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Longitudinal Associations Among Depression, Obesity, and Alcohol Use Disorders in Young Adulthood

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Abstract

Objective—This study examined concurrent and prospective relations between clinical depression, obesity, and alcohol use disorders during young adulthood to better understand common etiology and the progression of co-occurrence.

Method—Participants were 776 young adults (393 males and 383 females) who were interviewed at ages 24, 27, and 30 with assessment of past-year major depressive episode, past-year alcohol abuse or dependence disorder, and obesity. Longitudinal path analyses were conducted separately for women and men, controlling for income and including stability of each of these outcomes

Results—Among women, depression was positively associated with later alcohol use disorders (ages 27 to 30: OR = 3.11), and alcohol use disorders prospectively predicted obesity (ages 24 to 27: OR = 3.84). Obesity predicted depression from ages 27 to 30 among women (OR = 2.14), but was protective against depression for males (OR = 0.31).

Conclusions—Results show that depression, obesity, and alcohol use disorders are interrelated conditions for women. A greater understanding of reasons underlying the co-occurrence of these conditions would benefit prevention and intervention efforts.

Keywords

Alcohol abuse; depression; obesity; young adults; comorbidity

Depression, obesity, and alcohol use disorders are all major public health problems in the United States. Current estimates suggest that the lifetime prevalence of Major Depressive Disorder in this country is 16%, with affected persons suffering from substantial symptom severity and role impairment [1]. Nearly one third of adults meet criteria for obesity [2], a disease that may soon overtake tobacco as the highest contributor to attributable deaths per

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year [3]. Alcohol use disorders and major depression are among the most prevalent mental disorders in the general population and have increased in more recent birth cohorts [1,4]. Alcohol abuse and dependence are common and disabling disorders, with lifetime prevalence rates nationally of 17.8% and 12.5%, respectively [5]. Young adulthood is an important developmental period during which the prevalence of many of these health problems peak, yet access to health care is limited [6]. A body of evidence is accumulating to show significant comorbidity both concurrently and over time, though most studies have focused on two of these three health conditions, as reviewed in the following sections.

Depression and Obesity

Data from the National Comorbidity Study-Replication study suggests that obesity is associated with an approximately 24% increase in the odds of mood disorder [7]. In many, but not all studies, gender has been found to significantly moderate the relationship between depressive symptoms and body weight [8,9]. Generally, studies have observed a positive association between depression and obesity for women [10–13], but a null or negative association for men [12–16]. The depression-obesity connection may be particularly relevant for females because women have more negative body esteem than men, and the cultural pressure to be slim is heightened among women [17].

The temporal sequence of depression and obesity during adulthood is unclear, with some studies suggesting that depressive symptoms or disorder predicts weight gain and obesity [10,11,18], and others finding that obesity predicts depression [19–21]. Several of these studies have been limited in that they only examined effects in one direction; that is, depression to obesity or obesity to depression.

Depression and Alcohol Use Disorders

Cross-sectional studies using community samples have provided evidence that heavy alcohol use is associated with an elevated risk of depressive symptoms and major depression [22,23]. Further, studies that have evaluated the impact of alcohol consumption at various levels have suggested that extreme levels of consumption, such as heavy episodic drinking and high quantity per occasion, are most strongly associated with depression [23–25]. In community samples, risk ratios between alcohol dependence and affective disorders have ranged from 1.8 to 4.2 [26], suggesting a moderate to strong association between alcohol use disorders and major depression, even independent of intoxication and withdrawal symptoms [27].

Longitudinal studies have found evidence that both alcohol dependence and major depression pose a significant risk for the later development of the other disorder [25]; however, the direction of this relationship is unclear. Some studies have found that risk for alcohol disorders is driven primarily by prior episodes of depression [28,29]. In the United States, 41.5% of adults with comorbid depression and substance use showed temporal precedence of major depressive disorder [1]. Other studies have reported that alcohol disorders lead to depression [25]. Both U.S. and Australian studies have found that females are more likely to suffer from comorbid alcohol and mental disorders, including depression [30]. Some longitudinal studies have found that depressive symptoms predict alcohol problems more strongly for women than for men [28,31]; in fact, for men, studies suggest there is a weak relationship between these disorders, or no relationship at all [24,32].

Alcohol Use Disorders and Obesity

There is limited evidence of a relationship between obesity and alcohol use disorders, although recent studies suggest that alcohol intake correlates with Body Mass Index [33]. Previous analyses of our sample have suggested that being overweight and obese in young adulthood

are consequences of heavy drinking during adolescence [34]. However, other studies suggest that alcohol abuse may be associated with a lower risk of being overweight and obese [7,35], with one study showing a stronger negative association for men, compared to women [36]. It has been suggested that disordered eating and alcohol misuse are both associated with high levels of reward sensitivity, which may provide common vulnerability [37]; ingestion of alcohol and eating for pleasure both cause dopaminergic activation in the reward pathway of the brain (nucleus accumbens).

Contributions of the Present Study

Prevention and treatment efforts for each of these problems are underway [38–40], though interventions tend to be targeted to these conditions singly. Together, depression, overeating, and heavy drinking have been referred to as “the toxic triangle,” with women appearing particularly vulnerable to these comorbidities [41]. Comorbidity appears to have particularly severe consequences, including poorer treatment response, increased disability, and greater cost of health services than any one of these conditions alone [42–45].

Many prior studies examining comorbidity of these disorders have not been able to look optimally at longitudinal patterns due to methodological limitations. The literature has been characterized by studies that use, at most, two time points [19,20,46] and tests of unidirectional effects that do not account for competing hypotheses [10,11,29,34]. Other studies have been conducted with mixed age groups [24,25,32] that might obscure developmental and age-related differences. Finally, the use of clinical samples within some of these studies [35] limits generalizability.

Because there is evidence of an association between socioeconomic factors and each of these disorders [47,48], we also controlled for income in the current study. Most, but not all of the previous literature examining co-occurrence of these disorders over time has included some control for socioeconomic factors [for an exception see 11].

The present study examines the longitudinal associations among depression, obesity, and alcohol use disorders in young adulthood in order to better understand common patterns of disorder progression and to inform possible prevention efforts. By examining multidirectional associations over three time points from a nonclinical cohort of young adults with attention to gender differences, this study seeks to advance the empirical foundation for addressing public health concerns over these comorbidities.

Method

Sample

Participants were initially recruited as part of a longitudinal study in the fall of 1985 when all fifth-grade students attending 18 elementary schools in Seattle were invited to participate.¹ Schools serving children from high-crime neighborhoods were oversampled. Of the 1,053 students making up the population, 808 (77%) agreed to participate in the longitudinal study, including 412 boys and 396 girls. These students were followed into adulthood. Overall

¹A portion of the sample was exposed to a multicomponent preventive intervention in the elementary grades, consisting of teacher training, parenting classes, and social competence training for children [67,68]. Consistent with prior analyses that have shown few differences in the covariance structures of the intervention and control groups [69–71], analyses for this report were based on the full sample after examining possible differences in the relationships of depression, obesity, and alcohol use disorders over time, comparing the control and intervention groups for females and males. We conducted two separate multi-group measured variable model tests comparing a model where all covariances between depression, obesity, and alcohol were constrained to be equal across the control and intervention groups to a model in which these paths were freely estimated. These tests showed no significant reduction in overall fit of the model for females ($\Delta\chi(8) = 7.70, p = .46$) or for males ($\Delta\chi(8) = 3.26, p = .92$). Results suggested no substantial group differences in the relationships of interest in this report, supporting a single-group analysis.

retention rates in adulthood ranged from 95% (at age 24) to 91% (at age 30) of those still living. Pregnant females and those with incomplete outcome data were excluded from the cross-sectional analyses, resulting in samples of 713 (88%) at age 24, 716 (89%) at age 27, and 647 (80%) at age 30, as shown in Figure 1. Tests of longitudinal models used full-information maximum likelihood algorithms in order to utilize all available data and were based upon a sample size of 776 (383 females and 393 males with data from at least one time point).

Participants were Caucasian (47%), African American (26%), Asian American (22%), and Native American (5%). Among those who reported their income at age 24, 34% reported a shared household income less than \$30,000, 33% reported income between \$30,000 and \$60,000, and the remainder of the sample reported income greater than \$60,000. All participants provided informed consent. Study protocols were approved by the University of Washington Institutional Review Board.

Procedure and Measures

For this phase of the study, participants were interviewed in person at ages 24, 27, and 30. Past-year depressive episode was assessed using a modified version of the Diagnostic Interview Schedule (DIS) [49,50]. The DIS has been used frequently in studies of psychiatric disorders among adults and has been demonstrated to be reliable and valid [51–53]. Eighteen items from the DIS were used to assess the presence of a past-year depressive episode at each age, which assessed symptoms of a major depressive episode that occurred within a two-week period, as outlined in the DSM-IV. Similarly, past-year alcohol dependence and abuse were measured using 14 items of the DIS, which also concur with criteria of the DSM-IV.

Information about height and weight was provided by participants beginning at age 24. Body Mass Index (BMI) was calculated using the following equation: $703 \times \text{weight (in pounds)} / \text{height}^2 \text{ (in inches)}$. National Heart, Lung, and Blood Institute standards were applied to BMI data to create a cutoff for obesity (BMI of 30 or greater) [54,55].

Statistical Analyses

The results are presented in two sections. First, descriptive information on the cooccurrence of these conditions for each time point and correlational tests of their association are presented separately by gender groups, using the Phi correlation coefficient. The second section presents results of multivariate cross-lagged path analyses conducted separately for males and females to test for bidirectional associations between major depression, alcohol use disorders, and obesity over time. In these analyses, each condition was modeled as a predictor of the other two conditions across adjacent time points. Models controlled for the effects of income at age 24, and allowed the covariance between each of the exogenous variables at age 24 to be freely estimated. Each model included freely estimated stability paths across adjacent time points, between the age 24 and 27 assessments, and between the age 27 and 30 assessments. Maximum likelihood estimators were used with standard errors computed using a sandwich estimator. Effect sizes are given by coefficient estimates as well as odds ratios (OR) with 95% confidence intervals (CI). All analyses were conducted in Mplus version 5.1 using the covariance matrix.

Results

Table 1 shows the proportion of the sample meeting criteria for individual and comorbid conditions, by age and gender. From 8.1% (females at age 21) to 11.8% (males at age 21) of participants showed some form of comorbidity in young adulthood. For females, comorbidity increased through young adulthood, whereas for males there was a decline. Correlation coefficients within disorders across time are shown in Table 2. Indicating high stability for each disorder, nearly all of the correlation coefficients within each given disorder across time

were significant, with the exception of major depressive episode at ages 24 and 30 for men. Correlations within time across disorders, consistent with comorbid problems, were more robust for women than for men, as shown in Table 3. For women, four correlations emerged as significant: obesity and the presence of a major depressive episode at ages 24 and 30, and alcohol use disorders and depression at ages 27 and 30. For men, the only significant correlation between conditions was for major depression and alcohol use disorders at age 30. In terms of significant correlations across disorders and across time, three significant values emerged, shown in Table 4. For women, obesity at age 27 was associated with depression at age 30, and depression at age 27 was associated with an alcohol use disorder at age 30. For men, obesity at age 27 was negatively associated with depression at age 30.

The results of the longitudinal co-occurrence models for women and men are shown in Figure 1 (for clarity, only significant paths are shown). Both the female and the male models demonstrated good fit according to fit index criteria (CFIs were greater than .99; RMSEA values were .07 for the female model and .04 for the male model). Three significant cross-lagged paths emerged for women: (a) women who had alcohol use disorders at age 24 were more likely to be obese at age 27 (OR = 3.84, 95% CI = 1.61, 9.14); (b) women who were obese at age 27 were more likely to report depression at age 30 (OR = 2.14, 95% CI = 1.05, 4.36); and (c) for women, depression at age 27 was associated with increased risk for alcohol disorders at age 30 (OR = 3.11, 95% CI: 1.29, 7.54). In addition to these cross-lagged effects, all stability pathways were significant. Income had a significant effect on obesity at age 24 for females, with higher income related to lower risk of obesity (for graphical clarity, income is not shown in Figure 1). For men, only one significant cross-lagged longitudinal path emerged. Obesity at age 27 was associated with lower odds of depression at age 30 (OR = 0.31, 95% CI = 0.10, 0.96). Income was significantly negatively related to major depression at age 27 for males.

A direct test of these overall model differences by gender was conducted by comparing a multigroup model in which the three significant cross-lagged paths in Figure 1 were free to vary for women and men to a model in which the path estimates were constrained to be equal for women and men. Stability paths were free to vary in both models. The overall chi-square difference test was significant, $\chi^2(3) = 11.90$, $p = .008$, indicating differences in the model for men and women.

Discussion

Nearly half of this community-based sample (40% - 54%) met criteria for at least one of these costly and impairing health-related conditions from age 21 to age 30, and 8% to 12% reported comorbid problems at some point during this period. Unique patterns of comorbid problems emerged for women and men, although many more significant associations within and across time were shown for women. For women, multiple relationships emerged between these three disorders, though the associations found were not consistent from age 24 to 27 and age 27 to 30, suggesting that the timing of these conditions may matter. For men, by and large, we found that these disorders are not co-related over time.

This study suggests that depression, obesity, and alcohol use disorders are more related for women than for men. These results are consistent with other psychological theories and research. For example, Susan Nolen-Hoeksema has theorized that women's vulnerability to "the toxic triangle" of disordered eating, problem drinking, and depression is caused by their greater tendency, compared with men, to respond to stress with rumination, a form of self-focused coping [41]. While we did not measure rumination in the current study, some research supports her theory. For example, she found that both men and women who scored high on rumination were more depressed and more likely to binge eat or turn to alcohol when they were

upset; and, overall, women were more prone to rumination [56]. Additionally, adolescent girls who scored high in rumination were more likely to develop more symptoms of depression, bulimia, and substance abuse over a three-year period compared to adolescent girls who scored low in rumination [57]. In addition, these disorders may share predisposing factors such as a common biological pathway, dysfunctional family, or poor self-control [58].

Throughout the measured period of young adulthood, the prevalence of comorbidity between conditions increased only for women. Consistent with prior research [12,13], depression and obesity were associated concurrently for women at two of the three time points. In contrast, among men in the study, depression and obesity were not concurrently associated. Depression and alcohol use disorders showed cross-sectional associations for both women and men, although more so at later ages (ages 27 and 30 for women; age 30 for men), with generally stronger associations for women. This age trend is consistent with studies showing increases in drinking as a means of coping with stress from the mid-20s to the early 30s [59]. Alcohol use disorders were not associated with obesity concurrently for women or men.

The longitudinal results also showed gender-specific patterns, though only one of the pathways showed a difference in direction, namely the relation between obesity and later depression. We found evidence of a positive prospective relation among females and a negative relation among males, consistent with other research that has identified gender as a moderator of the association between obesity and depression [9]. The ‘jolly fat’ hypothesis suggests that being overweight and the dietary habits associated with obesity may protect older adults against the experience of depression [60]. This hypothesis has received some support in other studies, but only among men [15]. In our study, we found that even as early as young adulthood there may be some protective effect of obesity for males in the development of depression. Our results are also consistent with the negative association between young adult depression and BMI in males observed by Pine and colleagues [46].

The presence of an alcohol use disorder at age 24 increased the risk of developing obesity for women at age 27. Further research is needed to understand whether this association is directly related to the ingestion of excessive alcohol, or is the result of other processes. One potential explanation is that the caloric energy of alcohol contributes to subsequent weight gain. A number of controlled studies have also found a short-term stimulation of appetite following alcohol ingestion [33], which, when coupled with calories ingested as alcohol, may lead to obesity. Another possibility is that hypersensitivity to reward may be a common vulnerability to both binge eating and chronic alcohol abuse [37].

The presence of a major depressive episode at age 27 increased the risk of developing an alcohol use disorder at age 30 among women only. Khantzian’s “self-medication hypothesis” theorizes that affective disturbances may increase the risk for the onset and maintenance of substance use. In particular, Khantzian suggests that “although they are not good antidepressants, alcohol and related drugs create the illusion of relief because they temporarily soften rigid defenses and ameliorate states of isolation and emptiness that predispose to depression” [61, p. 233]. Reviews of the self-medication hypothesis have reported inconsistent findings, and potential gender differences have not been thoroughly addressed by the research [62,63]. However, studies using experience-sampling methods, such as examining sadness-to-drinking intervals, to evaluate the self-medication hypothesis have suggested some gender differences in the consequences of self-medication. In a daily study of college students, women who reported more alcohol-related problems and were motivated to drink as a way to cope, drank more following sadness in comparison to men. The author suggests that attempted self-medication with alcohol may have more dire consequences for women because it enhances ruminative coping. Findings of the current study are consistent with others showing that substance use is particularly linked to stress-related processes, such as depression and post-traumatic stress, for

women [64,65]. The finding that females experiencing depression are at higher risk for developing an alcohol use disorder suggests that there are potential gender differences in attempts to self-medicate with alcohol, and that this may explain women's drinking more than men's.

Consistent with literature showing the role of socioeconomic factors as risks for these disorders, our analyses showed income was negatively related to obesity for women (age 24) and was significantly negatively associated with depression for men (age 27). An association between increased BMI and lower social class specific to women has been consistently found in epidemiological studies, with early pregnancy cited as one factor suspected to play a role [46]. Future research should continue to account for socioeconomic factors, as failure to do so may overestimate disorder co-occurrence that could otherwise be accounted for by shared risk factors such as low income and social status.

Limitations, Strengths, and Future Directions

There are limitations of the current study. The study was conducted with a community sample in Seattle, Washington, with participants from higher crime areas somewhat overrepresented. Thus, caution should be used in generalizing both prevalence rates and associations between conditions to other communities. However, many findings are consistent with those found in the general population, such as the gender-specific relation between depression and obesity [46], and we know of no specific studies to indicate that utilizing an urban population would undermine our findings. In addition, while the study included three time points, analyses did not allow an examination of comorbidity of these conditions continuously during the study time frame. This may be particularly important for more episodic conditions such as depression. The use of path analysis presents limitations in that the size of the cross-lagged loadings are affected by both the true longitudinal relations and the reliability among measures. Further, obesity was calculated on the basis of self-reported weight and height; however, previous studies have suggested that the sensitivity and specificity of obesity measurement based on self-reported weight and height data is very high, indicating that resulting error is likely to be very low [66]. Additionally, intentional under- or over-reporting these measures may have been deterred due to the fact that the interviews were conducted in person.

The strengths of this study include the use of a nonclinical community sample, reducing the potential biases that can arise when narrowly defined samples are selected from treatment settings. Moreover, this study is one of the first to examine comorbidity with longitudinal tracking between these three important health conditions over time during young adulthood. We also used statistical analyses that controlled for income and stability over time.

Results indicate that depression, obesity, and alcohol use disorders are interrelated health conditions for women more so than for men, with implications for future research on prevention and treatment relevant to psychiatry and primary care. First, more research exploring the impact of interventions that can lead to the amelioration of more than one of these conditions among women, such as increasing physical activity and learning effective stress management strategies, is warranted. For some women, there may be some common pathogenic processes underlying these conditions, as they can all be triggered by stress and involve behavior in their maintenance. Randomized controlled trials of intervention programs for these conditions that measure broader outcomes than the target problem of interest can provide even more stringent tests of etiological pathways. Second, the stability of each disorder during young adulthood reiterates the importance of conducting prevention earlier in the life course, including childhood and adolescence. There are already a number of preventions for these disorders that target these early developmental stages, but further attention to early prevention may be warranted [38,39]. Third, the relevance of income for obesity and depression suggests that targeting low-income populations to prevent these problems may be important. Fourth,

addressing alcohol use among young women may have the additional benefit of reducing obesity for some participants. Overall, a greater understanding of the mechanisms underlying these linkages could lead to improved efforts to reduce these common but critical preventable public health problems.

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Figure 1.
Retention and sample sizes for cross-sectional analyses.

Figure 2.

Results of longitudinal co-occurrence model by gender.

Note. All paths were initially estimated, only significant paths are shown. Unstandardized estimates (standard error) for males (above) and females (below). * $p < .05$.

Table 1
Proportion of Sample Meeting Criteria for Individual and Comorbid Conditions, by Age and Gender

Condition	Age 24		Age 27		Age 30	
	Females (n = 358)	Males (n = 355)	Females (n = 353)	Males (n = 363)	Females (n = 323)	Males (n = 324)
No disorders	.601	.479	.558	.457	.520	.500
MDE only	.092	.048	.057	.058	.059	.049
Obese only	.159	.130	.212	.174	.232	.210
AUD only	.067	.225	.062	.207	.074	.136
MDE+Obese	.045	.008	.042	.019	.056	.009
MDE+AUD	.017	.042	.028	.028	.025	.034
Obese+AUD	.011	.062	.025	.041	.015	.056
All 3	.008	.006	.014	.017	.019	.006
Any disorder	.399	.521	.442	.543	.480	.500
Any comorbidity	.081	.118	.109	.105	.115	.105

MDE = Major Depressive Episode; AUD = Alcohol Use Disorder (Alcohol Abuse or Alcohol Dependence).

Table 2

Correlations within disorders across time

	Age 24 w/ 27		Age 27 w/ 30		Age 24 w/ 30	
	Female	Male	Female	Male	Female	Male
Major Depressive Episode	.23*	.29*	.47*	.33*	.24*	.06
Obesity	.64*	.66*	.77*	.72*	.59*	.57*
Alcohol Use Disorders	.20*	.41*	.20*	.42*	.42*	.34*

Table 3

Correlations within time across disorders

	Age 24		Age 27		Age 30	
	Female	Male	Female	Male	Female	Male
MDE w/ Obesity	.12*	.06	.08	.03	.13*	-.10
MDE w/ Alcohol Use Disorder	.08	.10	.21*	.07	.19*	.13*
Obesity w/ Alcohol Use Disorder	-.03	-.01	.01	-.08	-.06	-.03

*
p < .05

Table 4

Correlations across time across disorders

	Age 24 w/27		Age 27 w/30		Age 24 w/30	
	Female	Male	Female	Male	Female	Male
MDE w/ Obesity	.06	-.03	.08	.09	.02	.07
Obesity w/ Depression	.11	.01	.14*	-.10*	.12	-.01
MDE w/ Alcohol Use Disorder	.05	-.04	.23*	.00	.05	.05
Alcohol Use Disorder w/ MDE10	.10	.00	.12	.08	.10	.07
Obesity w/ Alcohol Use Disorder	.06	-.07	-.01	-.06	.02	-.06
Alcohol Use Disorder w/ Obesity	.10	-.04	.03	-.03	.03	-.07

*
p < .05.