult to determine how BD may be adversely affecting individuals in the model that was applied. The college environment is drinking friendly, so this variable may lack the ability to distinguish problem drinkers from the sample without incorporating additional considerations such as frequency of BD. Since stigma is associated with overweight/obesity and binge eating, it is possible that more stigma is associated with BE as compared to BD in the college-age population, thus resulting in anxiety, depression and BMI as significant outcomes of BE but not for BD in the present study.

Data showed that BE was a strong predictor for elevated BMI. This finding is congruent with similar findings in that higher BMI was associated with BE disorder in addition to heightened binge and psychiatric symptom severity (Bulik, Sullivan, & Kendler,

2002; Filipova & Stoffel, 2016; Lipson & Sonneville, 2017; Napolitano & Himes, 2011).

Disordered eating in young adulthood demonstrated the highest rates of problematic eating

behaviors ten years later in a study by Pearson et al. (2017); and greater psychological

problems in young adulthood showed greater predictors for BE later in life (Goldschmidt,

Wall, Zhang, Loth, & Neumark-Sztainer, 2016). Since BE has been associated with poor

outcomes from treatment for weight loss (Dakanalis et al., 2014; Tanofsky-Kraff et al., 2013),

the present study provides further evidence that when BE is present in overweight and obese

individuals, tailored interventions should be considered (Ivezaj, White, & Grilo, 2016).

Our study reflects findings consistent with the literature that show more Whites BD

(Substance Abuse and Mental Health Services Administration, 2013); however no racial

differences were noted among BE outcomes in the sample. Racial differences for BE vary

across data sources, but most indicate that no major racial differences exist for BE (National

Eating Disorder Association, 2013; Swanson, Crow, Le Grange, Swendsen, & Merikangas,

2011). BE outcomes among the sexes also differ in the literature, with some studies

indicating that BE occurs equally in males and females, while other studies emphasize that the

sexes differ in terms of treatment considerations more than BE rates (Mitchison et al., 2017;

Shingleton, Thompson-Brenner, Thompson, Pratt, & Franko, 2015). In the present sample the

female college students showed significantly more BE, anxiety and depression than the male

students. These outcomes warrant further study as well as the outcomes related to cigarette

use. Although not a primary goal of the study, cigarette use was a significant indicator for

anxiety and depression in this sample.

4.1 Limitations

Several main limitations exist for the present study. There was not an adjustment of p-value for multiple comparisons since we were hypothesis generating and not testing in this secondary data analysis. Generalizability is also limited, as the sample consisted of college freshmen and those with a history of alcohol exposure only, thus limiting understanding of BD and BE as it relates to the broader young adult population. Approximately one-fourth of overall sample was excluded for analyses. Because we wanted to include only those with a history of alcohol exposure, this may affect applicability of prevalence rates to broader epidemiological studies in the literature. Outcomes may look different if participants were from a different age range and/or included those that had never been exposed to alcohol. In addition, data were self-reported, and BE may be considered a socially unacceptable trait more so than BD in the population of study. Frequency of binge episodes within the month timeframe was not assessed. It is possible that frequency of binge occurrences could have been an indication of predictors and outcomes under study. Moreover, baseline anxiety and depression rates independent of the binge are unknown. Alternate forms of tobacco use and drug use were not assessed in the present study.

Stressful events remained a predictor in all binge models except for BMI. The study is looked at stressful life events as constructed in the Stressful Life Events scale, but additional stressors may exist that were not addressed in this study. More research needs to be done in this area to determine what role stressful events have in BE and BD, and whether binge outcomes differ with respect to recent or cumulative lifetime stressors.

Lastly, the data set was large so statistically significant results may or may not demonstrate clinical relevance. While the literature supports the model under study, it is difficult to say with certainty that all statistically significant outcomes merit clinical significance.

5. Conclusions

Literature suggests that BD and BE often occur in conjunction with adverse psychological conditions as well as coexisting high risk health behaviors. In addition to elevated BMI levels, anxiety and depression are health outcome risks partially mediated by BE in this college-age population, with negative urgency emerging as a strong predictor for BE and anxiety and depression outcomes. These findings highlight the importance of questioning patients about eating behaviors even when it is not a presenting complaint, as maladaptive eating may be present in conjunction with psychological distress indicators. Findings also point to the importance of openly discussing effects of BE with patients, as well as on college campuses.

In terms of BD, anxiety, depression and elevated BMI are not significant health outcomes mediated by this behavior among college-age individuals in the sample. It is a challenge to establish alcohol-related predictors and outcomes among a sample where the behavior is largely culturally acceptable. Researchers and practitioners may want to address frequency of BD when evaluating symptoms associated with the behavior.

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Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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Table 1

Characteristics of Binge Drinking/Non-Binge Drinking and Binge Eating/Non-Binge Eating Groups

Demographic Characteristic	Total N=4107	BD N=1968 (48%)	NBD N=2139 (52%)	*p*-value	BE N=982 (24%)	NBE N=3125 (76%)	*p*-value
Age (Median (IQR))	18.5 (18.3, 18.8)	18.5 (18.3, 18.8)	18.5 (18.2, 18.8)	0.0098[1]	18.5 (18.2, 18.8)	18.5 (18.3, 18.8)	0.0392[1]
Race/Ethnicity				<0.0001[1*]			0.0545[1*]
Asian	451 (11%)	208 (11%)	243 (11%)		109 (11%)	342 (11%)	
Black	753 (19%)	285 (15%)	468 (22%)		171 (18%)	582 (19%)	
White	2282 (56%)	1161 (60%)	1121 (53%)		532 (55%)	1750 (57%)	
Hispanic/Latino	273 (7%)				56 (6%)	193 (6%)	
Other	326 (9%)				101 (10%)	230 (7%)	
American Indian/Alaskan Native	16 (0%)						
More than one Race	273 (7%)						
Native Hawaiian/Pacific Islander	24 (1%)						
Not Reported	13 (0%)						
Sex				0.3246[2]			0.0066[2]
Female	2559 (63%)	1240 (63%)	1319 (62%)		647 (66%)	1912 (61%)	
Mother's Education				0.0115[2]			0.7208[2]
Unknown	51 (1%)	23 (1%)	28 (1%)		11 (1%)	40 (1%)	
Less than HS	152 (4%)	54 (3%)	98 (5%)		41 (4%)	111 (4%)	
HS/GED	662 (16%)	317 (16%)	345 (16%)		151 (16%)	511 (17%)	
Some Post HS	875 (22%)	402 (21%)	473 (22%)		219 (23%)	656 (21%)	
College Degree+	2315 (57%)	1144 (59%)	1171 (55%)		547 (56%)	1798 (57%)	
Father's Education				0.1435[1]			0.7208[2]
Unknown	186 (5%)	82 (4%)	104 (5%)		56 (6%)	130 (4%)	
Less than HS	177 (4%)	81 (4%)	96 (6%)		47 (5%)	130 (4%)	
HS/GED	742 (18%)	331 (17%)	411 (20%)		165 (17%)	577 (19%)	
Some Post HS	733 (18%)	352 (18%)	381 (18%)		172 (18%)	561 (18%)	
College Degree+	2182 (54%)	1080(56%)	1102 (53%)		519 (54%)	1663 (54%)	

Clinical Characteristic	Total (N=4107)	BD (N=1968)	NBD (N=2139)	p-value	BE (N=982)	NBE (N=3125)	p-value
BMI Classification				0.0091[3]			<0.0001[3]
Underweight	341 (8%)	139 (7%)	202 (9%)		53 (5%)	288 (9%)	
Normal Weight	2740 (67%)	1359 (69%)	1381 (65%)		604 (62%)	2136 (68%)	
Overweight	692 (17%)	316 (16%)	376 (18%)		208 (21%)	484 (15%)	
Obese	284 (7%)	134 (7%)	150 (7%)		107 (11%)	177 (6%)	
Unknown	50 (1%)	20 (1%)	30 (1%)		10 (1%)	40 (1%)	

Notes. NBD = Non-binge drink; NBE = Non-binge eat; BD =Binge drink; BE = Binge eat;
[1]Mann-Whitney U-test; [1]*p*-value obtained from race/ethnicity categories (Asian, Black, White, Hispanic/Latino, & Other);
[2]Chi-square test, appropriate d.f.
[3]Chi-Square. 3 d. f. (Unknown excluded from analysis)
BMI categories: Underweight (less than 18.5), Normal weight (18.5 to 24.9), Overweight (25 to 29.9) and Obese (30 or greater)

Table 2
Predictor and Health Outcome Variable Means and Standard Deviations of Binge Drinking/Non-Binge Drinking Groups & Binge Eating/Non-Binge Eating Groups

Variable	BD Mean (SD)	NBD Mean (SD)	p-value	BE Mean (SD)	NBE Mean (SD)	p-value
Depression	9.1 (3.7)	8.8 (3.5)	0.0088	10.0 (12.3)	8.6 (3.5)	<0.0001
Anxiety	6.8 (3.1)	6.7 (3.0)	0.4041	7.4 (3.4)	6.5 (2.9)	<0.0001
Stressful Events	3.7 (2.4)	3.5 (2.3)	0.0424	4.1 (2.5)	3.4 (2.3)	<0.0001
Impulsivity Variables						
Lack of Perseverance	1.8 (0.6)	1.7 (0.6)	<0.0001	1.8 (0.6)	1.7 (0.6)	0.0033
Premeditation	1.9 (0.6)	1.8 (0.6)	<0.0001	1.9 (0.6)	1.8 (0.6)	<0.0002
Negative Urgency	2.3 (0.8)	2.1 (0.8)	<0.0001	2.4 (0.8)	2.1 (0.7)	<0.0001
Positive Urgency	2.1 (0.8)	2.0 (0.7)	<0.0001	2.2 (0.8)	2.0 (0.7)	<0.0001
Sensation Seeking	3.1 (0.7)	3.0 (0.7)	<0.0001	3.0 (0.7)	3.0 (0.7)	0.2585

BD/BE Anxiety Mediation Steps (Tables 1a – Table 5)

Table 1a. Baron and Kenny Step 1
Linear Regression Summary for Prediction of Anxiety Score by Predictor

Predictor	Parameter Estimate	Standard Error	*t*-statistic	Model R^2	*p*-value
Lack of Perseverance	0.43	0.09	5.00	0.0064	<0.0001
Lack of Premeditation	0.32	0.08	3.91	0.0039	<0.0001
Negative Urgency	1.28	0.06	20.84	0.1002	<0.0001
Positive Urgency	0.88	0.06	13.65	0.0456	<0.0001
Sensation Seeking	-0.33	0.07	-4.44	0.0050	<0.0001
Stressful Events	0.28	0.02	13.88	0.0449	<0.0001

Table 2a. Baron and Kenny Step 2 (Binge Drinking)
Logistic Regression Summary for Prediction of Binge Drinking by Predictor Variables

Predictor	Parameter Estimate	Standard Error	Chi-Square	En R^2	Gen R^2	Odds Ratio	95% CI	AUC	*p*-value
Lack of Perseverance	0.28	0.06	24.66	0.0046	0.0085	1.32	1.19:1.48	0.55	<0.0001
Lack of Premeditation	0.37	0.05	45.98	0.0086	0.0159	1.44	1.30:1.61	0.56	<0.0001
Negative Urgency	0.29	0.04	46.30	0.0087	0.0159	1.34	1.23:1.46	0.56	<0.0001
Positive Urgency	0.24	0.04	30.10	0.0056	0.0103	1.27	1.17:1.39	0.55	<0.0001
Sensation Seeking	0.31	0.05	39.76	0.0074	0.0137	1.36	1.24:1.50	0.56	<0.0001
Stressful Events	0.02	0.01	2.98	0.0005	0.0010	1.02	1.00:1.05	0.52	0.0845

Table 2b. Baron and Kenny Step 2 (Binge Eating)
Logistic Regression Summary for Prediction of Binge Eating by Predictor Variables

Predictor	Parameter Estimate	Standard Error	Chi-Square	En R^2	Gen R^2	Odds Ratio	95% CI	AUC	*p*-value
Lack of Perseverance	0.20	0.06	9.23	0.0021	0.0035	1.22	1.07:1.38	0.53	<0.0001
Lack of Premeditation	0.24	0.06	14.70	0.0034	0.0056	1.27	1.21:1.43	0.54	<0.0001
Negative Urgency	0.39	0.05	62.38	0.0146	0.0239	1.48	1.34:1.63	0.58	<0.0001
Positive Urgency	0.32	0.05	41.50	0.0096	0.0157	1.38	1.25:1.52	0.57	<0.0001
Sensation Seeking	0.07	0.07	1.33	0.0003	0.0005	1.07	0.96:1.19	0.51	0.2946
Stressful Events	0.12	0.02	64.06	0.0141	0.0231	1.13	1.10:1.17	0.58	<0.0001

Table 3a. Baron and Kenny Step 3
Linear Regression Summary for Prediction of Anxiety Score by Mediation Variables

Predictor	Parameter Estimate	Standard Error	*t*-Statistic	R^2	*p*-value
Binge Drinking	0.08	0.09	0.84	0.0002	0.4037
Binge Eating	0.92	0.11	8.34	0.0167	<0.0001

Table 4a. Baron and Kenny Step 4 (Univariate - BE)
X +BE Anxiety Prediction

Predictor	Parameter Estimate	Standard Error	*t*-statistic	R^2	*p*-value
Lack of Perseverance	0.39	0.08	4.63	0.0230	<0.0001
BE	0.92	0.11	8.15		<0.0001
Lack of Premeditation	0.23	0.08	3.43	0.0205	<0.0006
BE	0.92	0.11	8.13		<0.0001
Negative Urgency	1.23	0.06	12.93	0.1087	<0.0001
BE	0.66	0.12	6.11		<0.0001
Positive Urgency	0.84	0.06	12.93	0.0577	<0.0001
BE	0.79	0.11	7.07		<0.0001
Stressful Events	0.25	0.02	11.11	0.0503	<0.0001
BE	0.76	0.12	6.47		<0.0001

Table 4b. Baron and Kenny Step 4 (Multivariate - BE)
Xs + BE Anxiety Prediction

Predictor	Parameter Estimate	Standard Error	*t*-statistic	*p*-value
Lack of Perseverance	0.35	0.09	4.44	<0.0001
Lack of Premeditation	-0.34	0.09	-4.15	<0.0001
Negative Urgency	1.10	0.08	14.45	<0.0001
Positive Urgency	0.26	0.08	3.34	0.0009
Stressful Events	0.21	0.02	9.58	<0.0001
BE	0.52	0.11	4.55	<0.0001

Note. Model Statistics: F-Statistic =94.6; *p*-value = <0.0001; Adjusted R^2 =0.14

Table 5
Regression Summary Statistics for Multivariate Analysis
Predictor(s) + BE + Confounders: Anxiety Prediction

Predictor	Parameter Estimate	Standard Error	*t*-statistic	*p*-value
Lack of Perseverance	0.37	0.09	4.02	<0.0001
Lack of Premeditation	-0.47	0.09	-5.08	<0.0001
Negative Urgency	1.00	0.08	13.00	<0.0001
Positive Urgency	0.33	0.08	4.22	<0.0001
Stressful Events	0.18	0.02	8.14	<0.0001
Binge Eating	0.49	0.11	4.24	<0.0001
Confounder				
Age	0.04	0.07	0.58	0.5639
Female Gender	0.86	0.10	8.39	<0.0001
Race/Ethnicity (Overall Effect)			*6.81	<0.0001
Race (Asian)	-0.21	0.16	-1.32	0.1879
Race/Ethnicity (Black)	-0.64	0.13	-4.93	<0.0001
Race/Ethnicity (Hispanic/Latino)	-0.53	0.21	-2.57	0.0103
Race/Ethnicity (Other)	-0.20	0.18	-1.12	0.2609
Nicotine Use (Overall Effect)			*11.38	0.0057
Nicotine Use (Moderate)	0.33	0.12	2.74	0.0061
Nicotine Use (Daily)	0.75	0.17	4.41	<0.0001
Spring Survey Participant	-0.15	0.12	-1.29	0.1971

Note. Model Statistics: F-Statistic = 45.7; *p*-value = <0.0001; Adjusted R^2 =0.17
**F-statistic for overall effect test (categorical variables only)

Table 6
Regression Summary Statistics for Multivariate Analysis
Predictor(s) + BD + Confounders: Depression Prediction

Predictor	Parameter Estimate	Standard Error	t-statistic	p-value
Lack of Perseverance	0.46	0.11	4.19	<0.0001
Lack of Premeditation	0.19	0.10	1.88	0.0603
Sensation Seeking	-0.44	0.09	-4.92	<0.0001
Binge Drinking	-0.03	0.12	-0.22	0.8251
Confounder				
Age	-0.00	0.09	-0.05	0.9572
Female Gender	1.23	0.12	10.54	<0.0001
Race/Ethnicity (Overall Effect)			*2.49	0.0415
Race (Asian)	0.07	0.19	0.37	0.7133
Race/Ethnicity (Black)	-0.35	0.16	-2.22	0.0268
Race/Ethnicity (Hispanic/Latino)	-0.29	0.25	-1.14	0.2540
Race/Ethnicity (Other)	0.17	0.22	0.80	0.4219
Nicotine Use (Overall Effect)			*55.79	<0.0001
Nicotine Use (Moderate)	0.86	0.14	5.97	<0.0001
Nicotine Use (Daily)	1.93	0.20	9.85	<0.0001
Spring Survey Participant	0.79	0.15	5.30	<0.0001

Note. Model Statistics: F-Statistic =25.2; *p*-value = <0.0001; Adjusted R^2 =0.08
**F-statistic for overall effect test (categorical variables only)

Table 7

Regression Summary Statistics for Multivariate Analysis
Predictor(s) + BE + Confounders: Depression Prediction

Predictor	Parameter Estimate	Standard Error	*t*-statistic	*p*-value
Lack of Perseverance	0.52	0.11	4.77	<0.0001
Lack of Premeditation	-0.39	0.11	-3.67	0.0002
Negative Urgency	1.47	0.08	18.41	<0.0001
Stressful Events	0.24	0.03	9.46	<0.0001
Binge Eating	0.79	0.13	5.87	<0.0001
Confounder				
Age	0.03	0.09	0.38	0.7029
Female Gender	1.0	0.12	8.33	<0.0001
Race/Ethnicity (Overall Effect)			*0.99	0.4128
Race (Asian)	-0.01	0.18	-0.04	0.9711
Race/Ethnicity (Black)	-0.18	0.15	-1.16	0.2470
Race/Ethnicity (Hispanic/Latino)	-0.28	0.24	-1.17	0.2435
Race/Ethnicity (Other)	-0.19	0.21	0.92	0.3553
Nicotine Use (Overall Effect)			*21.65	<0.0001
Nicotine Use (Moderate)	0.59	0.14	4.13	<0.0001
Nicotine Use (Daily)	1.17	0.20	5.91	<0.0001
Spring Survey Participant	0.78	0.14	5.67	<0.0001

Note. Model Statistics: F-Statistic = 61.6; *p*-value = <0.0001; Adjusted R^2 =0.20

*F-statistic for overall effect test (categorical variables only)

Table 8
Regression Summary Statistics for Multivariate Analysis
Predictor(s) + BE + Confounders: BMI Prediction

Predictor	Parameter Estimate	Standard Error	*t*-statistic	*p*-value
Binge Eating	1.42	0.15	9.28	<0.0001
Confounder				
Age	0.20	0.11	1.80	0.0727
Female Gender	-0.37	0.14	-2.70	0.0070
Race/Ethnicity (Overall Effect)			*32.08	<0.0001
Race (Asian)	-0.49	0.21	-2.29	0.0219
Race/Ethnicity (Black)	1.79	0.18	10.04	<0.0001
Race/Ethnicity (Hispanic/Latino)	0.91	0.28	3.26	0.0011
Race/Ethnicity (Other)	0.71	0.24	2.89	0.0038
Nicotine Use (Overall Effect)			*2.16	0.1151
Nicotine Use (Moderate)	-0.02	0.16	-0.11	0.9126
Nicotine Use (Daily)	-0.45	0.22	-2.05	0.0401
Spring Survey Participant	0.58	0.17	3.40	0.0007

Note. Model Statistics: F-Statistic = 24.4; *p*-value = <0.0001; Adjusted R^2 =0.06
**F-statistic for overall effect test (categorical variables only)

Appendix A. BD/BE Depression Mediation Steps

Appendix A. Table 1. Baron and Kenny Step 1
Linear Regression Summary for Prediction of Depression Score by Predictor

Predictor	Parameter Estimate	Standard Error	*t*-statistic	Model R^2	*p*-value
Lack of Perseverance	0.67	0.10	6.55	0.0109	<0.0001
Lack of Premeditation	0.50	0.10	5.22	0.0069	<0.0001
Negative Urgency	1.66	0.07	22.97	0.1192	<0.0001
Positive Urgency	0.90	0.08	11.63	0.0335	<0.0001
Sensation Seeking	-0.47	0.08	-5.34	0.0072	<0.0001
Stressful Events	0.36	0.02	15.08	0.0527	<0.0001

Appendix A. Table 2a. Baron and Kenny Step 2 (Binge Drinking)
Logistic Regression Summary for Prediction of Binge Drinking by Predictor Variables

Predictor	Parameter Estimate	Standard Error	Chi-Square	En R^2	Gen R^2	Odds Ratio	95% CI	AUC	*p*-value
Lack of Perseverance	0.28	0.06	24.66	0.0046	0.0085	1.32	1.19:1.48	0.55	<0.0001
Lack of Premeditation	0.37	0.05	45.98	0.0086	0.0159	1.44	1.30:1.61	0.56	<0.0001
Negative Urgency	0.29	0.04	46.30	0.0087	0.0159	1.34	1.23:1.46	0.56	<0.0001
Positive Urgency	0.24	0.04	30.10	0.0056	0.0103	1.27	1.17:1.39	0.55	<0.0001
Sensation Seeking	0.31	0.05	39.76	0.0074	0.0137	1.36	1.24:1.50	0.56	<0.0001
Stressful Events	0.02	0.01	2.98	0.0005	0.0010	1.02	1.00:1.05	0.52	0.0845

Appendix A. Table 2b. Baron and Kenny Step 2 (Binge Eating)
Logistic Regression Summary for Prediction of Binge Eating by Predictor Variables

Predictor	Parameter Estimate	Standard Error	Chi-Square	En R^2	Gen R^2	Odds Ratio	95% CI	AUC	*p*-value
Lack of Perseverance	0.20	0.06	9.23	0.0021	0.0035	1.22	1.07:1.38	0.53	<0.0001
Lack of Premeditation	0.24	0.06	14.70	0.0034	0.0056	1.27	1.21:1.43	0.54	<0.0001
Negative Urgency	0.39	0.05	62.38	0.0146	0.0239	1.48	1.34:1.63	0.58	<0.0001
Positive Urgency	0.32	0.05	41.50	0.0096	0.0157	1.38	1.25:1.52	0.57	<0.0001
Sensation Seeking	0.07	0.07	1.33	0.0003	0.0005	1.07	0.96:1.19	0.51	0.2946
Stressful Events	0.12	0.02	64.06	0.0141	0.0231	1.13	1.10:1.17	0.58	<0.0001

Appendix A. Table 3. Baron and Kenny Step 3
Linear Regression Summary for Prediction of Depression Score by Mediation Variables

Predictor	Parameter Estimate	Standard Error	*t*-Statistic	R^2	*p*-value
Binge Drinking	0.30	0.11	2.63	0.0002	0.0086
Binge Eating	1.42	0.13	10.80	0.0277	<0.0001

Appendix A. Table 4a. Baron and Kenny Step 4 (Univariate - BD)
X + BD Depression Prediction

Predictor	Parameter Estimate	Standard Error	*t*-statistic	R^2	*p*-value
Lack of Perseverance	0.65	0.10	6.37	0.0119	<0.0001
BD	0.23	0.11	1.99		0.0461
Lack of Premeditation	0.48	0.10	4.97	0.0079	<0.0000
BD	0.23	0.12	1.97		0.0487
Negative Urgency	1.66	0.07	22.81	0.1192	<0.0001
BD	0.03	0.11	0.26		0.7953
Positive Urgency	0.89	0.08	11.45	0.0341	<0.0001
BD	0.18	0.12	1.53		0.1259
Sensation Seeking	-0.50	0.09	-5.64	0.0098	<0.0001
BD	0.37	0.12	3.14		0.0017

Appendix A. Table 4b. Baron and Kenny Step 4 (Multivariate - BD)
Xs + BD Depression Prediction

Predictor	Parameter Estimate	Standard Error	*t*-statistic	*p*-value
Lack of Perseverance	0.47	0.11	4.21	<0.0001
Lack of Premeditation	0.35	0.11	3.33	0.0009
Sensation Seeking	-0.49	0.09	-5.53	<0.0001
BD	0.27	0.12	2.34	0.0193

Note. Model Statistics: F-Statistic =21.6; *p*-value = <0.0001; Adjusted R^2=0.02

Appendix A. Table 5a. Baron and Kenny Step 4 (Univariate - BE)
X + BE Depression Prediction

Predictor	Parameter Estimate	Standard Error	*t*-statistic	R^2	*p*-value
Lack of Perseverance	0.61	0.10	6.11	0.0374	<0.0001
BE	1.38	0.13	10.37		<0.0001
Lack of Premeditation	0.44	0.10	4.63	0.0338	<0.0006
BE	1.40	0.13	10.42		<0.0001
Negative Urgency	1.58	0.07	21.92	0.1347	<0.0001
BE	1.07	0.13	8.37		<0.0001
Positive Urgency	0.83	0.08	10.69	0.0561	<0.0001
BE	1.28	0.13	9.64		<0.0001
Stressful Events	0.34	0.03	12.74	0.0687	<0.0001
BE	1.15	0.14	8.16		<0.0001

Appendix A. Table 5b. Baron and Kenny Step 4 (Multivariate - BE)
Xs + BE Depression Prediction

Predictor	Parameter Estimate	Standard Error	*t*-statistic value	*p*-value
Lack of Perseverance	0.53	0.11	4.90	<0.0001
Lack of Premeditation	-0.33	0.11	-3.06	0.0022
Negative Urgency	1.55	0.08	19.46	<0.0001
Stressful Events	0.28	0.03	11.05	<0.0001
BE	0.85	0.14	6.28	<0.0001

Note. Model Statistics: F-Statistic = 140.0; p-value = <0.0001; Adjusted R^2 =0.17
Final Depression Models: Previously shown (Tables 6-7).

Appendix B. BD/BE BMI Mediation Steps

Appendix B. Table 1. Baron and Kenny Step 1
Linear Regression Summary Statistics for Prediction of BMI

Predictor	Parameter Estimate	Standard Error	t-statistic	Model R^2	p-value
Lack of Perseverance	-0.12	0.12	-0.99	0.0003	0.3217
Lack of Premeditation	-0.09	0.11	-0.76	0.0002	0.4464
Negative Urgency	-0.06	0.09	-0.66	0.0001	0.5082
Positive Urgency	-0.04	0.09	-0.41	0.0000	0.6846
Sensation Seeking	-0.47	0.10	-4.60	0.0054	<0.0001
Stressful Events	0.04	0.03	1.26	0.0004	0.2086

Appendix B. Table 2a. Baron and Kenny Step 2 (Binge Drinking)
Logistic Regression Summary for Prediction of Binge Drinking by Predictor Variables

Predictor	Parameter Estimate	Standard Error	Chi-Square	En R^2	Gen R^2	Odds Ratio	95% CI	AUC	p-value
Lack of Perseverance	0.28	0.06	24.66	0.0046	0.0085	1.32	1.19:1.48	0.55	<0.0001
Lack of Premeditation	0.37	0.05	45.98	0.0086	0.0159	1.44	1.30:1.61	0.56	<0.0001
Negative Urgency	0.29	0.04	46.30	0.0087	0.0159	1.34	1.23:1.46	0.56	<0.0001
Positive Urgency	0.24	0.04	30.10	0.0056	0.0103	1.27	1.17:1.39	0.55	<0.0001
Sensation Seeking	0.31	0.05	39.76	0.0074	0.0137	1.36	1.24:1.50	0.56	<0.0001
Stressful Events	0.02	0.01	2.98	0.0005	0.0010	1.02	1.00:1.05	0.52	0.0845

Appendix B. Table 2b. Baron and Kenny Step 2 (Binge Eating)

Logistic Regression Summary for Prediction of Binge Eating by Predictor Variables

Predictor	Parameter Estimate	Standard Error	Chi-Square	En R^2	Gen R^2	Odds Ratio	95% CI	AUC	*p*-value
Lack of Perseverance	0.20	0.06	9.23	0.0021	0.0035	1.22	1.07:1.38	0.53	<0.0001
Lack of Premeditation	0.24	0.06	14.70	0.0034	0.0056	1.27	1.21:1.43	0.54	<0.0001
Negative Urgency	0.39	0.05	62.38	0.0146	0.0239	1.48	1.34:1.63	0.58	<0.0001
Positive Urgency	0.32	0.05	41.50	0.0096	0.0157	1.38	1.25:1.52	0.57	<0.0001
Sensation Seeking	0.07	0.07	1.33	0.0003	0.0005	1.07	0.96:1.19	0.51	0.2946
Stressful Events	0.12	0.02	64.06	0.0141	0.0231	1.13	1.10:1.17	0.58	<0.0001

Appendix B. Table 3. Baron and Kenny Step 3

Linear Regression Summary Statistics for Prediction of BMI by Mediation Variable

Predictor	Parameter Estimate	Standard Error	*t*-Statistic	R^2	*p*-value
Binge Drinking	0.04	0.13	0.28	0.0000	0.7779
Binge Eating	1.34	0.15	8.78	0.0187	<0.0001

Appendix B. Table 4. Baron and Kenny Step 4 (Multivariate - BD)

X(s) + BE BMI Prediction

Predictor	Parameter Estimate	Standard Error	*t*-statistic	*p*-value
BE	1.40	0.16	8.94	<0.0001

Note. Model Statistics: F-Statistic = 77.1; *p*-value = <0.0001; Adjusted R^2 =0.02

Final BMI Model: Previously shown (Table 8).

Manuscript 3

A Genome-Wide Association Study Investigating Binge Drinking and Eating in College-Age Youth

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ABSTRACT

Background: Binge eating (BE) is becoming more prevalent and is included as a unique

eating disorder in the Diagnostic and Statistical Manual's Fifth Edition (DSM-5). BE is

closely linked to overweight/obesity while both binge drinking (BD) and BE are

associated with marked psychological distress. BD and BE are prevalent among

American college students and can lead to long-term health consequences. Evidence

shows that BE and alcohol-use disorders are moderately heritable (approximately 40%

and 50%, respectively). Studies propose that the dopaminergic, opioidergic, and

serotonergic pathways may be affected in each binge type; however, the etiology of binge

behavior remains largely unexplained.

Objective: This study examined BD and BE in a college-age population to test whether

shared single nucleotide polymorphisms (SNPs) presented for binge drinking and binge

eating.

Methods: Participants were part of a primary study at a public urban university that

assessed mental health and high-risk health behaviors. A secondary analysis used

genome-wide association studies (GWAS) to examine genetic associations with binge

phenotypes.

Results: The BD and BE GWAS identified no genome-wide significant (GWS) hits.

However, the BE GWAS gene-based tests revealed five potential candidate genes:

PURG, LYPD5, SKAP2, TRAPPC1, and *NCOA2*. No genetic overlap was noted between

BE and BD.

Discussion: Further studies are needed to understand the genetics of BE and BD. While

the college-age population engages in both binge types at high rates, further determinants

may be needed regarding BD to separate risky drinking behaviors from problem drinking at this age. Authors also discuss the study as an actualization of team science.

Key Words: genome-wide association study (GWAS), binge drink, binge eat, college-youth, comorbidity, addiction, team science

Binge eating disorder (BED) has surpassed other eating disorders and is now the eating disorder with the highest prevalence (Montano, Rasgon, & Herman, 2016; Striegel-Moore & Franko, 2008). The DSM-5 removed it from the Eating Disorder Not Otherwise Specified category and instead included it as a unique feeding and eating disorder (American Psychiatric Association, 2013). Binge eating (BE) is defined as eating an amount that is larger than what most people would eat in a discrete time period in similar circumstances and as experiencing a lack of control over eating during the episode (American Psychiatric Association, 2013). Marked psychological distress is associated with binge eating (Brunault et al., 2016; Castellini et al., 2016; Vanderlinden, Grave, Vandereycken, & Noorduin, 2001), as well as robust associations of binge eating coexisting with impulsivity (Kessler, Hutson, Herman, & Potenza, 2016; Leehr et al., 2016) and overweight/obesity (Davis et al., 2017; Tanofsky-Kraff et al., 2013). BED is present in approximately 3% of the population (Mustelin, Bulik, Kaprio, & Keski-Rahkonen, 2017) and BE itself is a behavior that is common on college campuses as well as within the general population, with rates ranging from 8% to 13% (da Luz et al., 2017; Filipova & Stoffel, 2016; Mitchison, Touyz, Gonzalez-Chica, Stocks, & Hay, 2017; Pearson et al., 2017). Moreover, binge eating is highly stigmatized and privatized contributing to underreport and under treatment (Ling, Rascati, & Pawaskar, 2017; Lipson & Sonneville, 2017; Montano et al., 2016; Pawaskar et al., 2016).

Binge eating is complex, multifaceted and multi-determined, thus influencing researchers and practitioners to approach the study of the condition from a holistic perspective. In addition to psychological-based associations to BE and comorbidity with other psychiatric disorders, BED demonstrates a moderate heritability rate of

approximately 40% (Boraska et al., 2012; Helder & Collier, 2011; Javaras et al., 2008; Lilenfeld, Ringham, Kalarchian, & Marcus, 2008; Mitchell et al., 2010; Reichborn-Kjennerud, Bulik, Tambs, & Harris, 2004; Trace, Baker, Penas-Lledo, & Bulik, 2013). While some researchers attribute binge eating to reward sensitivity and arousal-based responses to foods (Eneva et al., 2017; Hebebrand et al., 2014; Loxton & Tipman, 2016; Woodward, Treat, Cameron, & Yegorova, 2017), others relate these responses to genetic and neurobiological mechanisms underlying addictive disorders (Kessler, Hutson, Herman, & Potenza, 2016; Volkow, Wang, & Baler, 2011).

There is evidence that molecular and genetic determinants also present for alcohol use disorder, and that substance use disorders show a genetic propensity towards addiction, however much genetic heterogeneity remains unexplained (Awofala, 2013; Kimura & Higuchi, 2011; Mackey et al., 2016; Tawa, Hall, & Lohoff, 2016; Wansink, Kniffin, & Shimizu, 2012; Yu & McClellan, 2016). While there is a substantial body of literature that investigates binge phenotypes separately, a smaller number of studies have directly compared genetics of comorbid binge eating and substance use disorders (Lilenfeld et al., 2008; Munn-Chernoff & Baker, 2016; Munn-Chernoff et al., 2013; Schreiber, Odlaug, & Grant, 2013; Schulte, Grilo, & Gearhardt, 2016). Kendler et al. (1995) were among the first to investigate eating and substance use disorders together in twin studies, and found that there was a 6% genetic overlap of bulimia nervosa with genetic liability to alcoholism. Bulimia nervosa is an eating disorder that contains a binge eating component, yet the binge is followed by a compensatory behavior such as excessive exercise and/or purging, for example. With the inclusion of BED as a unique diagnosis in the DSM-5, coupled with the limited understanding surrounding the etiology

of binge behavior, this study aims to determine if genetic overlap is seen among binge

drinking and binge eating phenotypes in the college-age sample of study.

Though the candidate gene era has been largely unsuccessful for complex traits

(Dick et al., 2015; Pearson & Manolio, 2008), the literature does provide some evidence

of genes and gene systems that may be shared between binge phenotypes (Agrawal et al.,

2013; Fortuna, 2010; Yilmaz, Hardaway, & Bulik, 2015). *FTO*, known as the "obesity

risk gene", while demonstrating strong genetic links to elevated body mass, is also

studied in terms of association with binge eating and loss of control eating (Castellini et

al., 2017; Micali, Field, Treasure, & Evans, 2015; Speliotes et al., 2010; Tanofsky-Kraff

et al., 2009), as well as alcohol dependence (Goodyear, Lee, Schwandt, Hodgkinson, &

Leggio, 2017; Hubacek et al., 2012; Lichenstein et al., 2014; Sobczyk-Kopciol et al.,

2011; Wang et al., 2013). Genetic dopaminergic variation has been widely studied in

regard to reward sensitivity related to dysregulated eating, obesity and risky alcohol use

(Barnea et al., 2017; Blum et al., 2011; Qi et al., 2014; van der Zwaluw, Kuntsche, &

Engels, 2011; Volkow et al., 2011; Volkow & Wise, 2005; Wise, 2013). Similarly,

serotonin transporter gene polymorphisms have also been studied in relation to binge

eating and emotional eating (Akkermann et al., 2012; Calati, De Ronchi, Bellini, &

Serretti, 2011; Koren et al., 2014; Monteleone, Tortorella, Castaldo, & Maj, 2006; van

Strien, van der Zwaluw, & Engels, 2010) as well as the role of the serotonergic system in

alcohol dependence (Enoch, Gorodetsky, Hodgkinson, Roy, & Goldman, 2011; Sari,

Johnson, & Weedman, 2011). Studies on influences in adolescent and college-age

alcohol use show that those with the *5-HTTLPR* s-allele in the *SLC6A4* gene may be at

risk for increases in alcohol use, especially in conjunction with heightened perceived

stress (Covault et al., 2007; Herman, Philbeck, Vasilopoulos, & Depetrillo, 2003; van der Zwaluw et al., 2011). Lastly, the role of *OPRM1* genotype also shows support for influence on cue-induced cravings for alcohol and is thought to play a part in alcohol dependence (Nutt, 2014; Ray, 2011; Ray, Bujarski, Squeglia, Ashenhurst, & Anton, 2014). Of related interest, Naltrexone, a mu-opioid receptor antagonist, is an FDA approved drug that is approved for treatment of patients with alcohol dependence as well as for those with problematic food cravings and BED (Ashenhurst, Bujarski, & Ray, 2012; Berrettini, 2016; Cambridge et al., 2013; Piquet-Pessoa & Fontenelle, 2016).

Because of the genetic overlap existent in the literature indicating similar pathophysiologic and translational findings for binge eating behavior and alcohol abuse when studied separately, this study aims to investigate if the presence of genetic influence on binge eating and binge drinking among college-age youth is evidenced from a genome-wide association study (GWAS). GWAS allow for an agnostic approach to identify genomic regions of interest instead of focusing solely on candidate gene methodology. College-age youth are a population vulnerable to new life stressors as well as to heightened binge eating and drinking rates (Kelly-Weeder & Edwards, 2011; Kuntsche, Kuntsche, Thrul, & Gmel, 2017; Martin, Groth, Longo, Rocha, & Martens, 2015). It is a time where behavioral-based addictions may take root and begin to develop into concerns related to impaired functioning later in life (Kessler et al., 2007; López-Caneda, Rodríguez Holguín, Corral, Doallo, & Cadaveira, 2014; Meyers & Dick, 2010). A cross-sectional analysis of data from years 2011-2013 of the *Spit for Science* dataset at a large urban university on the East Coast of the United States was used to investigate if

shared single nucleotide polymorphisms (SNPs) presented for binge drinking and binge eating in college-age youth.

METHODS

Data and Setting

A secondary data analysis of *Spit for Science* data was utilized for the current project. *Spit for Science* is a university-wide study that commenced in the fall of 2011 and investigates how genes and environments influence behavior and substance use during the developmental phase of young adulthood. The study takes place at a large, urban four-year university in the mid-Atlantic region of the United States. Incoming freshmen age 18 years or older are invited to participate. Participants are asked to complete a baseline survey and to provide a four-ml saliva sample for DNA processing in the fall or mid-spring semester of their freshman year. They are invited to complete a follow-up survey mid-spring semester of each subsequent year of their undergraduate education, and survey data are collected using a university-hosted electronic data organization tool, Research Electronic Data Capture (REDCap) (Harris et al., 2009). Participants receive ten dollars for the completion of each survey, as well as for contributing the one-time saliva sample (Dick et al., 2014).

Participants

Fall participant data collected from college freshman upon entry to the study during the years 2011-2013 were utilized for this secondary data analysis. After excluding those who had never been exposed to alcohol, those who were not of European or African ancestry (due to sample size requirements for GWAS; see Association

Analyses below), and those who were missing a DNA sample, the final sample included

2386 participants.

Measures

Binge Drink Phenotype

These data informed gene identification by way of GWAS based on a binary

phenotypic model for binge. The BD phenotype was formed based on the National

Institute on Alcohol Abuse and Alcoholism (NIAAA) definition for BD, which includes

the consumption of four or more alcoholic drinks for females and five or more alcoholic

drinks for males during one setting on at least one day out of the past month (NIAAA,

2017). Those who responded "no" to the question "Have you ever had at least one drink

of any kind of alcohol?" were excluded from the study. The BD phenotype was formed

based upon responses to questions about the number of drinks consumed on a typical day

when the participant drank. Those questions included frequency-based consumption

questions from the Alcohol Use Disorders Identification Test (AUDIT): "How many

drinks containing alcohol do you have on a typical day when you drink?" and "During

the past 30 days on the days that you drank how many drinks did you have each day?"

(Babor et al., 2001). Those students who were exposed to alcohol but did not meet binge

drinking criteria were considered controls for the binge drink group.

Binge Eat Phenotype

Endorsement of BE was determined based on responses to a question derived

from the Eating Disorder Examination-Questionnaire (EDE-Q), which has been

incorporated into the DSM-5 diagnostic criteria for binge eating disorder (BED) (Dick et

al., 2014; Fairburn & Beglin, 1994). To assess for the presence of BE, individuals were

asked whether there have been times during the last four weeks "when you felt that you had eaten what other people would regard as an unusually large amount of food given the circumstances" (Dick et al., 2014). Students who did not endorse binge eating in the past 28 days were considered controls for the eating group.

Genotyping and Ancestry Assignment

The DNA samples were genotyped on the Affymetrix Biobank Version 2 Array imputed using 1000 genomes phase 3 reference panel. From five ancestry groups determined by ancestry principal components (PC) we included European and African subsamples for future analyses. American, East Asian and South Asian descent ancestry groups had small sample sizes and were therefore excluded from the analyses. Details regarding sample extraction, QC, imputation and ancestry PC calculations are provided in a manuscript by B. T. Webb et al. (2017).

Association Analyses

Association analyses were used to test for allele frequency differences between cases and controls at single nucleotide polymorphisms (SNPs) across the genome. This technique has been used to identify areas of the genome that warrant further investigation. Case-control GWAS were conducted for BD and BE, separately, using SNPTEST v2.5.2, a program for the analysis of single SNP association in genome-wide studies (MAF = 0.005, Info = .95) (Marchini, Howie, Myers, McVean, & Donnelly, 2007). Sex and sub-sample specific ancestry PCs were included as covariates. For each phenotype, samples of European and African ancestry were analyzed separately, and then meta-analyzed with a tool for meta-analysis in GWAS called METAL that uses p-values across the GWAS and takes direction of effect and sample size into account

(Willer, Li, & Abecasis, 2010) to combine European and African subsample results. To

assess if there are any systematic biases that may be present in the GWAS, genomic

inflation (lambda) was estimated using R (R Core Team, 2016). The "q-value" package

in R (https://github.com/jdstorey/qvalue) was used to calculate the false discovery rate for

each single nucleotide polymorphism.

GWAS results were further analyzed and visualized through FUMA, a web-

based platform that allows for functional mapping, annotation, visualization and

interpretation of GWAS results (Watanabe, Taskesen, van Bochoven, & Posthuma,

2017). FUMA also serves as a convenient platform from which to run post-GWAS

analyses. For this study we ran Multiobjective Analyzer for Genetic Marker Acquisition

(MAGMA) software through the FUMA platform. MAGMA takes GWAS p-values from

each SNP and conducts a hypothesis-free gene-based analyses. Briefly, the approach

considers associations between the phenotype and aggregate signal from SNPs within a

gene rather than each SNP individually. MAGMA combines the effects of SNPs within a

gene by averaging p-values across the gene to get a gene-based p-value (de Leeuw,

Mooij, Heskes, & Posthuma, 2015). Genes are then ranked by these p-values.

Importantly, MAGMA accounts for linkage disequilibrium (LD) such that only those

SNPs in a gene that carry independent information from each other are evaluated. In the

analyses, the LD threshold was set to r2=0.6 to impose a threshold to limit the number of

redundant SNPs, and the reference population was African.

In a subsequent step to determine genetic variation among those who endorsed

binge drinking and/or binge eating, an abbreviated hypothesis-based candidate gene

approach was used. Predetermined candidate genes entailed five genes of interest due to

their association with the binge drinking and binge eating phenotypes, obesity and addiction pathways found in the literature: *DRD2, DRD4, OPRM-1, 5-HTT,* and *FTO.* The genes were identified by their position and size drawn from the University of California Santa Cruz (UCSC) Human (Homo sapiens) Genome Browser Gateway February 2009, GRCh37/hg19 assembly (Kent et al., 2002). Analyses were conducted by extracting GWAS results for SNPs up- and downstream from each gene in order to capture regulatory regions (averaging +/- 400 base pairs in each direction), and were subsequently supplied to Locus Zoom software for visualization (Pruim et al., 2010).

RESULTS

Descriptive Statistics

Participant demographics of sex, age, genetically-informed ancestry and maternal/paternal education histories for the population of interest are presented in Table 1. The African ancestry group was compromised of 603 (25%) participants, while the European ancestry group had 1783 (75%) participants. The sample consisted of more females than males (64% vs. 36%, respectively), and females reported slightly higher BE levels (67% vs 33%, p = 0.084) while participants of European ancestry reported significantly higher BD levels (81% vs 19%, p = <0.0001). Mean binge eat and drink values for each phenotype are reported in Table 1.

Table 1

Demographics of Binge Drink/Non-Binge Drink and Binge Eat/Non-Binge Eat Groups

NBD = Non-binge drink; NBE = Non-binge eat; BD =Binge drink; BE = Binge eat

Characteristic	Total Sample N=2386	BD N=1036 (43%)	NBD N=1350 (57%)	*p*-value	BE N=582 (24%)	NBE N=1804 (76%)	*p*-value
Median Age (IQR)	18.5 (18.2, 18.7)	18.4 (18.2, 18.7)	18.5 (18.2, 18.7)	0.2376[1]	18.4 (18.2, 18.7)	18.5 (18.2, 18.7)	0.1429[1]
Ancestry				<0.0001[2*]			0.8337[2*]
African	603 (25%)	201 (19%)	402 (30%)		149 (26%)	454 (25%)	
European	1783 (75%)	835 (81%)	948 (70%)		443 (74%)	1350 (75%)	
Sex				0.3458[2]			0.0844[2]
Female	1536 (64%)	656 (63%)	656 (63%)		392 (67%)	1144 (63%)	
Mother's Education				0.0355[2]			0.7122[2]
Student does not know	20 (1%)	9 (1%)	11 (1%)		8 (1%)	34 (1%)	
Less than HS	58 (2%)	14 (1%)	44 (3%)		34 (4%)	96 (4%)	
HS or GED	354 (15%)	159 (15%)	195 (15%)		129 (16%)	403 (17%)	
Some ED post HS	524 (22%)	219 (21%)	305 (23%)		184 (23%)	516 (21%)	
College degree +	1410 (60%)	627 (61%)	783 (59%)		441 (55%)	1382 (57%)	
Father's Education				0.4621[2]			0.4036[2]
Student does not know	107 (5%)	44 (4%)	63 (5%)		33 (6%)	74 (4%)	
Less than HS	75 (3%)	31 (3%)	44 (3%)		16 (3%)	59 (3%)	
HS or GED	427 (18%)	171 (17%)	256 (19%)		95 (16%)	332 (19%)	
Some ED post HS	460 (20%)	205 (20%)	255 (19%)		114 (20%)	346 (20%)	
College degree +	1282 (55%)	575 (56%)	707 (53%)		319 (55%)	963 (54%)	

[1]Mann-Whitney U-test; [2*]*p*-value obtained from ancestry categories (African, European);
[2]Chi-square test, appropriate d.f.

GWAS Results

SNP-Based Results

Results were available for 2,869,225 markers for BD and 2,869,175 markers for BE after meta-analysis. QQ plots and lambda calculation suggested no evidence of genomic inflation (lambda 0.984 and 1.004, respectively). Neither GWAS produced GWS SNPs ($p \leq 5$ x 10^{-8}), and the q-values for the top SNP for BE (0.97) and BD (0.99) exceeded 0.9, suggesting no evidence of significant signal enrichment. Table 2 shows top SNPs ranked by p-value for the BD and BE GWAS, the chromosome in which the SNP lies, its base pair position, and gene name (if the SNP falls within a gene). The overall results for each GWAS are visualized in Figures 1a and 1b using Manhattan plots. Each dot in the Manhattan plots represents a SNP and SNPs are grouped by chromosome along the x-axis and significance along the y-axis. The most concentrated signal enrichment is on chromosome 16 for BD and chromosome 15 for BE (Figures 1a and 1b), though, as stated before, the lack of significance suggests these results should be interpreted with caution.

Table 2

Top SNP signals from Binge Drink and Binge Eat GWAS

Phenotype	Chromosome	SNP	Position (base pair)	Gene	p-Value
Binge Drink					
	16	rs3760118	70799409	*VAC14*	1.56E-06
	16	rs7204966	80289745	LOC102724084	4.69E-06
	16	rs2139108	80270313	LOC102724084	4.78E-06
	16	rs9924980	80287180	LOC102724084	7.63E-06
	13	rs73446888	28163123	*LNX2*	8.51E-06
Binge Eat					
	15	rs7173733	81121664	*CEMIP*	2.63E-06
	15	rs28459142	81122298	*CEMIP*	5.58E-06
	2	rs1430347	73367059		8.21E-06
	15	rs55653454	81114639	*CEMIP*	8.39E-06
	4	rs6843243	28979132		8.43E-06

Note: BD = Binge Drink; BE = Binge Eat; No single SNP GWS ($p \leq 5$ x 10^{-8})

FIGURE 1a: *Manhattan plot of Binge Drink SNP-Based GWAS summary statistics*

Each dot in the Manhattan plots represents a SNP. SNPs are grouped by chromosome along the x-axis and significance along the y-axis. The red dashed line indicates GWS SNPs threshold ($p \leq 5$ x 10^{-8}).
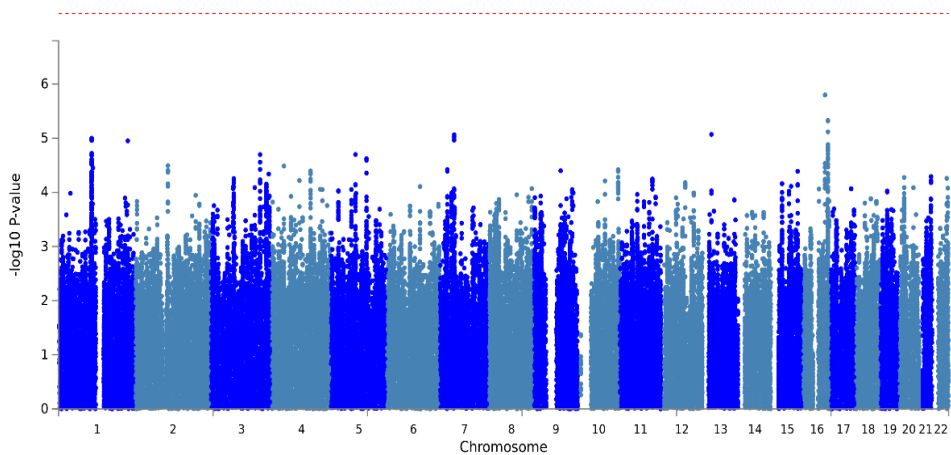
FIGURE 1b: *Manhattan plot of Binge Eat SNP-Based GWAS*
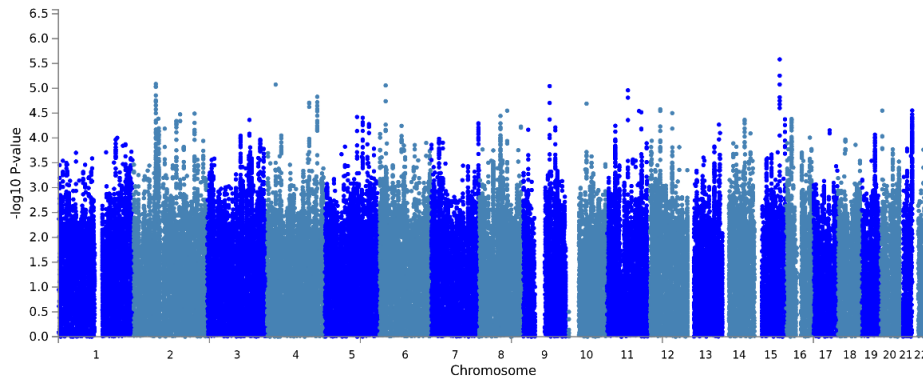
Gene-Based Results

Aforementioned hypothesis-based genes of interest that have been isolated from previous candidate gene studies in the literature demonstrated no significant outcomes. To test for hypothesis-free gene-based associations with BD and BE, MAGMA was used. This gene-based analysis approach considered associations between the phenotype and aggregate signal from GWAS SNPs within a gene rather than each SNP individually. Based on 14,689 genes present in this analysis and Bonferroni correction, the genome-wide p-value was set at $p = 0.05/14689 = 3.4e-6$.

No hypothesis-free genes met genome-wide significance from the BD gene-based test. However, five new genes demonstrated genome-wide significance for BE ($p<3.4E-6$): *PURG* ($p = 1.24e-06$), *LYPD5* ($p = 1.38e-06$), *SKAP2* ($p = 2.03e-06$), *TRAPPC1* ($p = 3.20e-06$), *NCOA2* ($p = 3.38e-06$). The Manhattan plot of the hypothesis-free gene-based test results for BE is presented in Figure 2. In this case, each dot represents a gene queried in the analysis. Genes are organized according to chromosome placement (x-axis) and significance level (y-axis). The red dashed line is the gene-based genome-wide

p-value threshold aforementioned, and the five GWS genes are noted above this threshold.

FIGURE 2: Binge eat hypothesis-free gene-based test results
results
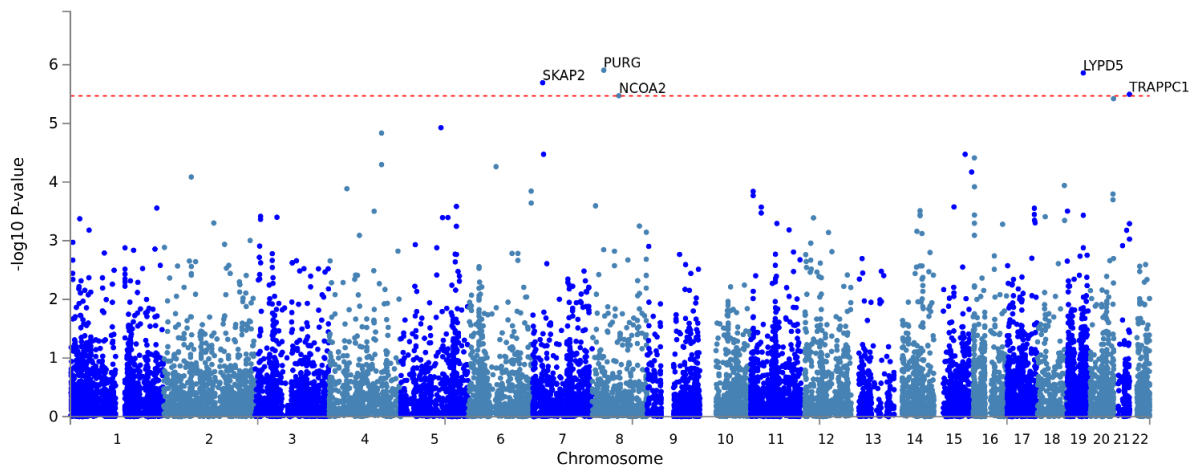
Note: Genome wide significance (red dashed line in the plot) was defined at *p* = 0.05/14689 = 3.4e-6.

DISCUSSION

Individual GWAS of BD and BE in a college-age population produced no genome-wide significant SNP signals. Though not GWS, top SNPs for BD lie within genes *VAC14* and *LNX2*. Top SNPs for BE lie within the *CEMIP* (*KIAA1199*) gene which is a gene related to pathways for glycosaminoglycan metabolism, colorectal, gastric and breast cancer progression; and is stated as a likely target gene of the Wnt/β-catenin signaling pathway (Jami et al., 2014; Jia et al., 2017; Zhang, Jia, & Jiang, 2014).

While the hypothesis-based candidate genes did not demonstrate significance, hypothesis-free gene-based analyses yielded five new candidate genes for BE. Of note, gene-based p-values for each of these 5 genes identified through BE were > 0.05 in the BD analysis, suggesting no evidence of overlap with the BE phenotype. *PURG* (Purine

Rich Element Binding Protein G) is a protein coding gene that lies closely to the Werner

syndrome (characterized by rapid appearance of aging) gene on an opposite strand on

chromosome 8 (Liu & Johnson, 2002). *LYPD5* is known to have a role in the metabolism

of proteins and is thought to also play a role in homeostasis of the skin (Gardsvoll,

Kriegbaum, Hertz, Alpizar-Alpizar, & Ploug, 2013). *SKAP2* is an adaptor protein coding

gene that is thought to affect the activation of the immune system, candidiasis, and the

Src signaling pathway (Reddy et al., 2011; Tanaka et al., 2016). *TRAPPC1* stands for

Trafficking Protein Particle Complex 1 and is involved in transporting proteins to the

Golgi apparatus (Sacher, Kim, Lavie, Oh, & Segev, 2008). The last of the five

significant genes for BE is *NCOA2* whose protein is thought to co-activate hormone

receptors that include thyroid, retinoid, Vitamin D and steroid receptors and *NCOA2* also

shows related pathways to Circadian rhythm genes (Eelen et al., 2006; Szwarc,

Kommagani, Lessey, & Lydon, 2014). Of the five candidate genes, *NCOA2* is the only

one to have previously documented involvement in eating-related behaviors. Lu et al.

(2015) found associations of a SNP with the gene, rs10504473, with obesity in the

Chinese Han population. The variant was not observed in the current sample, though

SNPs located near rs10504473 showed signal enrichment in the BE GWAS.

Limitations and Future Considerations

While the present study identified new candidate genes of significance from the

BE phenotype, it did not yield any statistically significant results from the BD GWAS.

Success in finding genetic risk variants for complex disorders is limited for small sample

sizes such as ours of 2386 in GWAS due to a combination of small sample sizes and

small effect sizes of each individual SNP in the GWAS. Large patient samples of

approximately 25-30,000 generate much more promising GWAS results, and genetic studies with sufficient sample sizes for complex disorders are needed (Hinney & Volckmar, 2013; Visscher et al., 2017). For example, though schizophrenia has long been known to have a strong underlying genetic component, identification of genes substantially contributing to the disorder had been lacking. A recent study of 25,000 persons with schizophrenia identified 100 associated loci and biological implications are now being investigated by drug experts (Lencz & Malhotra, 2015). GWAS done on large samples appears to lead to the opportunity to expedite the path of deriving clinical utility from GWAS findings.

As Pearson and Manolio state in their 2008 article on interpreting a GWAS, "Misclassification of case participants can markedly reduce study power and bias study results toward no association, particularly when large numbers of unaffected individuals are misclassified as affected" (p. 1338). Our GWAS samples were precisely formed according to PC ancestry in their inclusion of African and European ancestry; however, the formation of our phenotypes is under question. With each GWAS including a small sample of 2386 individuals, it was likely imperative to have a phenotype classified correctly for the potential of genetic variation to be identified across groups. It is suspected that the BE group was a better classified group than the BD group in this college-age population. Preliminary analyses suggest that the BD phenotype showed rates in alignment with BD in undergraduate college populations nationally at 43%. It is probable that risky drinking behaviors could not be separated from problem drinking at this age by forming the phenotype from a binary approach assessing BD within a month. Including frequency of BD episodes within the month would have helped to more

precisely classify risky drinking from problem drinking in this population where BD is more common than the national average, however more specific and detailed binge frequency was not available in primary data set.

While lack of genome-wide significant SNPs may have stemmed from oversaturation of the BD phenotype in the study population, it is worth mentioning that a yes/no approach to BE within a month resulted in identification of genome-wide significance at the gene level. This may further support that there is relevance behind simply asking participants if they felt they had eaten what other people would regard as an unusually large amount of food given the circumstances to identify the presence of BE across populations, and may also be translatable to practice. Hypothesis-free gene based statistical relevance indicates that we may have had a well-classified phenotype, despite the small N for a GWAS; however, it is difficult to say whether any of the significant genes for BE can be replicated in additional samples or are clinically relevant at this point. Since statistical significance does not mean clinical significance, replication is an important consideration in research. Even when significant results are yielded, history shows that studies are often not replicable without an N of approximately 30,000 that then presents a threshold that may yield statistically significant replicable results (Visscher et al., 2017).

Additional future considerations could include more advanced modeling techniques to address genetic overlap between traits. Genome-wide complex trait analysis (GCTA) can measure shared heritability between traits (Yang, Lee, Goddard, & Visscher, 2011). The relatively small sample sizes present in this study prohibited these analyses. A new technique (MTAG: Multi-Trait Analysis of GWAS) was recently

developed which allows multiple phenotypes to be examined simultaneously. It can boost power (combining samples to increase sample size) while also correcting for non-independence between samples (Turley et al., 2017).

A subsequent significant consideration that this study has to offer future studies is the integral role that team science played in conducting this research. The term "team science" is often used perhaps without reflection about the richness that team science contributes in actuality. Nurse Scientists brought a holistic perspective regarding complex multi-faceted disorders; however collaborative efforts with geneticists, statisticians and molecular biology were also imperative to move this research forward. The parent study afforded the opportunity to collaborate and also invited cross disciplinary connections to move the work forward.

Practitioners and researchers regularly attend conferences on their domain of focus; however inter-mingling expert perspectives involving narrowly understood disorders are helpful to build knowledge acquisition in an efficient manner (Dick & Hancock, 2015). When specialists come together on complex issues, it promotes conversations that help grow knowledge across domains. The *Spit for Science* parent study conducted within the university setting is an excellent demonstration of the opportunities afforded by collaborative science that would not be made possible without a team effort.

CONCLUSION

Further studies are needed to understand the genetics of BE and BD. The present study identified significant genes from the BE GWAS, however no statistically significant results were noted from the BD GWAS, and no genetic overlap was identified

across phenotypes. Moreover, genes of interest that have been isolated from previous

candidate gene studies demonstrated no noteworthy or significant outcomes for

discussion. When performing a GWAS, especially a GWAS with a small sample size, it

is crucial that phenotypes of interest are precise, including only affected persons. While

the college-age population engages in both binge drinking and binge eating at high rates,

frequency estimates may need to be taken into account for BD to separate risky drinking

behaviors from problem drinking at this age. This did not appear to be the case for BE,

as a binary response for BE appeared to point to problematic eating behavior.

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Summary and Conclusions

The aims of this secondary data analysis of the *Spit for Science* project at a large mid-Atlantic based urban university were to determine:

1. If binge behaviors are associated with stress, impulsivity, and health outcome risks of obesity, anxiety, and depressive symptoms.

2. If shared single nucleotide polymorphisms (SNPs) present for binge drinking and binge eating from a Genome-Wide Association Study (GWAS) and a candidate gene approach.

Manuscript Summary

As a point of departure, the first manuscript investigated self-reported measures and corresponding psychometric properties for binge eating (BE) and binge eating disorder (BED). BED gained its own diagnostic code in the new edition of the DSM-5 and is associated with loss of control eating as well as psychological comorbidities in the literature and marked psychological distress in the DSM-5 (American Psychiatric Association, 2013; Javaras et al., 2008; Becker & Grilo, 2015; Roberto et al., 2016). It was discovered that many of the measures that are utilized to assess binge eating are also employed to assess other eating disorders or potentially related concepts of interest. Evaluating the presence or absence of binge eating is available in multiple measurements; yet practitioners are not able to diagnose BED unless the measure includes the diagnostic criteria for BED as presented in the DSM-5. The measurement of the general pathology of eating disorders appears psychometrically sound with established self-report measures that are in use. However, assessing the specific psychopathology of BE as it relates to BED and possible psychosomatic and biobehavioral etiologies, as well as the shared and

distinct factors of eating disorders, remains an evolving area of study as evidenced by the myriad of measures that were reviewed and are being used among researchers and practitioners.

The goal of the second manuscript was to explore aim 1 through the applicability of the variables in a hypothetical bio-behavioral model of binge drinking (BD) and BE behaviors among college-age individuals, with binge serving as the mediator between predictors (perceived stress, and five impulsivity domains: negative urgency, lack of premeditation, lack of perseverance, sensation seeking, and positive urgency) and outcomes (anxiety, depressive symptoms, and body mass index (BMI)) in the model. BD did not show strong commonalities with BE among the college-age population. Anxiety, depression and BMI were significant outcomes of BE but not BD in the present study. Negative urgency was a particularly salient predictor of BE when considering anxiety and depression outcomes, while the sensation seeking impulsivity domain dropped out of the model for BE. Depression was the only outcome variable that carried over to the final model for BD from the bivariate models, and in this model BD was not statistically significant in the multivariable model.

Data showed that BE is a strong indicator for higher BMI. This finding is congruent with similar findings in that higher BMI was associated with BED in addition to heightened binge and psychiatric symptom severity (Bulik, Sullivan, & Kendler, 2002; Filipova & Stoffel, 2016; Lipson & Sonneville, 2017; Napolitano & Himes, 2011). The female college-age students showed significantly more BE, anxiety and depression than the male students. These outcomes warrant further study as well as the outcomes related

to cigarette use. Although not a primary goal of the study, cigarette use was included as a covariate and was a significant indicator for anxiety and depression in this sample.

The final manuscript identified significant new (hypothesis-free) candidate genes from the BE GWAS; however, the BD and BE GWAS identified no genome-wide significant (GWS) hits. The BE GWAS gene-based tests revealed the following five potential candidate genes: *PURG, LYPD5, SKAP2, TRAPPC1*, and *NCOA2*. No genetic overlap was noted between BD and BE. Moreover, *DRD2, DRD4, FTO, OPRM1* and *SLC6A4* genes of interest that have been isolated from previous candidate gene studies on BD or BE demonstrated no noteworthy or significant outcomes for discussion.

Study Limitations

There are well-known problems with self-reported data and cross-sectional analyses, contributing to issues that interfere with establishment of a causal chain. Given the lengthy nature of the baseline survey, participants could have experienced survey fatigue and answered questions without providing a thoughtful response. Participants also may have evolving perceptions related to perceived stress, impulsivity, drinking, eating, and health outcome variables, given life changes over time, yielding results that could differ if the survey were completed at another time. Although survey administration time was considered as a covariate in the study, the timing of survey administration could have also influenced the outcomes in that a test may have been imminent during spring survey administration versus fall survey administration. Study results show that predictors + BD/BE in the depression prediction model demonstrated a significant difference for spring participants, indicating heightened depression. There was also a significant difference noted between fall and spring

participants for the predictor + BE BMI model, where spring participants showed an increase in BMI as compared to the fall participants.

The analysis was limited by the variable constraints that were available for study within the primary data set. Frequency of binge drinking and eating could not be considered in the assessment since it was not a variable in the primary data set. Generalizability is also limited, as the sample consisted of college freshmen and those with a history of alcohol exposure only, thus limiting understanding of BD and BE as it relates to the broader young adult population. Approximately one-fourth of overall sample was excluded for analyses. Because we wanted to include only those with a history of alcohol exposure, this may affect applicability of prevalence rates to broader epidemiological studies in the literature. Outcomes may look different if participants were from a different age range and/or included those that had never been exposed to alcohol.

Sample size appeared to have a notable influence on results for both aims. The n for the genetic investigation was underpowered at 2386, while the n for the biostatistical portion of the study was rather large at 4107 that statistically significant differences among variables were often seen where small effect sizes were noted (as evaluated by Cohen's effect size guidelines of a small effect size being 0.20 or greater). This complicated study results in three notable ways. First, clinical utility for statistically significant items is under question when effect sizes are narrow, though implied by previous findings supported in the literature. Next, a binary response for the BE group classification appeared to point to problematic eating behavior while a binary response to form the BD group did not yield similar results. It is difficult to ascertain whether this

was because the biobehavioral model of binge behavior under study did not apply to BD

as it did to BE, or whether the significant outcomes for BE are a reflection of a more

precisely defined pathology as it relates to binge. Moreover, it is challenging to

confidently eliminate the potential for genetic overlap across binge groups if it is

suspected that a binary approach to phenotypic group formation might not have been

stringent enough to yield actual pathology among the BD group within the population of

interest. Since the BE GWAS yielded significant gene-based results and the BD GWAS

did not, it cannot be ruled out that pathology may not have been accurately captured

within the BD sample.

Future Implications

Binge drinking shows alarmingly high rates (~30%) in the general population, but it

could be that in the general population, binge rates better distinguish problem drinkers than in

a college population where binge drinking is present in approximately 43% of the sample

(National Institute on Alcohol Abuse and Alcoholism, n.d.). Despite BD having many

adverse outcomes in the college-age population, it is difficult to determine how BD may be

adversely affecting individuals in the model that was applied. The college environment is

drinking friendly, so this variable may lack the ability to distinguish problem drinkers from

the sample without incorporating additional considerations such as frequency of BD.

While the genetic analysis did yield statistically significant gene-based findings for the

BE GWAS, the BD genetic analysis did not yield any statistically significant findings despite

the multiphasic approaches that were conducted. When performing a GWAS, especially a

GWAS with a small sample size, it is crucial that phenotypes of interest are precise, including

only affected persons. While the college-age population engages in both binge drinking and

binge eating at high rates, frequency estimates may need to be taken into account for BD to separate risky drinking behaviors from problem drinking at this age. Further studies are needed to understand the genetics of BE and BD. While the college-age population engages in both binge types at high rates, auxiliary determinants may be needed regarding BD to separate risky drinking behaviors from problem drinking at this age.

Since stigma is associated with overweight/obesity and binge eating, it is possible that more stigma is associated with BE as compared to BD in the college-age population, thus contributing to resulting anxiety, depression and BMI as significant outcomes of BE but not for BD in the present study. While the current study established that these health outcomes were elevated in individuals who binge eat, the origin of the outcomes remains a topic in need of further study. Heightened perceived stress and negative urgency indicate that they are predictors for BE, but causation is far from established. BE has been associated with poor outcomes from treatment for weight loss (Dakanalis et al., 2014; Tanofsky-Kraff et al., 2013), and the present study suggests further evidence that when BE is present in overweight and obese individuals, tailored interventions should be considered (Ivezaj, White, & Grilo, 2016).

Future Contributions of this Work Applied to Nursing Science

BE remains an area of primary interest for my future work. The topic is multifaceted and is an area that is well-positioned for a holistic-focused domain such as nursing science. In addition to opportunities that may emerge from the National Institute of Nursing Research (NINR), the National Institute on Drug Abuse (NIDA) is an institute of interest in that their goals align with my research topic. BE appears to reflect the National Institute on Drug Abuse's (NIDA) definition of addiction as having biological, behavioral and social components characterized by compulsive, often uncontrollable substance craving, seeking,

and use, despite negative health and social consequences (NIDA, n.d.). Dr. Nora Volkow,

who remains the director of NIDA since 2012, researches the science of the biochemical

influence that the brain has on food choices and consumption. Researchers are becoming

increasingly interested around the concept of "food addiction", given the rising obesity rates;

and the term food addiction is still hotly debated in the field of addiction science. BED is a

new standalone diagnosis in the DSM-5, whose etiology remains poorly understood. The

"Feeding and Eating Disorders" chapter in *The Diagnostic and Statistical Manual of Mental

Disorders* (5th ed.; *DSM–5*; American Psychiatric Association [APA], 2013) states that "the

relative contributions of shared and distinct factors in the development and perpetuation of

eating and substance use disorders remain insufficiently understood…there are robust

associations between obesity and a number of mental disorders" (e.g., binge eating disorder)

(p. 329). The DSM-5 reports that factors influencing maladaptive eating behavior are in need

of further study.

Future research opportunities exist given weekly practice endeavors in a weight

loss clinic within a large teaching hospital in collaboration with a physician whose

thinking is in alignment with my own in regard to binge eating having an addictive

component. The aims of the research project were relational in their focus; and causality

was not a component of the study. It is my goal to build upon the relationships that were

discovered for BE in this endeavor, and to move the research forward within the model of

a predictive study to discover the temporal precedence of variables. Initial studies that

build in this way will establish the evidentiary foundation necessary to support the

development and testing of interventions for individuals who struggle with binge eating.

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doi:10.1002/eat.22089

Appendix AA. MUSC IRB Approval for the Study

Health Sciences south carolina

a collaborative to advance health sciences

Date: Friday, June 02, 2017 5:35:28 PM   Print   Close

Pro00054557 : Binge Drinking and Binge Eating Behaviors View: Study Identification - Identification in a College Age Population - Carley Lovell

VIEW000072

Study Identification Information

This is the first step in your Human Research Application. You will automatically be guided to the appropriate forms needed to complete your submissions.

1.0   Full Title:

Enter the full study title

An Exploratory Analysis of Psychological and Genetic Based Outcomes Related to Binge Drinking and Binge Eating Behaviors in a College Age Population

2.0   Short Title:

Enter a short descriptive title for this study (85 characters maximum):

Binge Drinking and Binge Eating Behaviors in a College Age Population

3.0   Briefly describe the scientific or scholarly rationale:

(i.e. purpose of research)

Binge eating and binge drinking behaviors peak in young adulthood and negatively affect both genders. 20 Binge eating is associated with marked psychological distress and a heightened risk for obesity and is a primary diagnostic criterion for binge eating disorder (BED). 7,20 The prevalence of BED continues to rise and is presently known to occur in about 1.4% of the population worldwide. 20 Notably, BED is acknowledged in the most recent edition of the Diagnostic and Statistical Manual of Mental Health Disorders, the DSM-5, as a specific eating disorder; and it was removed from the category of a provisional eating disorder, where it was first introduced in 1994. 3,20,21 Binge drinking is a behavior self-reported by approximately 40% in young adulthood, and perpetuation of binge drinking increases the risk for substance use disorder (SUD) as well as secondarily associated physical, emotional, and social health problems. 20 A review of the age at onset of mental disorders based on results from the World Health Organization's World Mental Health Survey Initiative found that three-fourths of lifetime mental disorders start by the mid-20s, and early interventions reduce severity and persistence of primary disorders, as well as help to prevent formation of secondary disorders such as binge drinking and eating. 2,3

Almost one-quarter of individuals with BED demonstrate a SUD within their lifetime, and approximately 2.7% of those with BED demonstrate the presence of SUD simultaneously.20 Moreover, in relatives of those with BED, heightened levels of SUD have been demonstrated.22,23 Alcohol use disorders have been linked to heritability determinants that

predispose one to addiction of the substance.24 The obesity epidemic led to research investigating physiological conditions that support the motivation of individuals to consume calorically dense foods. One branch of inquiry involves the reward circuitry system as supported in addiction science, illustrated by lay terms that emerged in connection to eating, such as "craving", "comfort foods" and "chocoholic". Addiction theorists argue that increased environmental availability of calorically dense foods interacts with individual biological make-up, predisposing some to be more susceptible to obesogenic influences. 12,25-31 However research that investigates a human genetic predisposition to binge eating and the contested term "food addiction" is still in the early stages. 23 This presents an opportunity to nurse scientists who are well positioned in holistic thinking to conduct such research within interdisciplinary teams.

Genetic research indicates that a polymorphism in the TaqIA allele of the dopamine 2 receptor (D2R) gene moderates responsivity of reward circuitry and contributes to compensatory reward seeking behaviors, increasing the risk for substance misuse as well as maladaptive eating behaviors 23,31-33. Those with one or two copies of the A1 allele have 30-40% less D2R than those without an A1 allele 30. Suggestion of associations of the A1 allele predisposing risk for substance misuse and obesity remains a topic of debate in addiction literature 30. However, addiction literature widely supports that dopamine plays a key role in reward and associated behaviors that lead to reward gratification 29,30,34. Studies also indicate that the DRD4, OPRM1, 5-HTT and FTO receptor genes have implications in a variety of addictive disorders grounded in impulsive behavior patterns, showing concurrent evidence of association to binge eating behavior 12,29,35-37. The genetic contribution of the proposed research is to investigate shared genetic variants among those who endorse binge behaviors compared to those who do not.

Heightened perceived stress as well as decreases in inhibitory control are common associations to binge eating and binge drinking. 13,38-40 Moreover, shared adverse psychological risks of heightened anxiety and depressive symptoms are demonstrated in the literature for both binge eating and binge drinking. 38,41-44 Because psychological and physiological health concerns are common to both binge behaviors, more research is needed to advance understanding about the association that these factors have with binge behaviors in college students. 3 To address that research gap, this proposed research will investigate perceived stress, inhibitory control, anxiety, and depressive symptoms of college students who self-report binge behaviors, as compared to students who do not self-report binge drinking and/or binge eating.

Fall and spring surveys from the 2011-2013 cohorts' first year of college were analysed (n~7000). The aims of the secondary data analyses of these cohorts from the Spit for Science project at Virginia Commonwealth University are to determine:
1. If shared single nucleotide polymorphisms (SNPs) present for binge

drinking and binge eating from a Genome-Wide Association Study (GWAS) and a candidate gene approach.

2. If binge behaviors are associated with stress, impulsivity, and health outcome risks of obesity, anxiety, and depressive symptoms.

3. If significant genetic outcome variants influence the main effects in binge groups seen with stress and impulsivity variables, and in health outcome risk variables of obesity, anxiety, and depressive symptoms.

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4.0   Brief Study Summary
Non-scientific description of the research study, using 3 to 10 sentences:

Statements such as "see protocol" are not acceptable.

Note: Text entered in the Brief Study Summary field will be used to describe your study at www.SCresearch.org, an online directory designed to facilitate recruitment, if inclusion on this site is indicated later in the application.

This proposed research will utilize a deidentified university data source of fall and spring surveys from 2011-2013 cohorts' first year of college (n~7000) to perform a secondary data analysis. Perceived stress, BMI, inhibitory control, anxiety, and depressive symptoms of college students who self-report binge behaviors compared to students who do not self-report binge drinking and/or binge eating will be analyzed. Shared genetic variation between binge drinking and binge eating will also be analyzed among participants in this deidentified college-aged sample using Genome-Wide Association Study (GWAS) and candidate gene approaches.

5.0   **Is this a pilot study?**
        Yes ⚪ **No**

**Pro00054557: Binge Drinking and Binge   View: Study Identification - Institutional Review Board
Eating Behaviors in a College Age
Population - Carley Lovell**

    Institution

1.0   **Select the appropriate Institutional Review Board (IRB) for review:**
        Medical University of South Carolina

**Pro00054557: Binge Drinking and Binge Eating   View: Study Identification - IRB Review Request
Behaviors in a College Age Population - Carley
Lovell**

IRB Review Request for Multi-site Studies

The *IRB of Record* is the IRB with the primary responsibility for reviewing a study. For a multi-site study, the internal IRB may serve as the IRB of Record for other sites as well, or they may defer review to another IRB.

IRB OF RECORD IS YOUR INTERNAL IRB

Central Review

1.0   The review model where your internal IRB has agreed to serve as the single, central IRB of Record for other sites involved in a multi-site study. Be sure to contact your local IRB to assure that appropriate authorization agreements have been or will be executed.

Is this a Central Review?
Yes ◉ No

IRB OF RECORD IS ANOTHER IRB

Facilitated Review

2.0   The review process used by your local, internal IRB as they make the determination whether or not to accept another IRB's review of a study.

Is this a Facilitated Review (non-HSSC IRB, non-NCI CIRB, non-contracted IRB)?

Yes ◉ No

Independent Review Model

3.0   The review model where the NCI CIRB is the sole IRB of Record responsible for both study review as well as review of local context considerations for enrolled institutions.

Is this an Independent Review (NCI CIRB)?
Yes ◉ No

External IRB Review

4.0   The review process used by your local, internal IRB where they defer IRB review to a contracted IRB. The external IRB becomes the IRB of record for all aspects of the study.

Is this an External IRB Review (e.g., WIRB, etc.)?
Yes ◉ No

Pro00054557: Binge Drinking and Binge Eating
Behaviors in a College Age Population - Carley
Lovell

View: Study Identification - MUSC IRB Selection

MUSC Institutional Review Board Selection

1.0   Select the appropriate committee:

IRB-I - Medical University of South Carolina	Cell Biology and Anatomy, Cell and Molecular Pharmacology & Experimental Therapeutics, Clinical Services, College of Health Professions, College of Nursing, College of Pharmacy, Dermatology, Harper Student Life Center, Medical Lab Sciences, Otolaryngology, Pathology and Laboratory Medicine, Pediatrics, Pharmaceutical Sciences, Pharmacy Practice, Physical Therapy, Psychiatry and Behavioral Sciences, Radiology, Urology
IRB-II - Medical University of South Carolina	Anesthesiology, Biochemistry and Molecular Biology, Center For Health Care Research, Experimental Oncology, Family Medicine, General Dentistry, Graduate Studies, Medicine, Microbiology and Immunology, Molecular and Structural Biology, Neurosciences, Obstetrics and Gynecology, Ophthalmology, Oral & Maxillofacial Surgery, Orthopedic Surgery, Pediatric Dentistry/Orthodontics, Physical Medicine & Rehabilitation, Prosthodontics, Public Health Sciences, Radiation Oncology, Stomatology, Surgery
IRB-III - Medical University of South Carolina	Industry Sponsored Trials

Pro00054557: Binge Drinking and Binge
Eating Behaviors in a College Age
Population - Carley Lovell

View: Study Identification - Study Personnel Affiliation

Study Personnel Affiliation

1.0   Are all personnel on this research study affiliated with the
        institution of the designated IRB? If no, the next screen will contain
        a list of HSSC eIRB users for all institutions.
            Yes ○ No

Pro00054557: Binge Drinking and Binge Eating   View: Study Identification – Study Personnel
Behaviors in a College Age Population - Carley Lovell

Study Personnel

1.0   **Principal Investigator:**
Click the Select button and choose a PI
Carley Lovell

2.0   **Study Coordinator**
Click the Select button and choose the individual who will assist in
coordinating the overall activities of the the research study.
Carley Lovell

3.0   **Co-Investigator(s)**
Click the Add button and select the Co-Investigators for this study:
*PI must obtain agreement of co-investigators prior to submitting their
names to the study.*

Name	Organization
Mathew Gregoski	MUSC External Affiliate
Gayenell Magwood	DEPT OF NURSING - MUSC
Martina Mueller	DEPT OF NURSING - MUSC

4.0   **Other Study Team Member(s)**
Click the Add button and select any other team members (other project
assistants, students, etc.):

Name	Credentials	Organization	Role on Study	Edit Permission

There are no items to display

5.0   **Guest List**
Click the Add button and select any user to have read-only access to
study information:

Name	Credentials	Organization

There are no items to display

Pro00054557: Binge Drinking and Binge Eating   View: Study Identification – Student-Trainee Mentor
**Behaviors in a College Age Population - Carley
Lovell**

Study Identification – Student/Trainee Mentor
The Principal Investigator on this research study is marked as a student/trainee in their system user
profile. A mentor must be selected.

1.0   **Select mentor**
Gayenell Magwood

Pro00054557: Binge Drinking and   View: Study Identification - eIRB Communication Coordinators
Binge Eating Behaviors in a College
Age Population - Carley Lovell

eIRB Communication Coordinators

1.0   Select those study team members that will handle eIRB
       communication for this study.
           Person
           Mathew Gregoski
       ☑ Carley Lovell
       ☑ Gayenell Magwood
           Martina Mueller

Pro00054557: Binge Drinking and Binge Eating Behaviors in View: Study Identification - Study Sites
a College Age Population - Carley Lovell

Study Sites

1.0   Indicate all affiliated sites that will be involved in the research
       study.
       Check all that apply:
       MUSC

       List any other affiliated facilities where research activities will take
       place:
       The study data is deidentified data that was generated on the campus of
       Virginia Commonwealth University, where the PI is nursing faculty. The PI
       is also a PhD of nursing student at MUSC and this current submission
       using the deidetified secondary data will be her dissertation project.

2.0   Does this study involve other non-affiliated institutions,
       organizations or sites?
           Yes ● No

Pro00054557: Binge Drinking and   View: Human Subjects Research - Human Subjects Research
Binge Eating Behaviors in a College
Age Population - Carley Lovell

Human Subjects Research
The following questions will assist you in determining whether this project meets the federal
requirements for Human Subjects Research.

1.0   Is this project a systematic investigation, including research
       development, testing, and evaluation, designed to develop or to
       contribute to generalizable knowledge?

Yes ● No

Note: http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.html#46.102

2.0   Does this project involve the investigator obtaining data about living individuals through 1) intervention or interaction with the individual; or 2) identifiable private information?

Yes ● No

Note: http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.html#46.102

3.0   **Does this project involve a Humanitarian Use Device (HUD) ?** *A HUD is a device intended to benefit patients in the treatment or diagnosis of a disease or condition affecting fewer than 4,000 individuals in the US per year. See additional guidance on* HUD Designations.

Yes   No

Pro00054557: Binge Drinking and Binge Eating Behaviors in a College Age Population - Carley Lovell   View: Human Subjects Research - MUSC Not Human Subjects Research

Not Human Subjects Research
Based on the responses you provided on the previous screen, this study does not qualify as research on human subjects. If you think this is not accurate, you may click the Back button to go to the previous page and read the questions and check your responses.

1.0   Select applicable justification:
a. the specimens and/or private information/data were not collected specifically for the currently proposed research project through an interaction/intervention with living individuals
AND
b. the investigator(s) including collaborators on the proposed research cannot readily ascertain the identity of the individual(s) to whom the coded private information or specimens pertain (e.g., the researchers access to subject identities is prohibited by written repository policies and/or through an agreement signed between the recipient researcher and the repository).

Pro00054557: Binge Drinking and Binge Eating Behaviors in a College Age Population - Carley Lovell   View: Human Subjects Research - Not Human Subjects Research - v2

Not Human Subjects Research

Based on the information provided, this research study is not considered Human Subject Research. Click the Finish button and submit application to the IRB.

1.0   Upload protocol document(s) so that the IRB may validate that this is Not Human Subject Research.

Name	Description	Orig. Author	Orig. Created	Last Modified
Deidentified Data Sharing Agreement		Carley Lovell	4/1/2016 2:20 PM	4/1/2016 2:20 PM
VCU IRB APPROVAL HM13352 2015-2016 Approval.pdf		Carley Lovell	4/1/2016 2:19 PM	4/1/2016 2:19 PM
HUMAN SUBJECTS Protocols_Lovell Study.docx		Carley Lovell	4/1/2016 2:19 PM	4/1/2016 2:19 PM

Appendix BB. IRB Approval Letter for Spit for Science

Office of Research and Innovation
Office of Research Subjects Protection
BioTechnology Research Park
800 East Leigh Street, Suite 3000
P.O. Box 980568
Richmond, Virginia 23298-0568

(804) 828-0868
Fax (804) 827-1448

TO: Danielle Dick

CC: Zoe Neale
Kimberly Pedersen

FROM: IRB Panel A

RE: Danielle Dick; IRB HM13352_CR3 Spit for Science: The VCU Student Survey

On 9/13/2016 this research study was *approved for continuation* according to 45 CFR 46.108(b) and 45 CFR 46.109(e) by VCU IRB Panel A.

The information found in the electronic version of this study's smart form and uploaded documents now represents the currently approved study, documents, informed consent process, and HIPAA pathway (if applicable). Please see instruction box below for details on viewing the approved study.

• Note: The uploaded revised DNA consent form cannot be approved with the continuing review. The Panel determined that an amendment should be submitted to include the revised DNA consent form.

In addition, the Panel discussed downgrading this study to expedited review during their review of the continuing review. Though participation in this study presents no greater than minimal risk, if there is a means for collecting direct identifiers separately from the survey itself, this would create an additional layer of protection for individual participants. The Panel will defer to the researchers to determine REDCap's capability for this additional protection. If you decide to make changes to the way identifiers are used please include this in the amendment. Once the amendment is submitted the Panel will review any proposed confidentiality protections to determine if future reviews can be done in an expedited manner.

This approval expires on 9/12/2017. Federal Regulations/VCU Policy and Procedures require continuing review prior to continuation of approval past that date. Continuing Review notices will be sent to you prior to the scheduled review.

If you have any questions, please contact the Office of Research Subjects Protection (ORSP) or the IRB reviewer(s) assigned to this study.

The reviewer(s) assigned to your continuing review will be listed in the History tab and on the continuing review workspace. Click on their name to see their contact information.

Attachment – Conditions of Approval

Conditions of Approval:

In order to comply with federal regulations, industry standards, and the terms of this approval, the investigator must (as applicable):

1. Conduct the research as described in and required by the Protocol.

2. Obtain informed consent from all subjects without coercion or undue influence, and provide the potential subject sufficient opportunity to consider whether or not to participate (unless Waiver of Consent is specifically approved or research is exempt).

3. Document informed consent using only the most recently dated consent form bearing the VCU IRB "APPROVED" stamp (unless Waiver of Consent is specifically approved).

4. Provide non-English speaking patients with a translation of the approved Consent Form in the research participant's first language. The Panel must approve the translated version.

5. Obtain prior approval from VCU IRB before implementing any changes whatsoever in the approved protocol or consent form, unless such changes are necessary to protect the safety of human research participants (e.g., permanent/temporary change of PI, addition of performance/collaborative sites, request to include newly incarcerated participants or participants that are wards of the state, addition/deletion of participant groups, etc.). Any departure from these approved documents must be reported to the VCU IRB immediately as an Unanticipated Problem (see #7).

6. Monitor all problems (anticipated and unanticipated) associated with risk to research participants or others.

7. Report Unanticipated Problems (UPs), including protocol deviations, following the VCU IRB requirements and timelines detailed in VCU IRB WPP VIII-7):

8. Obtain prior approval from the VCU IRB before use of any advertisement or other material for recruitment of research participants.

9. Promptly report and/or respond to all inquiries by the VCU IRB concerning the conduct of the approved research when so requested.

10. All protocols that administer acute medical treatment to human research participants must have an emergency preparedness plan. Please refer to VCU guidance on http://www.research.vcu.edu/irb/guidance.htm.

11. The VCU IRBs operate under the regulatory authorities as described within:
a) U.S. Department of Health and Human Services Title 45 CFR 46, Subparts A, B, C, and D (for all research, regardless of source of funding) and related guidance documents.
b) U.S. Food and Drug Administration Chapter I of Title 21 CFR 50 and 56 (for FDA regulated research only) and related guidance documents.
c) Commonwealth of Virginia Code of Virginia 32.1 Chapter 5.1 Human Research (for all research).

Conditions of Approval (version 010507)

Appendix C. Spit for Science Data Sharing Agreement

The data covered under this agreement are data generated from *Spit for Science: The VCU Student Survey*. In accepting this agreement, I agree to the following terms and conditions of data use:

1. I will not use the data in any manner except that explicitly stated in this document.
2. I will not attempt any linkage or combination of the data to any other data set for any other purpose.
3. I will not re-release, share, provide access to, or otherwise make the data available to any other party. In the event that trainees or statisticians will be directly working with me on these analyses, I will review these data sharing procedures with them before allowing them access to the dataset.
4. I agree to use the data for statistical reporting and analysis only.
5. I understand that the study investigators have de-identified the data set to the best of their ability and I will not attempt, in any way, to re-identify or contact any person included in the data.
6. I will keep the data provided to me secure and treat all materials as confidential.
7. I will destroy the dataset upon completion of intended use of the data.
8. I understand that I will be expected to attend periodic meetings of all scientists involved in working with Spit for Science data, and that I may be asked to present my findings at these meetings.
9. I agree to deposit any variables or scales (and associated syntax) created using Spit for Science data back into the Spit for Science registry.
10. I understand that I will be contacted at least annually by the Spit for Science registry and asked to provide an update of my progress. I agree to provide project updates as requested by the Spit for Science team.
11. I agree that any requests that use data from the first three cohorts of Spit for Science (incoming freshman from fall 2011 – 2013) must be approved by Drs. Dick and Kendler, the PIs for the first three cohorts of data collection. Drs. Dick and Kendler will be actively involved in discussions about the development of study protocols and kept abreast of study progress for any analyses using data from the first three cohorts.
12. I understand that all abstracts, posters, presentations, and manuscripts using data from the Spit for Science project must be submitted for review by the Paper Review Committee prior to submission/presentation. These can be submitted for review by emailing spit4science@vcu.edu.
13. All presentations/manuscripts using data from the proposed Spit for Science spin-off project must include the appropriate acknowledgments for the Spit for Science project, including grant funding for the parent project. This information will be provided by the Spit for Science Project and Registry Coordinator, who can be reached by e-mailing spit4science@vcu.edu.
14. I understand that the Spit for Science Steering Committee can terminate approval for any projects for which the investigator and/or his/her associated research team members are found to be in violation of this agreement.
15. I understand that any investigators violating the terms of this agreement will be reported to the IRB.

Signature: *Carley S Orell*

Date: 6.29.15

For Spit for Science use only:

Spit for Science Director or Designee Signature: *Amy Pedeva*

Date approved: 7/6/2015

Date data was released: 7/6/2015

Version of data released: 4/30/2015

Version: May 22, 2014   De-Identified Data Sharing Agreement

2

Appendix D. Spit for Science Progress Report

This document is for investigators who have approval to perform secondary analyses with data from the Spit for Science project. Investigators should complete this form annually, for all on-going projects using data from the Spit for Science project.

Primary Investigator: Carley Lovell	Affiliation: Virginia Commonwealth University School of Nursing and PhD student in nursing science at Medical University of South Carolina
Email: lovellcg@vcu.edu	Co-Investigator(s): Dissertation Committee Members Include: Dr. Gayenell Magwood (Chair, MUSC) Dr. Martina Mueller (MUSC) Dr. Amy Adkins (VCU) Dr. Dace Svikis (VCU)

Currently using: ☒ Phenotypic Data   ☒ Genotypic Data

TITLE of research project utilizing Spit for Science: The VCU Student Survey data and/or participants:
An exploratory analysis of psychological and genetic based outcomes related to binge drinking and binge eating behaviors in a college age population

BRIEF ABSTRACT of approved analyses and (when applicable) associated results (150-400 words)
Note: Your abstract may be used for overview reports for the university and/or other publications created by the Spit for Science team. Please avoid overly technical terminology.
Researchers will perform a secondary analysis consisting of phenotypic and genetic data from approximately 7000 individuals from cohorts 1-3 of years 2011-2013 of the *Spit for Science* dataset at Virginia Commonwealth University (VCU) to test physiological and psychological theories common to binge drinking and binge eating behaviors. The principal purpose of this exploratory study is to investigate a biobehavioral conceptual framework model of binge eating and drinking behavior that draws from psychological and physiological variables that are common to both binge drinking and binge eating in the literature. Shared genetic variation between binge drinking and binge eating will be analyzed among participants in this college-aged sample using Genome-Wide Association Study (GWAS) and candidate gene approaches. Associations of binge behaviors to impulsivity, stress, and health outcome risks of obesity, anxiety, and depressive symptom indicators will be studied. Lastly, genetic variation outcomes will be considered against main effects in binge groups seen in impulsivity, stress, and health risk outcome variables. Covariates of gender, race, age, nicotine use, and maternal or paternal history of anxiety/depression or problem drinking will also be measured in the analyses. The study team includes expert consultants in nursing, biostatistics, and quantitative genomic statistics. The overarching study goal is to inform future prospective studies on binge behaviors in this population.

CURRENT STATUS of your project:
(e.g. analysis, drafting manuscript, under review, etc. Please also include your projected end date.)
My data set and codebook have been developed and genetic analysis has begun. The projected end date for the project will be spring 2017.

Do you have plans to use these data for a grant submission? ☒ **Yes**   ☐ **No**
        If yes, provide details:
VCU School of Nursing Intramural Grants Program is funding $2,095.00 direct costs for the project.

Do you have plans to use these data for a publication? ☒ **Yes**   ☐ **No**
        If yes, provide details: A minimum of two manuscripts will be submitted. Details are unknown at present.

Do you have plans to use these data for participant selection in a future Spin-Off study?
☐ **Yes**   ☒ **No**
        If yes, provide details: I am not going to likely be able to do this since I am using the first three cohorts.

OTHER UPDATES:

2015-2016 PUBLICATIONS:
Please provide full citations for any publication(s) in which you used Spit for Science data
NA

2015-2016 PRESENTATIONS:
Please list citations for any past or planned professional oral or poster presentation(s) in which you used(?) Spit for Science data

Podium Presentations:
Lovell, C., Aliev, F., Kendler, K., Dick, D., Adkins, A. (2016). *Investigation of Shared Genetic Variation for Binge*
        Eating and Binge Drinking Behavior in College Age Youth. International Society of
        Nurses in Genetics World Congress, Dublin, Ireland.

Poster Presentations:
Lovell, C**,** Svikis, D, Kendler, K., Dick, D., Thacker, L., Aliev, F., & Adkins, A. (2016). *Gender Comparison*
        *of Parental Problem Drinking History with Binge Eating and Binge Drinking Behavior
        Among College Age Youth.* Poster presentation at the 12th Annual Women's Health
        Research Day, VCU Institute of Women's Health, Richmond, VA.

Lovell, C, Magwood, G, Kendler, K, Dick, D, Thacker, L, Aliev, F, Adkins, A. (2016).
Associations of
        *Maternal and Paternal Problem Drinking with Binge Eating and Binge Drinking
        Behaviors Among College Youth.* Poster presentation at the 30th Annual Conference of
        the Southern Nursing Research Society, Williamsburg, VA.

Please note that all derived variables created for analyses must be deposited back into the Spit for Science master dataset, along with accompanying documentation. If you are using genotypic data, GWAS results, polygenic scores, code, etc. must be deposited. Please coordinate with the Spit for Science Project Coordinator at spit4science@vcu.edu. Variables and associated documentation must be submitted to the Spit for Science Registry prior to publication of associated papers.

Appendix E. Codebook

Data Collected:

VCU SEMESTER / YEAR	
Cohort Survey	**Semester / Year**
2011 FR Intro	Fall 2011
2012 FR Intro	Fall 2012
2013 FR Intro	Fall 2013
2011 FR New	Spring 2012
2012 FR New	Spring 2013
2013 FR New	Spring 2014

Overall:

FR = Freshmen

Y1F   Y1 = Year 1   F = Fall

Y1S   Y1 = Year 1   S = Spring

Groups:

Group_alc:

Non Binge Drink= NBD

Binge Drink = BD

Group_eat:

Non Binge Eat = NBE

Binge Eat = BE

Missing Data:

-9 = skip (question was asked within the survey but was skipped due to logic branching)

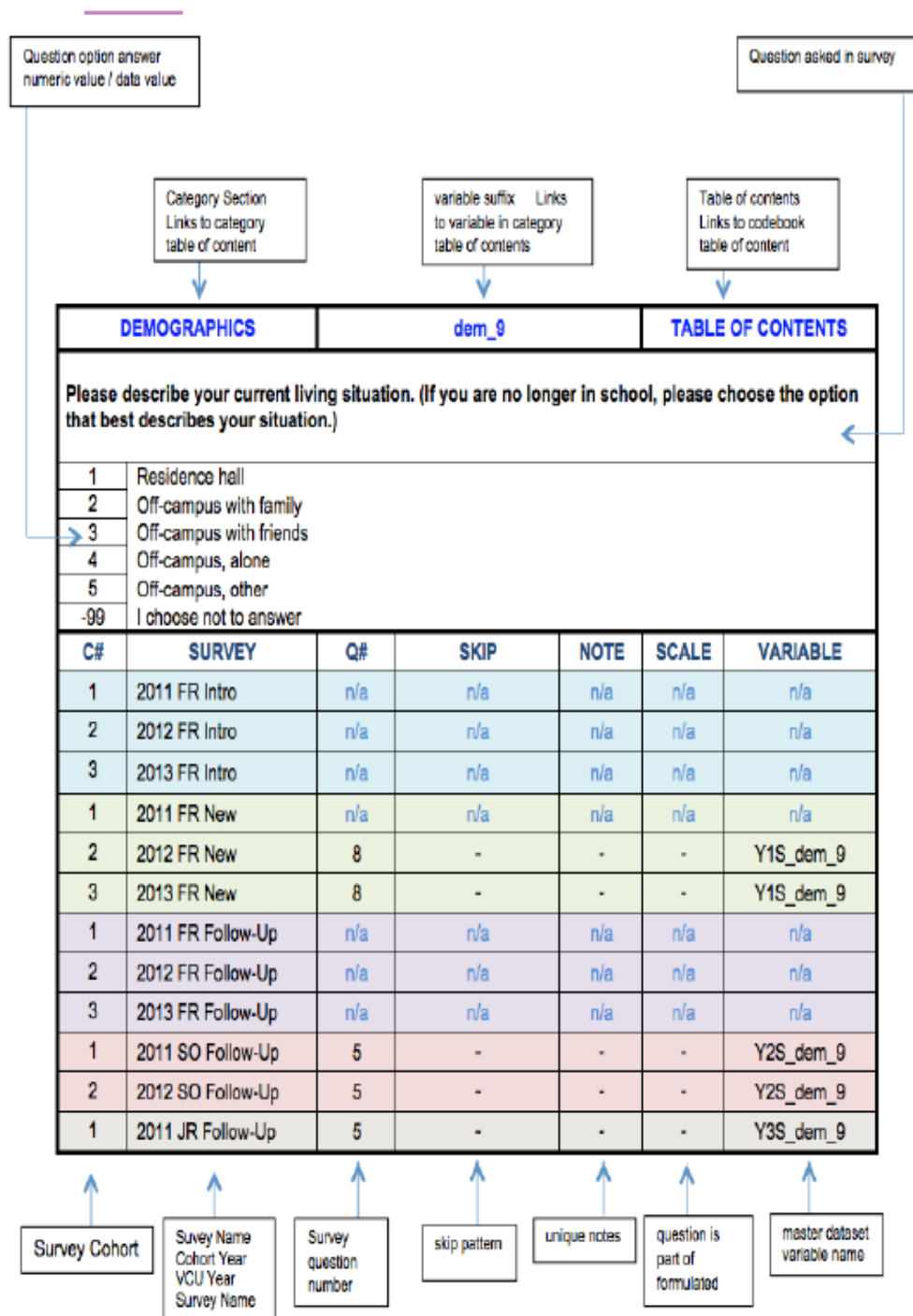-99 = I choose not to answer

-999 = I don't know

Pro-rating explanation

Some scales may incorporate pro-rating. This will be noted in this appendix if pro-rating *has* been used. Briefly, pro-rating is a simple method to handle missing data. If an individual has missing data items for a scale or calculated variable (and meets the missing data threshold noted in each sale, if applicable), a mean of available items is taken and multiplied by the total number of items that make up the calculated variable.

Example: The sum of 6 items (S4Sfan_1 – S4Sfan_6) go into the "S4Sfan" calculated variable. Individuals can give a response of 1 to 4 for each item. If an individual is missing 2 of the items, the pro-rated score is calculated as follows:

S4Sfan_1 = 4 S4Sfan_2 = X S4Sfan_3 = 2 S4Sfan_4 = 4 S4Sfan_5 = 3 S4Sfan_6 = X

Average of available data = [4+2+4+3]/4 = 3.25 Pro-rated value = 3.25 * 6 (total number of items) = 19.5

Question option answer numeric value / data value

Question asked in survey

Category Section
Links to category
table of content

variable suffix   Links
to variable in category
table of contents

Table of contents
Links to codebook
table of content

DEMOGRAPHICS	dem_9	TABLE OF CONTENTS

Please describe your current living situation. (If you are no longer in school, please choose the option that best describes your situation.)

1	Residence hall
2	Off-campus with family
3	Off-campus with friends
4	Off-campus, alone
5	Off-campus, other
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	SCALE	VARIABLE
1	2011 FR Intro	n/a	n/a	n/a	n/a	n/a
2	2012 FR Intro	n/a	n/a	n/a	n/a	n/a
3	2013 FR Intro	n/a	n/a	n/a	n/a	n/a
1	2011 FR New	n/a	n/a	n/a	n/a	n/a
2	2012 FR New	8	-	-	-	Y1S_dem_9
3	2013 FR New	8	-	-	-	Y1S_dem_9
1	2011 FR Follow-Up	n/a	n/a	n/a	n/a	n/a
2	2012 FR Follow-Up	n/a	n/a	n/a	n/a	n/a
3	2013 FR Follow-Up	n/a	n/a	n/a	n/a	n/a
1	2011 SO Follow-Up	5	-	-	-	Y2S_dem_9
2	2012 SO Follow-Up	5	-	-	-	Y2S_dem_9
1	2011 JR Follow-Up	5	-	-	-	Y3S_dem_9

Survey Cohort

Suvey Name
Cohort Year
VCU Year
Survey Name

Survey
question
number

skip pattern

unique notes

question is
part of
formulated

master dataset
variable name

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ALCOHOL	TABLE OF CONTENTS
alc_1	Have you had at least one drink of any kind of alcohol.
alc_6	How many drinks containing alcohol do you have on a typical day when you drink.
alc_7	How many days did you drink one or more alcoholic drinks: Past 30 days.
alc_8	On the days you drank how many drinks did you have each day: Past 30 days.

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ALCOHOL		alc_1		TABLE OF CONTENTS
In your entire life, have you had at least one drink of any kind of alcohol, not counting small tastes or sips? Count as a drink a can or bottle of beer; a wine cooler or a glass of wine, champagne, or sherry; a shot of liquor or a mixed drink or cocktail.				
0	No			
1	Yes			
-99	I choose not to answer			
C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	58	-	-	alc_1_combined
2	2012 FR Intro	43	-	-	alc_1_combined
3	2013 FR Intro	44	-	-	alc_1_combined
1	2011 FR New	41	-	-	alc_1_combined
2	2012 FR New	42	-	-	alc_1_combined
3	2013 FR New	43	-	-	alc_1_combined

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ALCOHOL			alc_6		TABLE OF CONTENTS

How many drinks containing alcohol do you have on a typical day when you are drinking?

1	1 or 2
2	3 or 4
3	5 or 6
4	7, 8, or 9
5	10 or more
-9	Skip
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	n/a	n/a	n/a	n/a
2	2012 FR Intro	51	Y1F_alc_2 = "No" or Y1F_alc_5 = "Never"	-	alc_6_combined
3	2013 FR Intro	52	Y1F_alc_2 = "No" or Y1F_alc_5 = "Never"	-	alc_6_combined
4	2014 FR Intro	52	Y1F_alc_2 = "No" or Y1F_alc_5 = "Never"	-	alc_6_combined
1	2011 FR New	46	Y1S_alc_2 = "No" or Y1S_alc_5 = "Never"	-	alc_6_combined
2	2012 FR New	50	Y1S_alc_2 = "No" or Y1S_alc_5 = "Never"	-	alc_6_combined
3	2013 FR New	52	Y1S_alc_2 = "No" or Y1S_alc_5 = "Never"	-	alc_6_combined

ALCOHOL				alc_7			TABLE OF CONTENTS	

Think specifically about the last 30 days, up to and including today. During the past 30 days, on how many days did you drink one or more drinks of an alcoholic beverage?

1	0	8	7	15	14	22	21	29	28
2	1	9	8	16	15	23	22	30	29
3	2	10	9	17	16	24	23	31	30
4	3	11	10	18	17	25	24	-9	Skip
5	4	12	11	19	18	26	25	-99	I choose not to
6	5	13	12	20	19	27	26	-999	Don't know
7	6	14	13	21	20	28	27		

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	62	Y1F_alc_2 = "No"	-	Y1F_alc_7
2	2012 FR Intro	52	Y1F_alc_2 = "No" or Y1F_alc_5 = "Never"	-	Y1F_alc_7
3	2013 FR Intro	53	Y1F_alc_2 = "No" or Y1F_alc_5 = "Never"	-	Y1F_alc_7
1	2011 FR New	n/a	n/a	n/a	n/a
2	2012 FR New	n/a	n/a	n/a	n/a
3	2013 FR New	n/a	n/a	n/a	n/a

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ALCOHOL				alc_8			TABLE OF CONTENTS	

On the days that you drank during the past 30 days, how many drinks did you usually have each day? Count as a drink a can or bottle of beer; a wine cooler or a glass of wine, champagne, or sherry; a shot of liquor or a mixed drink or cocktail.

1	1	6	6	11	11	16	16	21	More than 20
2	2	7	7	12	12	17	17	-9	Skip
3	3	8	8	13	13	18	18	-99	I choose not to answer
4	4	9	9	14	14	19	19	-999	Don't know
5	5	10	10	15	15	20	20		

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	63	Y1F_alc_2 = "No" & Y1F_alc_7 = "0"	-	Y1F_alc_8
2	2012 FR Intro	53	Y1F_alc_2 = "No," Y1F_alc_5 = "Never" or Y1F_alc_7 = "0"	-	Y1F_alc_8
3	2013 FR Intro	54	Y1F_alc_2 = "No," Y1F_alc_5 = "Never" or Y1F_alc_7 = "0"	-	Y1F_alc_8
1	2011 FR New	n/a	n/a	n/	n/a
2	2012 FR New	n/a	n/a	n/	n/a
3	2013 FR New	n/a	n/a	n/	n/a

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Body Mass Index, CALCULATED		
BMI	BMI	TABLE OF CONTENTS
American Psychiatric Association (2000). Diagnostic and statistical manual of mental disorders (4th ed., Text Revision). Washington, DC: Author.		
C#	SURVEY	VARIABLE
1	2011 FR Intro	BMI_Combined
2	2012 FR Intro	BMI_Combined
3	2013 FR Intro	BMI_Combined
1	2011 FR New	BMI_Combined
2	2012 FR New	BMI_Combined
3	2013 FR New	BMI_Combined

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	CURRENT HEALTH	TABLE OF CONTENTS
hea_1a	(SCL-90) Anxiety Nervousness or shakiness inside.	
hea_1b	(SCL-90) Anxiety Suddenly scared for no reason.	
hea_1c	(SCL-90) Depression (SCL-90) Expanded Depression Feeling blue.	
hea_1d	(SCL-90) Depression (SCL-90) Expanded Depression Worrying too much about things.	
hea_1e	(SCL-90) Depression (SCL-90) Expanded Depression Feeling no interest in things.	
hea_1f	(SCL-90) Anxiety Feeling fearful.	
hea_1g	(SCL-90) Depression (SCL-90) Expanded Depression Feeling hopeless about the future.	
hea_1h	(SCL-90) Anxiety Spells of terror or panic.	

ANXIETY, CALCULATED	
hea_anx_combined	hea_1a hea_1b hea_1f hea_1h
DEPRESSION, CALCULATED	
hea_dep_combined	hea_1c hea_1d hea_1e hea_1g

(SCL-90) SYMPTOM CHECKLIST-90 : ANXIETY, CALCULATED		
CURRENT HEALTH	hea_anx	**TABLE OF CONTENTS**
Derogatis, L.E. & Cleary, P.A. (1977). Confirmation of the Dimensional Structure of the SCL-90: A Study in Construct Validation. *Journal of Clinical Psychology, 33*(4), 981-989.		
C#	**SURVEY**	**VARIABLE**
1	2011 FR Intro	hea_anx_combined
2	2012 FR Intro	hea_anx_combined
3	2013 FR Intro	hea_anx_combined
1	2011 FR New	hea_anx_combined
2	2012 FR New	hea_anx_combined
3	2013 FR New	hea_anx_combined

(SCL-90) SYMPTOM CHECKLIST-90 - DEPRESSION, CLACULATED		
CURRENT HEALTH	hea_dep	TABLE OF CONTENTS

Derogatis, L.E. & Cleary, P.A. (1977). Confirmation of the Dimensional Structure of the SCL-90: A Study in Construct Validation. *Journal of Clinical Psychology, 33*(4), 981-989.

C#	SURVEY	VARIABLE
1	2011 FR Intro	hea_dep_combined
2	2012 FR Intro	hea_dep_combined
3	2013 FR Intro	hea_dep_combined
1	2011 FR New	hea_dep_combined
2	2012 FR New	hea_dep_combined
3	2013 FR New	hea_dep_combined

DEMOGRAPHICS		dem_1			TABLE OF CONTENTS
AGE					
	VCU REGISTRY				
C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	-	-	-	Y1F_dem_1
2	2012 FR Intro	-	-	-	Y1F_dem_1
3	2013 FR Intro	-	-	-	Y1F_dem_1
1	2011 FR New	-	-	-	Y1F_dem_1
2	2012 FR New	-	-	-	Y1F_dem_1
3	2013 FR New	-	-	-	Y1F_dem_1

DEMOGRAPHICS		dem_2		TABLE OF CONTENTS

SEX	
1	Male
2	Female
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	3	-	-	Y1F_dem_2
2	2012 FR Intro	2	-	-	Y1F_dem_2
3	2013 FR Intro	2	-	-	Y1F_dem_2
1	2011 FR New	2	-	-	Y1F_dem_2
2	2012 FR New	2	-	-	Y1F_dem_2
3	2013 FR New	2	-	-	Y1F_dem_2

DEMOGRAPHICS		dem_3		TABLE OF CONTENTS

Which one of these groups' best describes you?

1	American Indian/Alaska Native
2	Asian
3	Black/African American
4	Hispanic/Latino
5	More than one race
6	Native Hawaiian/Other Pacific Islander
7	Unknown
8	White
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	4	-	-	Y1F_dem_3
2	2012 FR Intro	3	-	-	Y1F_dem_3
3	2013 FR Intro	3	-	-	Y1F_dem_3
1	2011 FR New	3	-	-	Y1F_dem_3
2	2012 FR New	3	-	-	Y1F_dem_3
3	2013 FR New	3	-	-	Y1F_dem_3

Footnote:
Demographic race/ethnicity variable recoded for genetic demographics: Ethnicity Recoded, Black 1, Other 1

Demographic race/ethnicity variable recoded for biostatistical demographics: Ethnicity Recoded2, Black2, Other2, Asian2, Hispanic2

DEMOGRAPHICS		dem_4a			TABLE OF CONTENTS

What is your height (feet)?

4	4
5	5
6	6
7	7
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	5	-	-	Y1F_dem_4a
2	2012 FR Intro	4	-	-	Y1F_dem_4a
3	2013 FR Intro	4	-	-	Y1F_dem_4a
1	2011 FR New	4	-	-	Y1F_dem_4a
2	2012 FR New	4	-	-	Y1F_dem_4a
3	2013 FR New	4	-	-	Y1F_dem_4a

DEMOGRAPHICS		dem_4b			TABLE OF CONTENTS

What is your height (inches)?

0	0	5	5		10	10
1	1	6	6		11	11
2	2	7	7		-99	I choose not to answer
3	3	8	8			
4	4	9	9			

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	5	-	-	Y1F_dem_4b
2	2012 FR Intro	4	-	-	Y1F_dem_4b
3	2013 FR Intro	4	-	-	Y1F_dem_4b
1	2011 FR New	4	-	-	Y1F_dem_4b
2	2012 FR New	4	-	-	Y1F_dem_4b
3	2013 FR New	4	-	-	Y1F_dem_4b

DEMOGRAPHICS		dem_5		TABLE OF CONTENTS

What is your weight while wearing indoor clothing?

1	less than 90 pounds	10	130-134	19	175-179	28	220-224		
2	90-94	11	135-139	20	180-184	29	225-229		
3	95-100	12	140-144	21	185-189	30	230-234		
4	100-104	13	145-149	22	190-194	31	235-239		
5	105-109	14	150-154	23	195-199	32	240-244		
6	110-114	15	155-159	24	200-204	33	245-249		
7	114-119	16	160-164	25	205-209	34	more than 250 pounds		
8	120-124	17	165-169	26	210-214	-99	I choose not to answer		
9	125-129	18	170-174	27	215-219				

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	6	-	-	Y1F_dem_5
2	2012 FR Intro	5	-	-	Y1F_dem_5
3	2013 FR Intro	5	-	-	Y1F_dem_5
1	2011 FR New	5	-	-	Y1F_dem_5
2	2012 FR New	5	-	-	Y1F_dem_5
3	2013 FR New	5	-	-	Y1F_dem_5

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DEMOGRAPHICS	dem_6	TABLE OF CONTENTS

This question is about the woman who functioned as a mother in your household when you were growing up; she could be your biological mother, stepmother, foster mother, adoptive mother or, perhaps, a grandmother or aunt. How far in school did she go?

1	Eighth grade or less
2	More than eighth grade, but did not graduate from high school
3	Went to a business, trade, or vocational school instead of high school
4	High school graduate
5	Completed a GED
6	Went to a business, trade, or vocational school after high school
7	Went to college, but did not graduate
8	Graduated from a college or university
9	Professional training beyond a four-year college or university
10	She never went to school
11	She went to school, but I don't know what level
12	There was no one who functioned as a mother in my household
-999	I don't know if she went to school
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	SCALE	VARIABLE
1	2011 FR Intro	7	-	-	-	Y1F_dem_6
2	2012 FR Intro	6	-	-	-	Y1F_dem_6
3	2013 FR Intro	6	-	-	-	Y1F_dem_6
1	2011 FR New	6	-	-	-	Y1F_dem_6
2	2012 FR New	6	-	-	-	Y1F_dem_6
3	2013 FR New	6	-	-	-	Y1F_dem_6

DEMOGRAPHICS	dem_7	TABLE OF CONTENTS

This question is about the man who functioned as a father in your household when you were growing up. How far in school did he go?

1	Eighth grade or less
2	More than eighth grade, but did not graduate from high school
3	Went to a business, trade, or vocational school instead of high school
4	High school graduate
5	Completed a GED
6	Went to a business, trade, or vocational school after high school
7	Went to college, but did not graduate
8	Graduated from a college or university
9	Professional training beyond a four-year college or university
10	She never went to school
11	She went to school, but I don't know what level
12	There was no one who functioned as a mother in my household
-999	I don't know if she went to school
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	SCALE	VARIABLE
1	2011 FR Intro	8	-	-	-	Y1F_dem_7
2	2012 FR Intro	7	-	-	-	Y1F_dem_7
3	2013 FR Intro	7	-	-	-	Y1F_dem_7
1	2011 FR New	7	-	-	-	Y1F_dem_7
2	2012 FR New	7	-	-	-	Y1F_dem_7
3	2013 FR New	7	-	-	-	Y1F_dem_7

BULIMIA NERVOSA BROAD					
EATING			**eat_1**	**TABLE OF CONTENTS**	
During the past four weeks (28 days), have there been any times when you felt that you had eaten what other people would regard as an unusually large amount of food given the circumstances?					
0	No				
1	Yes				
-999	Not sure				
-99	I choose not to answer				
C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	142	-	1	eat_1_combined
2	2012 FR Intro	130	-	1	eat_1_combined
3	2013 FR Intro	133	-	1	eat_1_combined
1	2011 FR New	127	-	1	eat_1_combined
2	2012 FR New	128	-	1	eat_1_combined
3	2013 FR New	138	-	2	eat_1_combined

FAMILY RELATIONS	TABLE OF CONTENTS
fam_3	Do you think your biological mother has ever had a drinking problem.
fam_5	Do you think your biological mother has had problems with depression or anxiety.
fam_6	Do you think your biological father has ever had a drinking problem.
fam_8	Do you think your biological father has had problems with depression or anxiety.

FAMILY RELATIONS		fam_3		TABLE OF CONTENTS

Do you think your biological mother has ever had a drinking problem? (By drinking problem we mean that her drinking caused problems at home, at work, with her health, or with the police, or that she received alcohol treatment.)

0	No
1	Yes
-999	I don't know
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	81	-	-	Y1F_fam_3
2	2012 FR Intro	79	-	-	Y1F_fam_3
3	2013 FR Intro	81	-	-	Y1F_fam_3
1	2011 FR New	68	-	-	Y1F_fam_3
2	2012 FR New	72	-	-	Y1F_fam_3
3	2013 FR New	75	-	-	Y1F_fam_3

FAMILY RELATIONS		fam_5		TABLE OF CONTENTS

Do you think your biological mother has ever had problems with depression or anxiety?

0	No
1	Yes
-999	I don't know
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	83	-	-	Y1F_fam_5
2	2012 FR Intro	81	-	-	Y1F_fam_5
3	2013 FR Intro	83	-	-	Y1F_fam_5
1	2011 FR New	70	-	-	Y1F_fam_5
2	2012 FR New	74	-	-	Y1F_fam_5
3	2013 FR New	77	-	-	Y1F_fam_5

FAMILY RELATIONS	fam_6	TABLE OF CONTENTS

Do you think your biological father has ever had a drinking problem?

0	No
1	Yes
-999	I don't know
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	84	-	-	Y1F_fam_6
2	2012 FR Intro	82	-	-	Y1F_fam_6
3	2013 FR Intro	84	-	-	Y1F_fam_6
1	2011 FR New	71	-	-	Y1F_fam_6
2	2012 FR New	75	-	-	Y1F_fam_6
3	2013 FR New	78	-	-	Y1F_fam_6

FAMILY RELATIONS	fam_8			TABLE OF CONTENTS

Do you think your biological father has ever had problems with depression or anxiety?

0	No
1	Yes
-999	I don't know
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	86	-	-	Y1F_fam_8
2	2012 FR Intro	84	-	-	Y1F_fam_8
3	2013 FR Intro	86	-	-	Y1F_fam_8
1	2011 FR New	73	-	-	Y1F_fam_8
2	2012 FR New	77	-	-	Y1F_fam_8
3	2013 FR New	80	-	-	Y1F_fam_8

NICOTINE USE		nic_4		TABLE OF CONTENTS	

How frequently did you smoke cigarettes in the last 30 days?

1	I didn't smoke any cigarettes in the last month
2	Once or twice
3	A few days (3 to 4 days a month)
4	A couple of days a week (5 to 11 days a month)
5	Three times a week (12 to 14 days a month)
6	Most days of the week (15 to 25 days a month)
7	Daily or almost daily (26 to 30 days a month)
-9	Skip
-99	I choose not to answer

C#	SURVEY	Q#	SKIP	NOTE	VARIABLE
1	2011 FR Intro	119	Y1F_nic_1 = "None"	-	nic_4_combined
2	2012 FR Intro	112	Y1F_nic_1 = "None"	-	nic_4_combined
3	2013 FR Intro	115	Y1F_nic_1 = "None"	-	nic_4_combined
1	2011 FR New	105	Y1S_nic_1 & Y1S_nic_2 = "None"	-	nic_4_combined
2	2012 FR New	106	Y1S_nic_1 = "None"	-	nic_4_combined
3	2013 FR New	110	Y1S_nic_1 = "None"	-	nic_4_combined

Footnote:
Nicotine Reference Categories:
Not at all = 1
Moderate = 2, 3, 4, 5
Daily, Almost Daily = 6, 7

PERSONALITY	TABLE OF CONTENTS
per_16	(UPPS) Negative Urgency When I feel bad, I will often do things I later regret in order to make myself feel better now.
per_17	(UPPS) Lack of Perseverance I generally like to see things through to the end.
per_18	(UPPS) Lack of Premeditation My thinking is usually careful and purposeful.
per_19	(UPPS) Sensation Seeking I quite enjoy taking risks.
per_20	(UPPS) Lack of Perseverance Unfinished tasks really bother me.
per_21	(UPPS) Positive Urgency I tend to lose control when I am in a great mood.
per_22	(UPPS) Lack of Premeditation I like to stop and think things over before I do them.
per_23	(UPPS) Sensation Seeking I welcome new and exciting experiences and sensations, even if they are a
per_24	(UPPS) Negative Urgency When I am upset I often act without thinking.
per_25	(UPPS) Positive Urgency Others are shocked or worried about I do when I am feeling very excited.
per_26	(UPPS) Negative Urgency When I feel rejected, I will often say things that I later regret.
per_27	(UPPS) Lack of Perseverance I finish what I start.
per_28	(UPPS) Positive Urgency I tend to act without thinking when I am really excited.
per_29	(UPPS) Lack of Premeditation I usually think carefully before doing anything.
per_30	(UPPS) Sensation Seeking I would enjoy the sensation of skiing fast down a high mountain slope.

(UPPS) IMPULSIVE BEHAVIOR	
Lack of Perseverance per_LackPreserv	per_17 per_20 per_27
Lack of Premeditation per_LackPremed	per_18 per_22 per_29
Negative Urgency per_NegUrg	per_16 per_24 per_26
Positive Urgency per_PosUrg	per_21 per_25 per_28
Sensation Seeking per_SS	per_19 per_23 per_30

UPPS) IMPULSIVE BEHAVIOR : LACK OF PERSEVERANCE		
PERSONALITY	per_lackperserv	TABLE OF CONTENTS

Lynam DR, Smith GT, Whiteside SP, Cyders MA. The UPPS-P: Assessing five personality pathways to impulsive behavior. Technical report. West Lafayette, IN: Purdue University; 2006.

C#	SURVEY	VARIABLE
1	2011 FR Intro	n/a
2	2012 FR Intro	per_lackperserv_combined
3	2013 FR Intro	per_lackperserv_combined
1	2011 FR New	per_lackperserv_combined
2	2012 FR New	per_lackperserv_combined
3	2013 FR New	per_lackperserv_combined

UPPS IMPULSIVE BEHAVIOR : LACK OF PREMEDITATION		
PERSONALITY	per_LackPremed	TABLE OF CONTENTS
Lynam DR, Smith GT, Whiteside SP, Cyders MA. The UPPS-P: Assessing five personality pathways to impulsive behavior. Technical report. West Lafayette, IN: Purdue University; 2006.		
C#	SURVEY	VARIABLE
1	2011 FR Intro	n/a
2	2012 FR Intro	per_lackpremed_combined
3	2013 FR Intro	per_lackpremed_combined
1	2011 FR New	per_lackpremed_combined
2	2012 FR New	per_lackpremed_combined
3	2013 FR New	per_lackpremed_combined

UPPS IMPULSIVE BEHAVIOR : NEGATIVE URGENCY		
PERSONALITY	per_NegUrg	**TABLE OF CONTENTS**
Lynam DR, Smith GT, Whiteside SP, Cyders MA. The UPPS-P: Assessing five personality pathways to impulsive behavior. Technical report. West Lafayette, IN: Purdue University; 2006.		
C#	SURVEY	VARIABLE
1	2011 FR Intro	n/a
2	2012 FR Intro	per_negurg_combined
3	2013 FR Intro	per_negurg_combined
1	2011 FR New	per_negurg_combined
2	2012 FR New	per_negurg_combined
3	2013 FR New	per_negurg_combined

UPPS IMPULSIVE BEHAVIOR : POSITIVE URGENCY		
PERSONALITY	per_PosUrg	TABLE OF CONTENTS

Lynam DR, Smith GT, Whiteside SP, Cyders MA. The UPPS-P: Assessing five personality pathways to impulsive behavior. Technical report. West Lafayette, IN: Purdue University; 2006.

C#	SURVEY	VARIABLE
1	2011 FR Intro	n/a
2	2012 FR Intro	per_posurg_combined
3	2013 FR Intro	per_posurg_combined
1	2011 FR New	per_posurg_combined
2	2012 FR New	per_posurg_combined
3	2013 FR New	per_posurg_combined

UPPS IMPULSIVE BEHAVIOR : SENSATION SEEKING		
PERSONALITY	per_senseek	**TABLE OF CONTENTS**
Lynam DR, Smith GT, Whiteside SP, Cyders MA. The UPPS-P: Assessing five personality pathways to impulsive behavior. Technical report. West Lafayette, IN: Purdue University; 2006.		
C#	**SURVEY**	**VARIABLE**
1	2011 FR Intro	n/a
2	2012 FR Intro	per_senseek_combined
3	2013 FR Intro	per_senseek_combined
1	2011 FR New	per_senseek_combined
2	2012 FR New	per_senseek_combined
3	2013 FR New	per_senseek_combined

STRESSFUL	TABLE OF CONTENTS
str_5	Total Overall Stressful Life Event Broken engagement or steady
str_6	Total Overall Stressful Life Event Separation from other loved one or
str_7	Total Overall Stressful Life Event Serious illness or injury.
str_8	Total Overall Stressful Life Event Burglarized or robbed.
str_9	Total Overall Stressful Life Event Trouble with police.
str_10	Total Overall Stressful Life Event Laid off or fired from a job.
str_11	Total Overall Stressful Life Event Major financial problems.
str_12	Total Overall Stressful Life Event Serious housing problems.
str_13	Total Overall Stressful Life Event Serious difficulties at school.
str_14	Total Overall Stressful Life Event Someone close to you passed away.
str_15	Total Overall Stressful Life Event Your mother or father had a serious illness or injury.
str_16	Total Overall Stressful Life Event Someone else close to you had a serious illness or injury.

TOTAL OVERALL STRESSFUL LIFE EVENTS	
str stressfulevents total	str_5 str_6 str_7 str_8 str_9 str_10 str_11 str_12 str_13 str_14 str_15 str_16
Since VCU collected, but not used since 2011-2013 Fr Intro missing	

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TOTAL OVERALL STRESSFUL LIFE EVENT		
[Lifetime] *Used for current study*		
STRESSFUL EVENTS	str_stressfulevents_total	TABLE OF CONTENTS
Kendler, K.S., Karkowski, L.M., & Prescott, C.A. (1999) Causal Relationship Between Stressful Life Events and the Onset of Major Depression. *Am J Psychiatry, 156,* 837-841.		
C#	SURVEY	VARIABLE
1	2011 FR Intro	str_stressfulevents_total
2	2012 FR Intro	str_stressfulevents_total
3	2013 FR Intro	str_stressfulevents_total
1	2011 FR New	str_stressfulevents_total
2	2012 FR New	str_stressfulevents_total
3	2013 FR New	str_stressfulevents_total

Appendix F

TABLE 1. VARIABLE, MEASUREMENT/INSTRUMENT AND TIMEFRAME			
Variable * = Calculated Scores	**Measures/Instruments/ and Cronbach's alpha ( )**	**Response Options**	**Timeframe**
*Anxiety	SCL-90 (0.85) for anxiety	1=Not at all 2=A little bit 3=Moderately 4=Quite a bit 5=Extremely -99=Missing	Past 30 days
Binge Drinking	NIAAA based binge definition for binge drinking	0=Never exposed (Will be excluded) 1=Binge 2=Nonbinge 3=Nondrinker -99=Missing (Coding will be necessary for males and females)	Past 30 days
Binge Eating	EDE-Q based definition for act of binge eating	1=Yes 0=No -99=Missing	Past 28 days
Body Mass Index (BMI)	Self-reported height/weight	S4S formula for calculation of continuous variable	At time of survey
Demographics	Self-reported race; continental ancestry; gender; age, maternal/paternal education	Self-reported race: Black/African American White Other Genetics: Corresponding continental ancestry principal components for AFR and EUR	NA
*Depression	SCL-90 (0.89) for depression	1=Not at all 2=A little bit 3=Moderately 4=Quite a bit 5=Extremely -99=Missing	Past 30 days

TABLE 1. VARIABLE, MEASUREMENT/INSTRUMENT AND TIMEFRAME			
Variable ** = Calculated Scores*	*Measures/Instruments/ and Cronbach's alpha ( )*	*Response Options*	*Timeframe*
Family Relations	A. Biological mother and/or father has ever had a drinking problem B. Biological mother and/or father has ever had problems with anxiety or depression	1=Yes 0=No -99=Missing	Lifetime
*Impulsivity	UPPS-P (Range of 0.69-0.79 across domains) for impulsivity 5 domains: - Lack of Perseverance - Lack of Premeditation - Negative Urgency - Positive Urgency - Sensation Seeking	1=Disagree Strongly 2=Disagree a little 3=Agree a little 4=Agree strongly -99=Missing	Timeframe not specified; justification due to personality being a stable construct
*Stress	Stressful life events (0.97) for depression predictability being applied to assess stress (Kendler, Karkowski, & Prescott, 1999)	1=Endorse 0=Not endorsed -99=Missing Sum score crated based on endorsement of total exposures	Lifetime
Nicotine Use *Note: -99 represents Choose not to answer" option that was coded as missing.*	Frequency of cigarette smoking	1 = Not at all 2 = Moderate use 3 = Almost daily/daily use	Past 30 days