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The role of anhedonia in the relationship between adverse childhood experiences (ACEs) and alcohol use and food addiction in a sample of emerging adults

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**The role of anhedonia in the relationship between adverse childhood experiences (ACEs)
and alcohol use and food addiction in a sample of emerging adults**

A Thesis

Presented in

Partial Fulfillment of the

Requirements for the Degree of

Master of Arts

By

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March, 2023

Department of Psychology

College of Science and Health

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Mediating role of anhedonia between ACES and addictive behaviors

Thesis Committee

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Biography

The author was born in Minneapolis, MN on April 2, 1998. Mary graduated from Cretin-Derham Hall, in Saint Paul, MN in 2016. She received her bachelor's degree in psychology with a concentration in cognitive neuroscience and minors in biology and Spanish from DePaul University in 2020.

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Abstract

Adverse childhood experiences (ACEs) are potentially traumatic events that occur before an individual reaches age 18, and previous research has shown that they are associated with numerous negative physical and mental health outcomes, including increased rates of depression, alcohol and substance use, disordered patterns of overeating, food addiction (FA), and obesity. Moreover, anhedonia, or an inability to feel pleasure, has been also shown to increase risk for alcohol and substance use, as well as FA and obesity. There is a lack of research on the specific role of anhedonia in the relationship between ACEs and FA/substance use. It is possible that anhedonia may play an important mediating role as individuals with anhedonia may seek out highly hedonic activities. Thus, the purpose of the current study was to explore the direct and indirect relationship between ACEs and alcohol use disorder (AUD) and FA symptoms via the mediating role of anhedonia in a diverse sample of emerging adults with histories of heavy drinking. Data analyses were conducted using Mplus version 8.7. A confirmatory factor analysis was used to specify the model and structural equation modeling was used to test the hypotheses. The initial measurement model was overidentified and demonstrated acceptable to favorable fit. Standardized results from a bootstrap analysis of the structural regression model showed significant direct effects of ACEs on FA and AUD symptoms. Results also found a significant indirect effect of ACEs on AUD symptoms through anhedonia, though this indirect effect was not significant for FA. Anhedonia could be a key target for the prevention and treatment of problematic alcohol use. Future research should examine the role of anhedonia in the maintenance of FA in non-heavy drinking samples.

Keywords: ACEs, alcohol use, anhedonia, food addiction, addictive behaviors

Introduction

More than 60% of adults in the United States have reported at least one adverse childhood experience (ACE), with nearly 17% experiencing 4 or more (CDC, 2021a). ACEs are potentially traumatic events that occur before an individual reaches adulthood (CDC, 2021a). There are three categories of ACEs including abuse, neglect, and household challenges, each of which is broken down further into subgroups (CDC, 2021a). ACEs have been theorized to lead to toxic stress, a type of stress that is chronic and much more harmful than normal, everyday stress (Shonkoff, 2016). Research on allostatic load, an overabundance of exposure to toxic stress, has revealed that brain development is negatively impacted by an excess of stress hormones, and that ACEs physically change the development of a child's brain (Bucci et al., 2016; Shonkoff, 2016). Additionally, a large body of previous research has linked ACEs with numerous negative physical and mental health outcomes, including depression, posttraumatic stress disorder, insomnia, obesity, and multiple types of cancer (Zarse et al., 2019).

In addition to physical and mental health outcomes, ACEs have also been linked to addictive behaviors such as increased substance use and alcohol consumption, as well as with increased risk for endorsing criteria for binge eating disorder and food addiction (FA; Takgbajouah & Buscemi, 2022). Indeed, some research has suggested that ACEs may predispose individuals to be more susceptible to engaging in highly reinforcing behavior, such as using substances or consuming highly palatable foods, by altering brain development in ways that increase the use of these highly reinforcing behaviors to self-regulate or cope with the lasting effects of trauma (Takgbajouah & Buscemi, 2022). Due to similarities between disordered patterns of overeating and substance use (Adams et al., 2019; Gordon et al., 2018; Rogers, 2017), FA has been described as a compulsive cycle of reward driven, uncontrollable, addictive like

patterns of overconsumption and is typically associated with highly palatable foods, like processed foods high in fat and sugar (Shell & Firmin, 2017).

The relationship between ACEs and FA/substance use is important because FA and substance use are associated with comorbid chronic diseases and premature death. FA has been shown to be endorsed in individuals with higher body mass indices (BMIs) consistent with overweight or obesity (de Sousa Fernandes et al., 2020; Pursey et al., 2014). This is unsurprising, as FA is associated with increased consumption of highly palatable foods, which is associated with obesity (de Sousa Fernandes et al., 2020). Currently, obesity affects more than 40% of adults in the US, a rate that has increased by over 10% since 1999 (CDC, 2022). Childhood obesity is also a growing problem in the US, affecting around 14.4 million youth (CDC, 2022). Globally, it has been estimated that more than 710 million individuals have obesity (Sifferlin, 2017). Obesity has been linked to a number of conditions that have the potential to lead to premature death, such as heart disease, diabetes, stroke, and multiple types of cancer (CDC, 2022). Much like obesity rates, rates of substance use disorder (SUD) prevalence have increased by more than 10% since the early 2000s (Grant et al., 2016). In 2020, 21.4% of individuals aged 12 or older reported using illicit drugs (SAMHSA, 2021). Of these individuals, 40.3 million, or 14.5% of individuals aged 12 or older, met criteria for a SUD. Alcohol Use Disorder (AUD) was the most commonly endorsed use disorder, affecting 28.3 million Americans (SAMHSA, 2021). This is significant, as heavy drinking is associated with alcoholic liver disease, which leads to nearly 30,000 deaths per year in the US (CDC, 2021b). Moreover, alcohol is linked with an additional 49,000 deaths per year, not including accidents and homicides (CDC, 2021b).

FA and alcohol use also share overlapping behavioral economic (BE) risk factors. BE Theory is informed by operant psychology and microeconomics, and asserts that when making

choices, an individual weighs the perceived cost and value of one choice versus another (Kahneman & Tversky, 1984; Vuchinich & Heather, 2003). Both highly palatable foods and alcohol are high value options that lead to immediate rewarding experiences with typically minimal short term costs, increasing their reinforcing value (Buscemi et al., 2021). This can lead to the development of an overvaluation of immediately rewarding choices and a devaluation of choices with delayed rewards, such as eating nutritious foods or other health behaviors. Additionally, individuals with comorbid alcohol use, FA, and obesity have been found to have greater environmental reward deprivation compared to individuals without comorbid FA (Buscemi et al., 2021). Environmental reward deprivation, or environments lacking opportunity for non-food or non-substance related reward can increase risk for both FA and alcohol use disorder (AUD), further highlighting the shared BE risks (Buscemi et al., 2021).

Direct relationships between ACEs and FA/substance use have been explored extensively and have shown a dose-response, positive relationship between the constructs (Holgerson et al., 2018; Poole et al., 2017; Zarse et al., 2019), while less is known about mechanisms that drive these associations. One possible mechanism to explore is anhedonia. Anhedonia is a core symptom of depression that is characterized by the inability to feel pleasure and represents a deficit in positive affect (Franken et al., 2007; Hasler et al., 2004). It is thought to be a manifestation of reward system dysfunction (Birnie et al., 2020; Craske et al., 2016; Dillon et al., 2009; Fan et al., 2021; Hatzigiakoumis et al., 2011; Höflich et al., 2019), and has been shown to be associated with worsened treatment outcomes in both children and adults (Craske et al., 2016; Höflich et al., 2019). Some research has looked at the role of depression as a mediator between childhood adversity/trauma and future engagement in addictive behaviors, like substance and alcohol use and emotional eating and FA (Kim et al., 2021; Lim et al., 2020; Michopoulos et al.,

2015; Walsh & Cawthon, 2014). Results are consistent and show that depression is a significant mediator of this relationship (Kim et al., 2021; Lim et al., 2020; Michopoulos et al., 2015; Walsh & Cawthon, 2014). However, previous research is limited in the sense that it has mainly focused on negative affect or emotion dysregulation (Lim et al., 2020; Michopoulos et al., 2015), and has neglected to explore the potential independent contribution of anhedonia to this relationship.

Anhedonia is an important consideration as it has been well documented in research that chronic stress, which is often linked to childhood adversity, increases risk for anhedonia specifically (Berenbaum & Connelly, 1993; Dillon et al., 2009). Similarly, several animal and human studies have shown significant associations between childhood adversity, maltreatment, and trauma, and increased levels of anhedonia (Agrawal et al., 2012; Bai et al., 2014; Bolton et al., 2018; Dillon et al., 2009; Fani et al., 2020; Germine et al., 2015; Molet et al., 2016). It has been theorized that early adversity (Birnie et al., 2020) and ACEs in general (Takgbajouah & Buscemi, 2022) lead to changes in reward system functioning, resulting in anhedonia (Birnie et al., 2020; Dillon et al., 2009). Therefore, investigating the impact of anhedonia specifically rather than solely depression may be important as a deficit in positive affect could have unique effects on the relationship between early adversity and addictive behaviors.

To date, most of the research on anhedonia and addictive behaviors has focused on direct relationships between anhedonia and substance use and eating behaviors in separate models. Research on the relationship between anhedonia and substance and alcohol use has revealed a strong association (Destoop et al., 2019; Fani et al., 2020; Garfield et al., 2014; Hatzigiakoumis et al., 2011). In particular, anhedonia has been shown to be connected to withdrawal, relapse, and the shift from recreational to excessive substance consumption or dependence (Fani et al., 2020; Hatzigiakoumis et al., 2011), as well as drug cravings (Garfield et al., 2014). Anhedonia has also

been shown to be positively associated with substance and alcohol use severity (Destoop et al., 2019; Fani et al., 2020), and negatively associated with substance use treatment success (Destoop et al., 2019). Moreover, individuals with SUDs score higher on measures of anhedonia in comparison to healthy controls, and anhedonia has been shown to be higher in individuals with comorbid substance and alcohol use, depression, and early life stress (Destoop et al., 2019; Trøstheim et al., 2020). That said, much of previous research has focused on anhedonia in the context of substance rather than alcohol use, and has looked at anhedonia as a consequence of using substances.

A limited amount of research has looked at the role of anhedonia in relation to eating behavior. A study looking at anhedonia and binge eating behavior patients with obesity with and without sleeve gastrectomy found that higher levels of anhedonia predicted smaller weight loss in patients with sleeve gastrectomy (Santonicola et al., 2020). Similarly, research has shown that regardless of the presence of depression, anhedonia was positively linked to binge, uncontrolled, and emotional eating, and that anhedonia negatively predicted weight loss (Keränen et al., 2010). While anhedonia has been associated with binge eating behavior and other forms of compulsive overeating, a recent review of literature on anhedonia in eating disorders found that no studies to date have looked at anhedonia in individuals with diagnosed binge eating disorder (Murray et al., 2021), though recent theoretical papers have proposed a model of binge eating that asserts that binge eating may be a way for individuals to attenuate the low levels of positive affect associated with anhedonia (Mason et al., 2021). Additionally, no studies to date have looked at anhedonia in individuals with FA specifically, or explored this relationship with alcohol use and FA simultaneously.

There is a body of research guided by BE Theory that shows that individuals with SUDs or FA have decreased motivation to engage in non-substance or non-food related activities (Acuff et al., 2019; Buscemi et al., 2014; Volkow et al., 2017), and also decreased ability to experience pleasure from non-substance or non-food related activities (Blumenthal & Gold, 2010). Anhedonia specifically may play an important maintaining role in FA/substance and alcohol use as individuals with anhedonia may seek out highly hedonic activities, such as consuming drugs, alcohol, or highly palatable food, as a way to experience the pleasure they are lacking from normal, non-substance or food related day to day activities (Sussman & Leventhal, 2014). This desire to experience pleasure may then lead to decreased reinforcement of these non-substance or food related activities, maintaining the cycle of use (Acuff et al., 2019). For these reasons, it may be important to explore anhedonia specifically rather than the broader construct of depression or depressed mood.

Given the high prevalence of ACEs, AUDs, and obesity, a common outcome of FA, it is important to elucidate the specific mechanisms driving the relationship between ACEs and addictive behaviors to identify potential targets for prevention, treatment, and future research to reduce the widespread impact of addictive behaviors. Moreover, as racial and ethnic minority groups are at increased risk for experiencing ACEs (CDC, 2021a), it is especially important to investigate these relationships in diverse samples as there may be unique risk or protective factors in populations that have been minoritized. Likewise, there may also be unique risk factors among heavy drinkers, as these individuals may endorse more ACEs (Takgbajouah & Buscemi, 2022), or have higher levels of depression (Hunt et al., 2020) or anhedonia (Destoop et al., 2019). Thus, the purpose of the current study was to explore the direct and indirect relationship

between adverse childhood experiences and FA and AUD symptoms via the mediating role of anhedonia in a diverse sample of emerging adults with histories of heavy drinking.

Statement of aims and hypotheses

1. Aim 1: To test the direct effect of ACEs on FA and AUD symptoms
 - a. Hypothesis 1: There will be a significant, positive direct effect of ACEs on FA and AUD symptoms, such that individuals with more ACEs will endorse more FA and AUD symptoms.
2. Aim 2: To test the direct effect of ACEs on anhedonia.
 - a. Hypothesis 2: There will be a significant, positive direct effect of ACEs on anhedonia, such that individuals with more ACEs will have higher levels of anhedonia.
3. Aim 3: To test the direct effect of anhedonia on FA and AUD symptoms
 - a. Hypothesis 3: There will be a significant, positive direct effect of anhedonia on FA and AUD symptoms such that individuals with higher levels of anhedonia will endorse more FA and AUD symptoms.
4. Aim 4: To test the indirect effect of ACEs on FA and AUD symptoms via anhedonia.
 - a. Hypothesis 4: There will be a significant indirect effect of ACEs on FA and AUD symptoms via anhedonia.

Methods

Participants

A total of 591 participants (mean age 22.64, 42.6% male, 45.5% white, 39.9% Black) participated in the study. Data were collected from September 2017 to February 2019 as part of a larger, longitudinal study looking at heavy episodic drinking in a sample of emerging adults from

Memphis, Tennessee (Minhas et al., 2020). Eligible participants were within three years of the legal drinking age (21-24.9 years of age) and reported 2 or more past month episodes of heavy drinking (more than 3 or 4 drinks for females and males respectively; Butt et al., 2011).

Participants were excluded if they were currently receiving treatment for alcohol or substance use, had a past or current diagnosis of a psychotic disorder, or were not fluent in English (Buscemi et al., 2021). The current study used data collected at baseline.

Procedures

Advertisements featured on social media, in newspapers, and on buses, along with emails, departmental research pools, flyers and in person recruitment methods were used to recruit participants (Buscemi et al., 2021; Minhas et al., 2020). Interested participants completed an eligibility screener and written informed consent was obtained from eligible participants. The study was completed in person and the assessment session took approximately 2 hours to complete. Participants were compensated \$40 for their time. All procedures were approved by the University of Memphis' Institutional Review Board (project #4320) (Buscemi et al., 2021).

Measures

Adverse Childhood Experiences (ACEs)

The Adverse Childhood Experiences questionnaire (ACE-Q) was used to measure early life stress. The ACEs questionnaire is a 10-item measure in which participants endorse whether they experienced 10 different types of childhood trauma. Types of trauma include physical, emotional, and sexual abuse, physical and emotional neglect, and experiencing different forms of household dysfunction such as divorce, domestic violence between household members, the incarceration of a household member, and having a household member who used substances or

experienced other mental illness (Felitti et al., 1998). The ACEs questionnaire has been shown to have good internal consistency (Cronbach's $\alpha = .88$; Murphy et al., 2014).

Anhedonia

The 14-item Snaith-Hamilton Pleasure Scale (SHAPS) was used to measure anhedonia. Each item is answered using a 4-point Likert scale (1 = Definitely Agree, 4 = Definitely Disagree) (ex: I would be able to enjoy my favorite meal; I would enjoy being with my family or close friends). Scores range from 0-14, with greater scores indicating greater levels of anhedonia (Franken et al., 2007). The SHAPS has been shown to have good internal consistency in nonclinical samples (Cronbach's $\alpha = .89$; Langvik & Borgen Austad, 2019).

Alcohol Use Disorder (AUD) symptoms

The ICD-10 AUD checklist was also used to record participants' past year drinking habits. The ICD-10 AUD checklist is an 11-item yes/no measure based on DSM-5 criteria for AUD (American Psychiatric Association, 2013). Items pertain to past year alcohol use and a sample item is "Did you find it difficult or impossible to control your alcohol use?"

Food Addiction (FA) symptoms

FA was measured using the 35-item Yale Food Addiction Scale (YFAS) 2.0. Participants reported past year eating habits and experiences with certain foods, such as sugary, fatty, or salty snacks. Items are based on criteria for SUDs, and scores range from 0-11 with higher scores indicating higher levels of FA (ex: I continued to eat certain foods even though I was no longer hungry; My eating behavior caused me a lot of distress; (Gearhardt et al., 2016). The YFAS has demonstrated good internal reliability in a young adult sample (Kuder-Richardson's $\alpha = 0.86$; Gearhardt et al., 2009).

Analytic Plan

Descriptive Statistics.

Descriptive statistics, including means, standard deviations, and frequencies, were run to describe the participant reported socio-demographic characteristics of the sample. Some examples of socio-demographic characteristics included in the proposed study are age, race/ethnicity, and student status.

Preliminary analyses

Income, sex, ethnicity, and student status were considered as control variables. Variables that were significantly related to the independent factor (ACEs) and the two outcome factors (FA & AUD symptoms) were included in the model as covariates. To assess the relationship between the potential control variables and the independent and outcome factors, bivariate correlations with income, one-way ANOVAs with ethnicity and student status, and independent sample t-tests with sex were run. Correlations were also run between all latent factors to assess multicollinearity.

Structural Equation Modeling.

Structural equation modeling was used to address aims 1-4. A two-step method was used; first, the structural regression model was respecified as a confirmatory factor analysis (CFA) model to test the fit of the measurement model. Second, the fit of the structural regression model was examined. Mplus version 8.7 was used to conduct the analyses.

Specification. The latent factor ACEs was indicated by each of the ten items that make up the ACE-Q. Anhedonia was indicated by each of the 14 items that make up the SHAPS. AUD symptoms were indicated by the ICD-10 AUD checklist. FA symptoms were indicated by items from the YFAS. Items were parceled based on the 11 criteria of the YFAS. The model was

unidimensional and there are no cross loadings among indicators. There was a directional relationship between ACEs and Anhedonia, between ACEs and FA symptoms and ACEs and AUD symptoms, and between anhedonia and FA symptoms and anhedonia and AUD symptoms (See Figure 1).

Identification. The factor loadings on ACE-Q1, SHAPS1, ICD-101, and YFAS1 were fixed to zero to give each latent variable a scale. There were 112 free parameters to estimate. The CFA model (Figure 2) was identified because each latent factor had at least two indicators, each latent factor had a scale, and the degrees of freedom (df) for the model are greater than zero (df = 983). The structural model (Figure 1) was also identified because it is recursive (there were no bidirectional arrows).

Estimation. Diagonally weighted least squares (WLSMV) were used to produce parameter estimates. This is ideal when at least one of the endogenous variables are categorical (Li, 2016). The large sample size ($n = 591$) gives good statistical power.

Evaluation. The model fit indices that were used include the model chi square, the Tucker Lewis index (TLI), the comparative fit index (CFI), the root mean square error of approximations (RMSEA) and its 90% confidence interval, and the standardized root mean square residual (SRMR). Good fit is indicated by a nonsignificant chi square value, and lower values indicate better fit. A value greater than 0.90 on the TLI and the CFI indicates good fit, a value less than 0.08 indicates good fit on the RMSEA, and a value less than 0.10 indicates good fit on the SRMR. Good fit on the RMSEA 90% confidence interval is indicated by a lower bound that is less than 0.05, and an upper bound that is less than 0.10.

Respecification. Competing models were compared by looking at the chi square difference testing. If the difference was significant, the original model showed better fit and was

more parsimonious. The structural model found to have the best fit was estimated and evaluated using the above-mentioned methods to test hypotheses 1-4. One-thousand bootstrap samples were used to test mediation effects with a 95% confidence interval. Identified control variables were regressed onto the outcome variables in the identified structural model.

Results

Sample Characteristics and Descriptive Statistics

The sample consisted of 591 participants. The mean age of participants was 22.64 (SD = 1.01) and 81.2% of the sample graduated high school or had an equivalent degree ($n = 480$). 42.1% of the sample identified as male ($n = 249$), 56.7% as female ($n = 335$), and 1.2% as transgender, nonbinary, or unsure ($n = 7$). Two hundred and sixty-nine participants identified as white (45.5%) and 236 identified as Black (39.9%). A little over half of the participants were currently not in school ($n = 260$, 52.5%), and 80.2% were employed full- or part-time ($n = 474$). See Table 1 for a full breakdown of sample characteristics. The average ACE score of participants was 1.81 (SD = 2.3; range 0-10). The average score on the SHAPS was 1.38 (SD = 2.0), with a score > 2 indicating diagnosable anhedonia (Franken et al., 2007). The median (interquartile range) number of YFAS symptoms endorsed was 0.0 (0.0-2.0), while the median (interquartile range) number of ICD-10 AUD symptoms endorsed was 1.0 (0.0-3.0). Scores of 2 or greater on these measures indicate the presence of FA (Gearhardt et al., 2009) or AUD (American Psychiatric Association, 2013). 14.3% of participants met criteria for mild FA, 7.7% met criteria for moderate FA, and 8.5% met criteria for severe FA. 20.2% met criteria for a mild AUD, 9.3% met criteria for a moderate AUD, and 10.5% met criteria for a severe AUD.

Preliminary Analyses

Income was significantly correlated with ICD-10 AUD symptom count ($r(587) = -.112, p = 0.007$), YFAS symptom count ($r(585) = -.113, p = 0.006$), and ACE score ($r(589) = -.250, p < 0.001$), indicating that it should be included in the model as a covariate. There were significant differences in YFAS symptom count across race/ethnicity ($F(10, 576) = [2.689], p = 0.003$) and sex ($t(585) = -4.217, p < 0.001$), though there were no significant differences for ICD-10 symptom count ($F(10, 578) = [1.313], p = 0.22; t(587) = 1.256, p = 0.063$) or ACE score ($F(10, 570) = [1.751], p = 0.067; t(579) = -2.810, p = 0.055$). Additionally, there were significant differences in ICD-10 symptom count across student statuses ($F(3, 585) = [4.654], p = 0.003$), but no significant differences in YFAS symptom count ($F(3, 583) = [0.396], p = 0.756$) or ACE score ($F(3, 577) = [0.813], p = 0.487$). This suggests that race/ethnicity, sex, and student status do not significantly impact the effect of ACEs on the outcome variables and did not need to be included in the model as covariates. There were no issues with multicollinearity among the latent factors (see Table 2 for correlations between latent variables).

Measurement Model

The measurement model consisted of four latent variables; ACEs, anhedonia, FA, and AUD (see Figure 2). The model was overidentified ($df = 983$), and the factor loading between each of the latent variables and their first indicator was fixed to 1 to assign each latent variable a scale. There were significant loadings between all indicators and their corresponding latent variables ($p < 0.001$) and all factor loadings were greater than 0.398. The identified measurement model demonstrated good fit (TLI = 0.947, CFI = 0.950, RMSEA = 0.024, RMSEA 90% C. I. = 0.020 – 0.027, SRMR = 0.080). A chi-squared test showed poor fit ($\chi^2 = 1309.020, df = 983, p <$

0.001), though this index is heavily influenced by a large sample size (Bergh, 2015). All latent variables were significantly correlated with each other (see Table 2).

Structural Model

Two structural regression models were tested to determine which model fit the data best. Model 1 examined the role of anhedonia as a partial mediator of the directional association between ACEs and the outcome variables FA and AUD symptoms (see Figure 1). Model 2 examined a nearly identical model, with anhedonia operating as a full mediator of the proposed directional association between ACEs and FA and AUD symptoms (see Figure 3). In line with recommendations for conducting SEM, several fit indices were assessed to provide converging evidence (i.e., χ^2 , TLI, CFI, RMSEA, SRMR) on the goodness of fit of each of the models. Model 1 showed favorable to good model fit (TLI = 0.947, CFI = 0.950, RMSEA = 0.024, RMSEA 90% C. I. = 0.020 – 0.027, SRMR = 0.080), though a chi-square difference test displayed poor fit ($\chi^2 = 1309.020$, $df = 983$, $p < 0.001$). The fully mediated model (Model 2) showed a marginal decrease in model fit, in which goodness of fit indices were acceptable, but decreased slightly (TLI = 0.920, CFI = 0.924, RMSEA = 0.029, RMSEA 90% C. I. = 0.026 – 0.032, SRMR = 0.093). Additionally, a chi-squared test indicated poor model fit as well ($\chi^2 = 1480.629$, $df = 985$, $p < 0.001$). A chi-square test for difference testing of Model 1 (partial) and Model 2 (full) revealed a significant difference in model fit ($\Delta\chi^2 (2) = 35.076$, $p < 0.001$). Thus, the partially mediated model was retained as it demonstrated better fit.

Standardized results from the partially mediated model (Model 1) suggest that ACEs positively and significantly predict Anhedonia ($\beta = 0.146$, $p = 0.006$), and positively and significantly predict FA ($\beta = 0.188$, $p = 0.001$) and AUD ($\beta = 0.313$, $p = 0.000$) symptoms. Anhedonia was positively and significantly related to AUD symptoms ($\beta = 0.174$, $p = 0.001$) and

was positively related to FA symptoms, though this association was non-significant ($\beta = 0.105, p = 0.051$). Additionally, the correlation between FA and AUD symptoms was significant ($r = 0.237, p = 0.001$).

Standardized results from a bootstrap analysis showed significant direct effects of ACEs on FA ($\beta = 0.188, p = 0.002, \text{C.I.} = 0.086 - 0.289$) and AUD ($\beta = 0.313, p = 0.000, \text{C.I.} = 0.221 - 0.405$) symptoms, as well as on anhedonia ($\beta = 0.146, p = 0.008, \text{C.I.} = 0.055 - 0.238$). Results also found a significant indirect effect of ACEs on AUD symptoms through anhedonia ($\beta = 0.025, p = 0.05, \text{C.I.} = 0.004 - 0.047$), though this indirect effect was not significant for FA symptoms ($\beta = 0.015, p = 0.159, \text{C.I.} = -0.003 - 0.033$). Anhedonia acted as a partial mediator of the association between ACEs and AUD symptoms, but not between ACEs and FA symptoms.

A final pruning model that removed nonsignificant pathways (Model 3) was tested to establish the final model (see Figure 4). This model indicated favorable to good model fit (TLI = 0.946, CFI = 0.949, RMSEA = 0.024, RMSEA 90% C. I. = 0.020 – 0.027, SRMR = 0.082), though a chi-squared test indicated poor model fit ($\chi^2 = 1315.652, df = 984, p < 0.001$). However, when compared to Model 1, a chi-square test for difference testing revealed a significant difference in model fit ($\Delta\chi^2 (1) = 3.859, p = 0.0495$). Thus, Model 1 was retained.

Income was added as a control variable to Model 1 (Model 1.1). Model 1.1 showed favorable to good model fit (TLI = 0.935, CFI = 0.939, RMSEA = 0.026, RMSEA 90% C. I. = 0.023 – 0.029, SRMR = 0.083). Standardized model results found that when controlling for income, ACEs continue to positively and significantly predict Anhedonia ($\beta = 0.128, p = 0.013$), FA ($\beta = 0.158, p = 0.007$) and AUD ($\beta = 0.296, p = 0.000$) symptoms. Anhedonia also continued to be significantly, positively related to AUD symptoms ($\beta = 0.170, p = 0.001$) and was positively related to FA, though again this association was non-significant ($\beta = 0.100, p = 0.056$).

Additionally, the correlation between FA and AUD symptoms was significant ($r = 0.229$, $p = 0.001$) (see Figure 5).

Discussion

This study aimed to examine the role of anhedonia in the relationship between ACEs and FA and alcohol use. Results showed that ACEs have a significant direct effect on FA and AUD symptoms, as well as on anhedonia. Anhedonia was also found to have a significant direct effect on AUD symptoms. Additionally, we found that ACEs have a significant indirect effect on AUD symptoms via anhedonia, and that anhedonia acted as a partial mediator of the relationship between ACEs and alcohol use only. These results remained consistent when controlling for income. In line with existing research, the results from the current study add support to the previously established direct relationship between childhood trauma and anhedonia (Agrawal et al., 2012; Bai et al., 2014; Bolton et al., 2018; Dillon et al., 2009; Fani et al., 2020; Germine et al., 2015; Molet et al., 2016), FA (Holgerson et al., 2018; Takgbajouah & Buscemi, 2022), and alcohol use (Poole et al., 2017; Takgbajouah & Buscemi, 2022; Zarse et al., 2019). Additionally, results also align with previous studies that have found positive relationships between anhedonia and alcohol use (Destoop et al., 2019; Fani et al., 2020; Garfield et al., 2014; Hatzigiakoumis et al., 2011) and disordered patterns of overeating (Keränen et al., 2010; Santonicola et al., 2020). Though the current study did not yield a significant relationship between anhedonia and FA, the results were approaching significant ($p = 0.051$) and show an expected positive relationship between the constructs. The standardized regression coefficient for the direct relationship between the two constructs was 0.105, reflecting a small effect of anhedonia on FA (Kline, 2016).

One potential reason for the lack of a significant, direct effect of anhedonia on FA could have been due to the fact that the sample was made up of individuals who reported at least two heavy drinking episodes in the past month. While existing research has explored the comorbidity of problematic alcohol use and FA (Buscemi et al., 2021; Hoover et al., 2022), there is also research that has suggested the existence of “addiction transference,” which occurs when an individual replaces one addictive behavior with another (Brunault et al., 2015; Conason et al., 2013; Cowan & Devine, 2008). It is possible that because the current sample consisted of individuals who engage in heavy episodic drinking, alcohol use was their “primary behavior” and there were not enough symptoms of FA present to have the statistical power to find a significant effect.

The current study has important implications for treatment. Findings suggest that anhedonia may be a significant symptom resulting from trauma that is implicated in addictive behaviors. Targeting anhedonia, and more specifically targeting anhedonia within the context of childhood trauma and how it relates to current functioning, may help more effectively treat addictive behaviors. Moreover, treating anhedonia in individuals with childhood trauma and problematic alcohol use specifically could help emerging adults reduce their AUD symptoms. In particular, as anhedonia represents a deficit in positive affect, interventions should focus on increasing positive affect, rather than or in addition to coping with negative affect. Research has shown that positive affect may play a crucial role in individuals recovering from SUDs (Carrico et al., 2013), and low positive affect has been theorized to maintain binge eating (Mason et al., 2021). A novel positive affect treatment (PAT), which focused on planning, reinforcing, and recounting pleasurable activities, has been shown to have superior outcomes in depression related outcomes compared to a treatment targeting negative affect (Craske et al., 2019).

Similarly, research has found that supplementing traditional interventions for heavy drinking with sessions that aim to reinforce non-substance related activities using BE principles is effective in reducing alcohol use and related problems (Murphy et al., 2012, 2019). Focusing on reducing anhedonia by increasing positive affect and reinforcing non-food or -substance related activities may have a significant impact on reducing addictive behaviors, and these interventions may be particularly important for individuals with ACEs and high levels of anhedonia. Furthermore, clinical interventions should focus on the motives driving overconsumption or problematic alcohol use and take a developmental perspective that accounts for the ways an individual's past trauma impacts current choices.

The findings of the current study should be considered within the context of its limitations. First, the sample consisted solely of emerging adults who engaged in heavy drinking. These individuals may have had on average lesser, or potentially even greater, symptoms of FA, which could have affected the results. Second, the current study used a cross sectional mediation model, so causality of the outcome latent factors is not ensured. However, the study examined the impact of adverse events that occurred in childhood. Due to the retrospective nature of these events, it is appropriate to test the mediation effects in a cross-sectional model. Nevertheless, future research may consider exploring longitudinal relations over time to elicit the temporal order of the associations and address the limitations of cross-sectional research. Longitudinal research on the role of anhedonia in addictive behaviors could be especially clarifying as much of the research on substance use and anhedonia focuses on substance induced anhedonia, rather than exploring the idea that the anhedonia preceded the use. Third, the sample was made up of individuals from one southern, American city, so generalizability of results to inhabitants of other regions of the U.S is limited.

Future research should examine the proposed model in samples of individuals who endorse clinically significant levels of FA or with diagnosed AUD. Among the sample, the average numbers of FA and AUD symptoms were relatively low and examining the current model in samples of individuals with greater symptomology may yield different results. Future research should also delineate between the different types of anhedonia (ex: participatory anhedonia, which refers to a lack of motivation to engage in pleasurable activities vs. consummatory anhedonia, or a lack of pleasure during typically pleasurable experiences (Fan et al., 2021)), as they may come with unique risk factors. Future research should look at ACE type as well, as certain ACEs may have unique interactions in the proposed models. For example, some research has suggested that emotional abuse and neglect may lead to unique risk for anhedonia due to the typically chronic nature of neglect in comparison to other types of adversity (Cohen et al., 2019). Additionally, it may be useful to include obesity as a covariate of the models. As stated above, FA is associated with obesity (de Sousa Fernandes et al., 2020; Pursey et al., 2014) and research has also shown that alcohol use is associated with obesity as well (Buscemi et al., 2021). Moreover, future research should consider using alternative measures of body composition, such as waist to height ratio (WHtR), rather than BMI. There are a number of studies that have found that WHtR is a better predictor for metabolic and cardiovascular disease among adults and adolescents, across multiple race and ethnic groups when compared to BMI (Ashwell et al., 2012; Gibson & Ashwell, 2020; Vasquez et al., 2019). Furthermore, given the stigma associated with the word “addiction,” future research should explore the possibility of using less stigmatizing terms when discussing these constructs. Finally, future research should also consider using a longitudinal design to explore the proposed model to ameliorate the limitations of a cross sectional design.

In conclusion, despite the aforementioned limitations, anhedonia was found to mediate the relationship between ACEs and alcohol use. Interventions for alcohol use may consider targeting anhedonia, and ideally childhood trauma and anhedonia simultaneously, to reduce AUD symptomology. The current study sampled a diverse population of emerging adults, and results are generalizable to emerging adults of numerous racial and ethnic identities as well as socioeconomic backgrounds, regardless of student status. Future research should explore the current model in longitudinal samples of individuals with clinically significant levels of FA or AUD, and should consider examining the model in independent samples to avoid confounding factors such as addiction transference. Though anhedonia was not found to significantly mediate the relationship between ACEs and FA, there was a small, positive effect of anhedonia on FA symptoms and future research on this topic is warranted to better serve individuals experiencing addictive patterns of overeating. Lastly, future research should continue exploring the role of anhedonia, as well as the potential independent influences of the different types of anhedonia, in the maintenance of addictive behaviors.

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Table 1

<i>Sociodemographic features</i>		
Characteristic	Number	Percent (%)
<i>Sex</i>		
Male	252	42.6
Female	339	57.4
<i>Gender</i>		
Male	249	42.1
Female	335	56.7
Transgender	3	0.5
Unsure	2	0.3
Other	2	0.3
<i>Ethnicity</i>		
White/European ancestry	269	45.5
Black/African ancestry	236	39.9
East Asian	6	1.0
South Asian	11	1.9
Southeast Asian	3	0.5
Middle Eastern/West Asian	3	0.5
First Nations/Inuit/Metis/Native Canadian	1	0.2
Pacific Islander	4	0.7
Latinx/Hispanic	33	5.6
More than one population group	24	4.1
Other	1	0.2
<i>Income</i>		
Less than \$15,000	99	16.8
At least \$15,000 but less than \$30,000	127	21.5
At least \$30,000 but less than \$45,000	96	16.2
At least \$45,000 but less than \$60,000	78	13.2
At least \$60,000 but less than \$75,000	37	6.3
At least \$75,000 but less than \$90,000	37	6.3
At least \$90,000 but less than \$105,000	32	5.4
At least \$105,000 but less than \$120,000	24	4.1
Greater than \$120,000	61	10.3
<i>Education Level</i>		
Less than high school graduate	6	1.0
High school graduate (or GED)	59	10.0
Some college / university	259	43.8
Associate's degree	37	6.3
Bachelor's degree completed	212	35.9
Master's degree completed	17	2.9
Professional degree completed (MD, PhD, JD)	1	0.2
<i>Student Status</i>		
No	310	52.5
Yes, less than part-time	6	1.0
Yes, part-time	50	8.5

Yes, full-time	225	38.1
<i>Employment</i>		
Full-time	260	44.0
Part-time	214	36.2
Legally disabled	4	0.7
Unemployed	113	19.1

Table 2*Correlations among latent factors*

Variable	1	2	3	4
1. ACEs	-			
2. Anhedonia	0.146**	-		
3. Food Addiction (FA)	0.203**	0.133	-	
4. Alcohol Use	0.338***	0.219***	0.300***	-

Note. $n = 591$, significant statistics denoted by ** for $p < 0.01$ and *** for $p < 0.001$

Figure 1

Model 1: Proposed Model with Partial Mediation

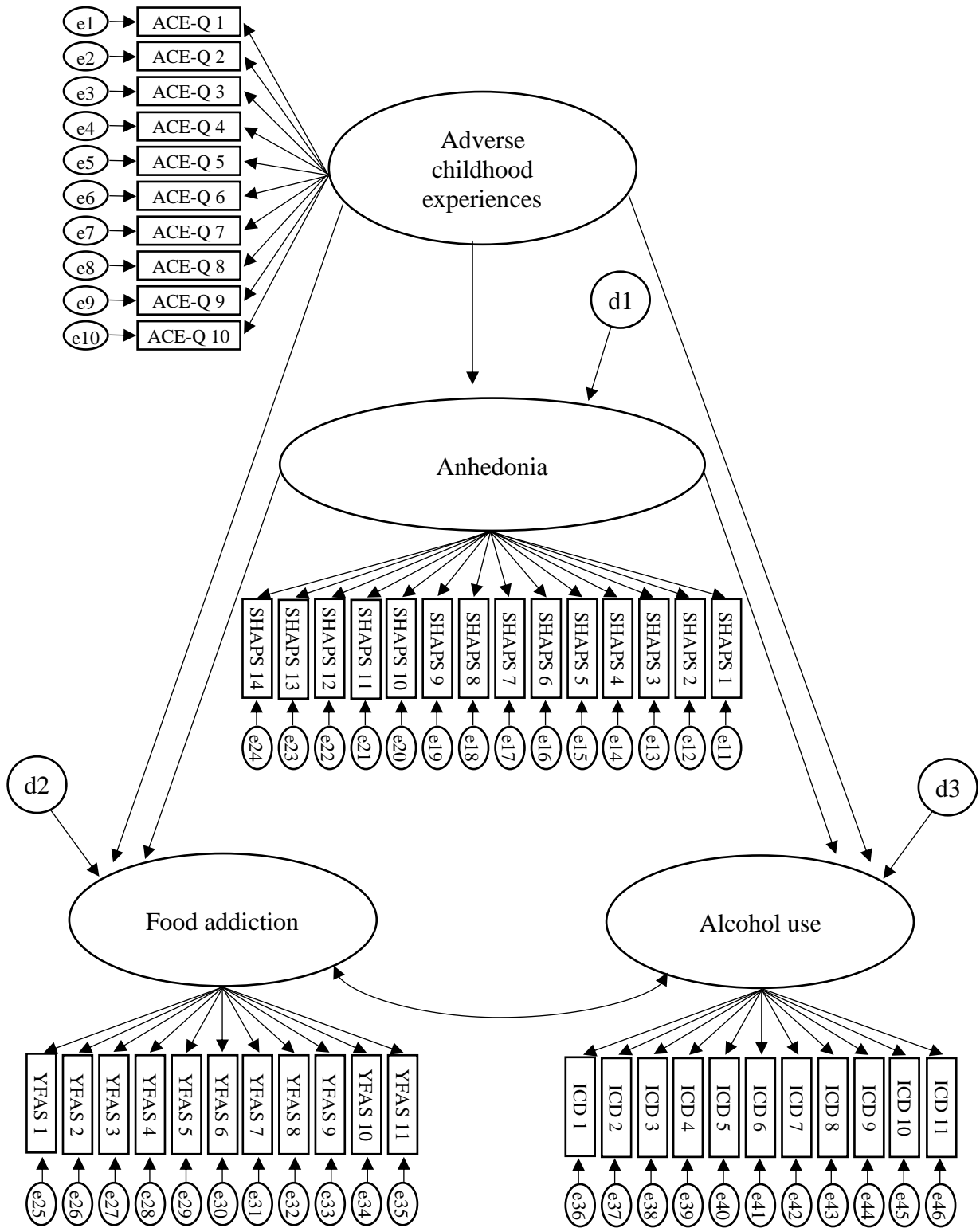


Figure 2

Measurement model

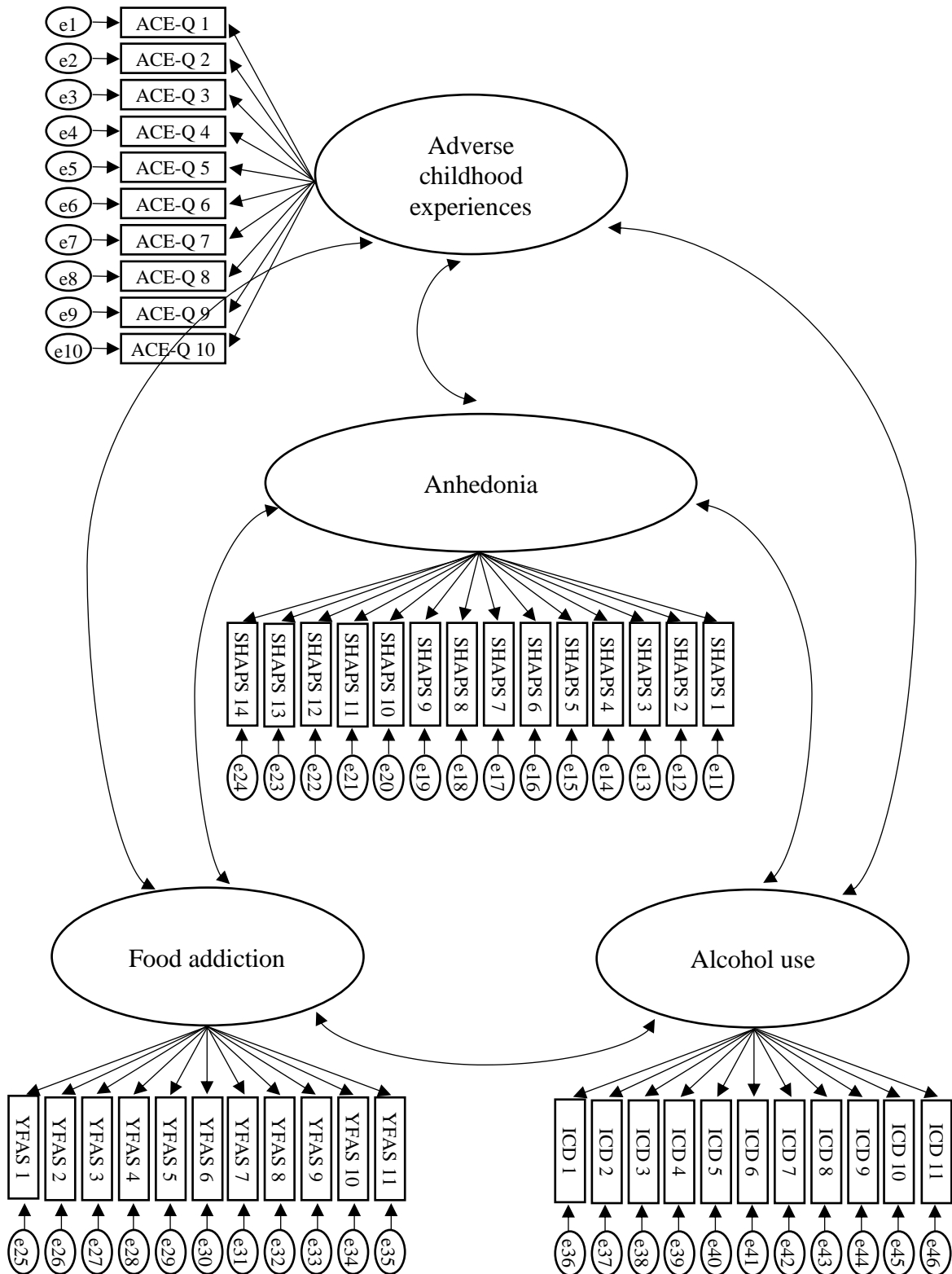


Figure 3

Model 2: Full mediation

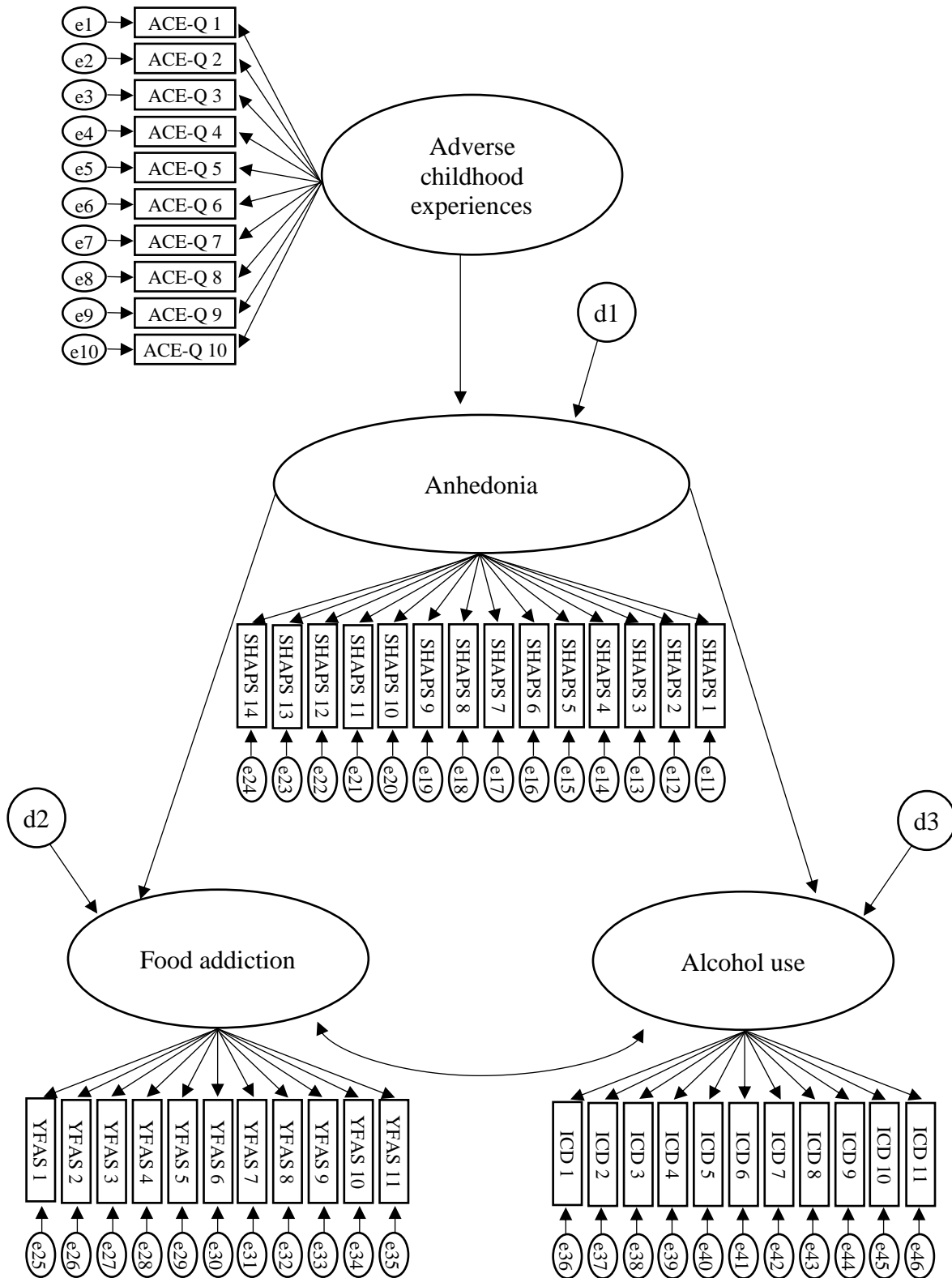


Figure 4

Model 3: Pruning model

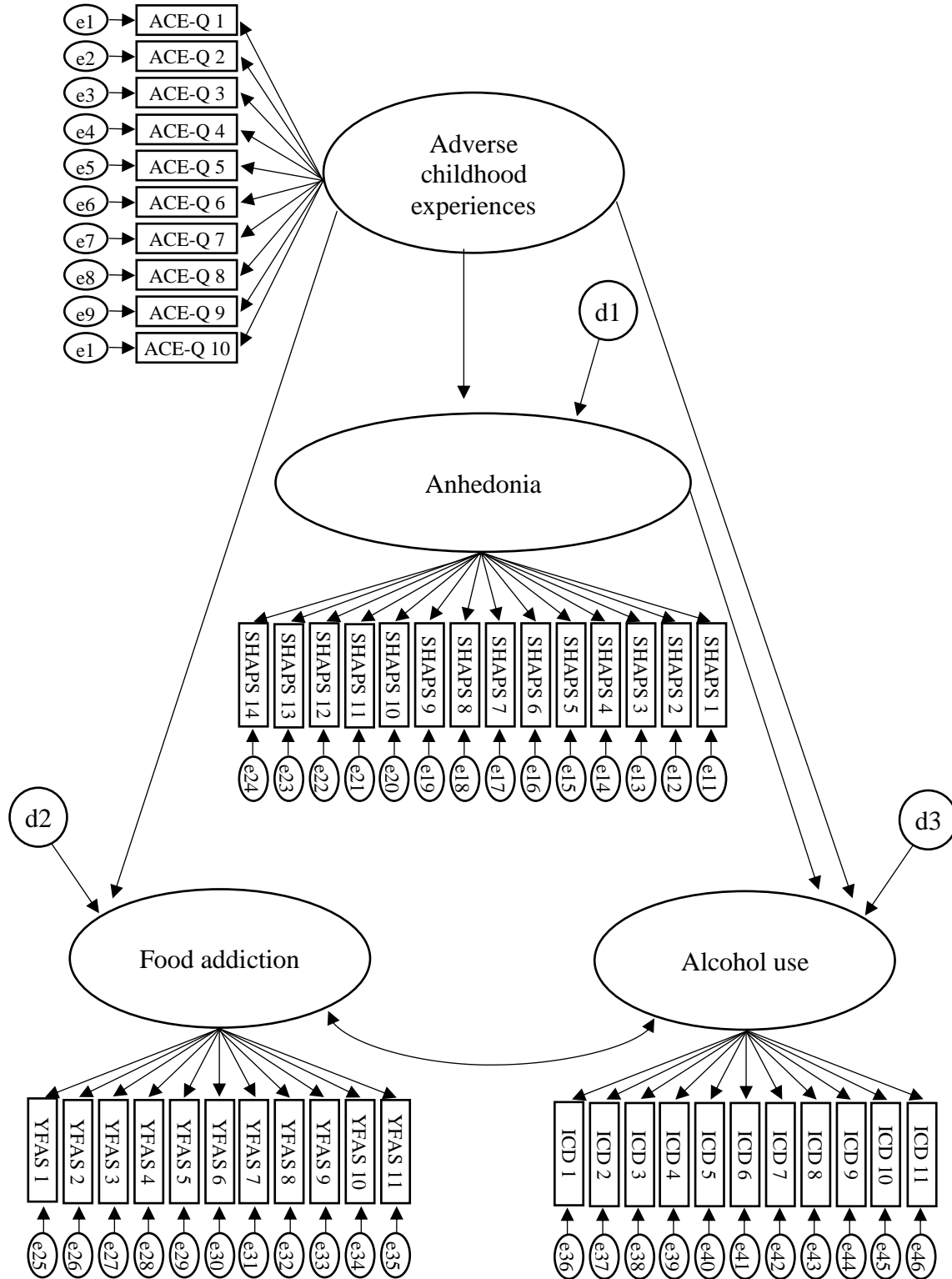
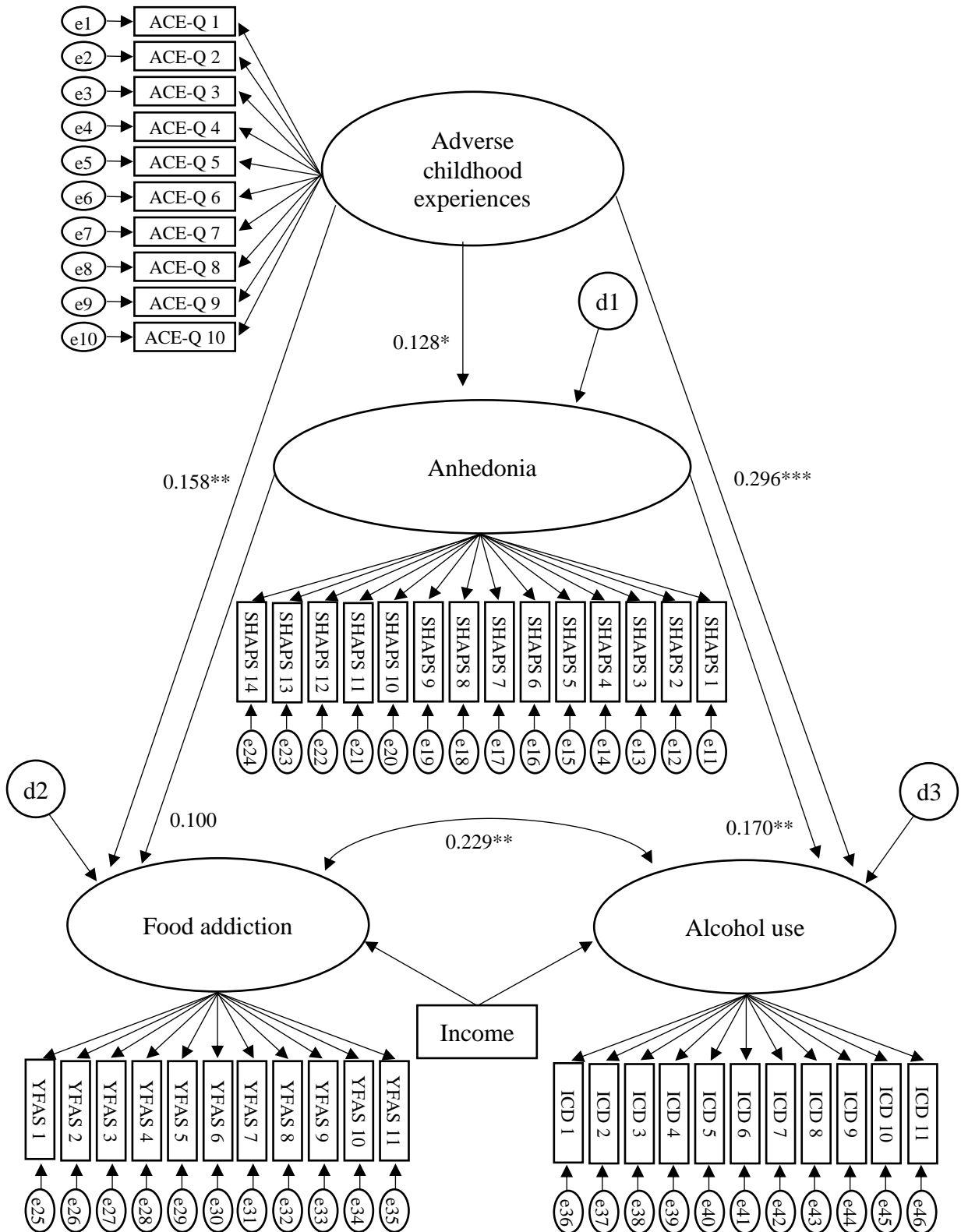


Figure 5

Model 1.1: Final model with covariates



Note. significant statistics denoted by * for $p < 0.05$, ** for $p < 0.01$, and *** for $p < 0.001$