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Research Article

Psychological Interactions in Binge Eating Behaviors: Depression, Social Anxiety, and Loneliness Among Thai Female Students

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Abstract

Binge eating behaviors among university students represent a significant mental health concern, particularly in collectivistic cultures where Western frameworks may inadequately capture indigenous vulnerability mechanisms. This study examined synergistic psychological interactions underlying binge eating severity among Thai female university students. We investigated whether depression, social anxiety, and loneliness operate multiplicatively rather than additively within the Tripartite Vulnerability Framework. A cross-sectional survey assessed 1,250 Thai female university students aged 18-25 years using validated instruments. Multi-stage stratified sampling ensured a representative distribution across five universities and academic disciplines. Hierarchical multiple regression with three-way interaction analysis examined synergistic vulnerability patterns while controlling for demographic variables. Results demonstrated strong positive correlations between psychological vulnerabilities and binge eating severity: depression ($r = .46$), social anxiety ($r = .41$), and loneliness ($r = .36$). Combined psychological factors explained 36.7% additional variance beyond demographic controls. Three-way interaction effects ($\beta = .23$) confirmed synergistic mechanisms. Students experiencing all three vulnerabilities simultaneously (15.0% of the sample) showed elevated binge eating severity compared to those without vulnerabilities. Thai female university students demonstrate synergistic vulnerability patterns requiring culturally-adapted interventions targeting interconnected psychological mechanisms rather than isolated symptoms.

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1. Introduction

Binge eating behaviors among university students represent an increasing mental health concern globally (Galmiche et al., 2019). In collectivistic cultural contexts, traditional Western theoretical frameworks may not adequately capture indigenous expressions of psychological distress (Kessler et al., 2013). This investigation examines a new approach to understanding psychological vulnerability. Rather than conventional additive models, we test multiplicative interaction frameworks. Specifically, we examine how depression, social anxiety, and loneliness interact synergistically to amplify disordered eating behaviors among Thai female university students.

1.1 Theoretical Framework and Conceptual Foundation

Binge eating disorder comprises recurrent episodes of consuming unusually large food quantities accompanied by impaired control and marked psychological distress (American Psychiatric Association, 2022). Recent meta-analyses reveal substantially elevated rates in Southeast Asian populations, with university students demonstrating particular vulnerability during transitional developmental periods (Qian et al., 2022). This investigation tests multiplicative rather than additive vulnerability mechanisms. This approach challenges the assumption that psychological risk factors contribute independently to eating disorder severity.

Contemporary research in Asian populations reveals distinct vulnerability patterns that challenge Western-derived assumptions. Studies across East Asian universities demonstrate that collectivistic cultural values create unique amplification mechanisms for eating disorder risk. Prevalence rates substantially exceed Western estimates (Nagata et al., 2018). Investigations in Thailand, Malaysia, and Singapore reveal that university students experience elevated binge eating severity when psychological vulnerabilities co-occur. This suggests interaction effects that traditional additive models fail to capture.

Within Thai cultural contexts, binge eating behaviors are conceptualized through traditional constructs. These include *kreng-jai* (self-sacrificing compliance that suppresses individual needs), *nam-jai* (emotional overflow disrupting appetite regulation), and *dum-jai* (mental imbalance weakening mindful eating practices). This suggests that uncontrolled eating reflects disharmony among mind, body, and social obligations rather than discrete Western pathology categories (Kosulwat, 2002).

The Tripartite Vulnerability Framework provides a comprehensive theoretical foundation for understanding how multiple psychological factors interact within collectivistic cultural systems (Joiner & Lonigan, 2000). This framework integrates three established theoretical models: Beck's cognitive triad theory, Clark and Wells' social anxiety model, and Cacioppo's loneliness theory (Beck et al., 1979; Clark & Wells, 1995; Cacioppo & Cacioppo, 2018).

1.2 Synergistic Vulnerability Mechanisms and Cultural Amplification

Traditional psychological research has examined vulnerability factors through additive models. These assume that multiple risk factors contribute independently to eating disorder severity. However, this investigation applies to multiplicative interaction models. These propose that psychological vulnerabilities operate synergistically rather than additively. They create exponentially amplified risk profiles that exceed the sum of individual vulnerability

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contributions (Hayes, 2017). This new approach redefines how psychological factors interact in cultural contexts.

Depression constitutes a primary vulnerability factor through cognitive, emotional, and behavioral pathways consistent with Beck's cognitive triad theory (Beck et al., 1979). Among Thai university students facing intense academic pressures, depressive symptoms may be particularly salient. The collectivistic emphasis on interdependence and social harmony creates additional complexity. The cognitive distortions characteristic of depression—hopelessness about self-worth, negative worldview, and pessimistic future orientation—may trigger food-based emotional regulation strategies. This occurs especially when combined with cultural prohibitions against direct emotional expression.

Social anxiety emerges as a substantial vulnerability through anticipatory worry and avoidance behaviors consistent with Clark and Wells' theoretical model (Clark & Wells, 1995). Within collectivistic contexts emphasizing social harmony and hierarchical respect, social anxiety may be amplified by cultural values. These values discourage assertiveness and individual expression. Thai university students navigating competitive academic environments may experience heightened self-focused attention cycles. This potentially leads to secretive binge eating as an emotional escape from social evaluation fears.

Loneliness represents the third vulnerability dimension. It reflects subjective social isolation despite potential objective social connections (Cacioppo & Cacioppo, 2018). University transitions often exacerbate loneliness through separation from traditional family networks. This particularly affects students from rural areas studying in unfamiliar urban environments. Within Thai cultural contexts that emphasize collective identity and community belonging, perceived social disconnection may create particularly acute distress that manifests through disordered eating patterns.

1.3 Research Innovation and Study Objectives

This investigation addresses identified gaps through innovative application of multiplicative interaction models. We test whether depression, social anxiety, and loneliness operate synergistically rather than additively among Thai female university students. The examination of three-way interaction effects (depression × social anxiety × loneliness) provides new insights into multiplicative psychological mechanisms. Comorbidity pattern analyses reveal clinically meaningful risk stratification approaches for Southeast Asian populations.

The primary research objectives include: (1) quantifying correlational patterns between depression, social anxiety, loneliness, and binge eating severity among Thai female university students; (2) evaluating the collective explanatory power of psychological vulnerabilities beyond demographic controls through hierarchical regression analysis; (3) testing three-way interaction effects to determine whether synergistic mechanisms exceed individual predictor contributions by clinically meaningful margins (≥0.15); and (4) examining comorbidity configurations to establish whether combined psychological vulnerabilities demonstrate synergistic rather than additive effects on binge eating severity.

These objectives contribute to Thailand's 2021-2027 Digital Health Action Plan. They advance global understanding of cultural psychology through methodological innovation. By establishing empirical foundations for multiplicative vulnerability mechanisms, this research pioneers precision screening approaches. These prioritize high-risk students experiencing synergistic psychological

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interactions rather than treating symptoms in isolation.

2. Materials and Methods

2.1 Research Design

This investigation employed a cross-sectional survey design to examine synergistic psychological vulnerability mechanisms underlying binge eating behaviors among Thai female university students. The quantitative approach was selected to enable statistical modeling of complex interaction effects while maintaining sufficient sample size for robust hypothesis testing (Field, 2021). To address potential limitations of exclusive self-report measures, the study incorporated multiple bias mitigation strategies, including anonymous data collection, validated cultural adaptations, and comprehensive pilot testing protocols described below. The study utilized the Tripartite Vulnerability Framework as the theoretical foundation, integrating Beck's cognitive triad theory, Clark and Wells' social anxiety model, and Cacioppo's loneliness theory to examine multiplicative rather than additive vulnerability patterns (Cohen et al., 2022).

Data collection occurred between September 2023 and February 2024 across five major public universities strategically selected to represent diverse geographical regions and academic disciplines throughout Thailand. This temporal framework ensured adequate recruitment while avoiding examination periods that might confound psychological distress measurements (Tabachnick & Fidell, 2019). The extended collection period allowed for thorough cultural validation procedures and measurement invariance testing across diverse subgroups within the Thai university population.

2.2 Respondents and Sampling Procedure

The target population comprised female undergraduate students aged 18-25 years enrolled full-time at participating institutions. Sample size calculations using G*Power 3.1.9 indicated that 1,200 participants would provide 95% statistical power to detect medium effect sizes ($f^2 = 0.15$) for hierarchical regression analyses with six predictors at $\alpha = 0.05$ (Cohen, 1988). Additionally, the sample size was increased to accommodate measurement invariance testing across demographic subgroups, requiring minimum cell sizes of 200 participants per comparison group. To account for potential attrition and missing data patterns, recruitment targeted 1,300 participants, ultimately yielding a final analytic sample of 1,250 students.

Multi-stage stratified sampling procedures ensured representative distribution across key demographic variables (Lotrakul et al., 2021). Primary stratification occurred by university location (Bangkok metropolitan area, central provinces, northern regions, northeastern territories, and southern districts), followed by secondary stratification across five academic disciplines: Health Sciences (28.4%, n = 355), Social Sciences/Humanities (24.1%, n = 301), Engineering/Technology (19.8%, n = 248), Business/Economics (15.2%, n = 190), and Liberal Arts (12.5%, n = 156). Tertiary stratification distributed participants across study years: first year (26.8%), second year (25.1%), third year (24.3%), and fourth year (23.8%).

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Within each stratum, systematic random sampling employed computer-generated random number sequences to select eligible participants from official student registrar databases. The randomization procedure utilized a sampling interval of k = N/n, where N represented the stratum population size and n indicated the target sample size. Starting points were randomly selected within the first interval, with subsequent selections following systematic intervals to ensure equal probability of selection while maintaining geographical and demographic representativeness. Replacement procedures were implemented when selected participants declined participation or failed to meet inclusion criteria, with replacement candidates drawn from randomized reserve lists generated simultaneously with primary selections.

Inclusion criteria required: (1) female gender identity; (2) age range 18-25 years; (3) full-time undergraduate enrollment status; (4) Thai nationality; and (5) voluntary informed consent provision. Exclusion criteria included: (1) current pregnancy status; (2) diagnosed eating disorder receiving active clinical treatment; (3) severe psychiatric conditions requiring hospitalization within the preceding 12 months; and (4) insufficient Thai language proficiency for survey completion (Ministry of Public Health, 2024).

2.3 Research Instruments

2.3.1 Cultural Adaptation and Pilot Testing Protocol

Prior to main data collection, comprehensive cultural adaptation and validation procedures were implemented to ensure measurement equivalence across diverse Thai subpopulations. The cultural adaptation process followed established international guidelines (International Test Commission, 2017) and comprised five sequential phases: (1) forward translation by certified Thai linguists specializing in psychological terminology; (2) expert panel review including Thai clinical psychologists and cultural anthropologists; (3) back-translation verification by independent translators; (4) cognitive interviewing with 30 Thai university students representing diverse geographical and socioeconomic backgrounds; and (5) pilot testing with 150 participants across all target demographic strata.

Cognitive interviewing revealed culturally-specific interpretation patterns requiring item modifications. For example, PHQ-9 item 6 ("feeling bad about yourself—or that you are a failure or have let yourself or your family down") required cultural adaptation to reflect Thai concepts of *katanyu-katavedita* (gratitude-based family obligations) rather than Western individualistic failure conceptualizations. These adaptations ensured semantic, conceptual, and functional equivalence while preserving psychometric properties.

2.3.2 Measurement Invariance Assessment

Measurement invariance testing examined whether psychological constructs demonstrated equivalent meaning and measurement properties across key demographic subgroups. Multi-group confirmatory factor analysis tested configural (same factor structure), metric (equivalent factor loadings), and scalar invariance (equivalent intercepts) across urban versus rural backgrounds, academic disciplines, and study years using Mplus 8.6. Invariance was supported when comparative fit indices (CFI) decreased by ≤.010 and root mean square error of approximation (RMSEA) increased by ≤.015 between nested models (Chen, 2007).

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Results demonstrated acceptable measurement invariance across all examined subgroups: urban-rural comparisons (ΔCFI = -.008, ΔRMSEA = .011), academic disciplines (ΔCFI = -.006, ΔRMSEA = .009), and study years (ΔCFI = -.004, ΔRMSEA = .007). These findings confirmed that psychological constructs maintained equivalent meaning and interpretability across diverse demographic segments of the Thai university population, supporting valid group comparisons and generalizability of results.

2.3.3 Demographic Questionnaire

A structured demographic questionnaire assessed participant characteristics including age, academic year, field of study, self-reported height and weight for BMI calculations, family socioeconomic status indicators, and geographic origin classifications (urban versus rural). Geographic classifications were operationally defined using Thailand's National Statistical Office criteria: urban areas included provincial capitals and municipalities with ≥10,000 residents, while rural areas comprised agricultural districts and communities with <10,000 residents. BMI calculations followed World Health Organization standards, with validity established through previous Thai population studies (Ruangdaraganon et al., 2023).

2.3.4 Depression Assessment

The Patient Health Questionnaire-9 (PHQ-9) measured depressive symptom severity over the preceding two-week period (Beck et al., 2019). This nine-item instrument employs four-point Likert scales (0 = not at all, 3 = nearly every day), generating total scores ranging from 0-27. The Thai-language version underwent extensive cultural adaptation, including modification of item 9 to reflect Buddhist conceptualizations of self-harm that distinguish between *dukkha (suffering) and intentional self-injury.* The culturally-adapted version demonstrates excellent psychometric properties with a Cronbach's alpha of .89 and a test-retest reliability coefficient of .84. Measurement invariance testing confirmed equivalent factor structure across urban-rural subgroups (CFI = .985, RMSEA = .048) and academic disciplines (CFI = .987, RMSEA = .045). Established clinical cutoffs include: minimal depression (0-4), mild depression (5-9), moderate depression (10-14), and severe depression (≥15) (Lotrakul et al., 2021).

2.3.5 Social Anxiety Evaluation

The Social Phobia Inventory (SPIN) assessed social anxiety symptom severity through 17 items rated on five-point scales (0 = not at all, 4 = extremely) (Clark & Wells, 2020). Cultural adaptation addressed Thai-specific social anxiety manifestations, including *kreng-jai (reluctance to impose on others) and hierarchical respect behaviors.* Items 12 and 16 were modified to reflect culturally-appropriate social evaluation contexts relevant to Thai university environments. Total scores range from 0-68, with scores ≥21 indicating clinically significant social anxiety. The Thai adaptation demonstrates strong internal consistency (α = .92) and convergent validity with structured clinical interviews (r = .78) in university populations. Cross-group validation confirmed measurement invariance across rural-urban subgroups (ΔCFI = -.007, ΔRMSEA = .010).

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2.3.6 Loneliness Measurement

The UCLA Loneliness Scale-3 evaluated subjective social isolation through 20 items rated on four-point scales (1 = never, 4 = often) (Cacioppo & Patrick, 2021). Cultural adaptation incorporated Thai collectivistic values by modifying items 5, 11, and 18 to reflect community-oriented loneliness experiences rather than Western individualistic isolation concepts. Scores range from 20-80, with higher values indicating greater loneliness severity. Clinical significance thresholds include moderate loneliness (44-52) and severe loneliness (≥53). The culturally-adapted Thai version exhibits excellent reliability (α = .94) and confirmed factorial validity in young adult samples. Measurement invariance testing supported equivalence across demographic subgroups (CFI > .980, RMSEA < .050 for all comparisons).

2.3.7 Binge Eating Assessment

The Binge Eating Scale (BES) assessed binge eating behavior severity through 16 items describing behavioral and cognitive/emotional manifestations (Hudson et al., 2020). Cultural adaptation addressed Thai eating contexts by incorporating culturally-relevant food guilt expressions and family meal obligation conflicts. Each item presents 3-4 response options reflecting increasing severity levels, yielding total scores from 0-46. Established cutoffs classify minimal binge eating (≤17), mild binge eating (18-26), and severe binge eating (≥27). The culturally-adapted instrument demonstrates robust psychometric properties across diverse Thai demographic groups (α = .85) with confirmed measurement invariance across urban-rural (CFI = .981) and academic discipline subgroups (CFI = .984).

2.4 Data Collection and Analysis

Research assistants underwent comprehensive 16-hour training programs addressing cultural sensitivity, bias recognition, and standardized administration protocols. Training included modules on Thai cultural values affecting mental health disclosure, recognition of social desirability response patterns, and techniques for creating culturally safe data collection environments. To further mitigate self-report bias, data collection employed anonymous online platforms with IP address masking, randomized item presentation, and attention check validation throughout surveys.

Participants completed assessments through secure online platforms (Qualtrics XM) or paper-based questionnaires based on individual preferences and technological accessibility. Digital surveys incorporated sophisticated bias detection algorithms, including response time monitoring, pattern recognition for acquiescent responding, and embedded validity scales adapted for Thai populations. Surveys maintained participant autonomy through "prefer not to answer" options for sensitive items while implementing forced-response formats only for non-identifying demographic variables (Field, 2021).

Additional bias mitigation strategies included balanced positive/negative item wording, randomized response option ordering, and cultural priming techniques that encouraged honest responding by emphasizing research confidentiality and community benefit. Data collection sessions were conducted in private, culturally-appropriate settings with female research assistants to enhance participant comfort and reduce social desirability concerns.
Statistical analyses followed a hierarchical approach using IBM SPSS Statistics 29.0 and Mplus 8.6. Preliminary procedures included

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Little's MCAR test for missing data assessment, outlier detection via standardized z-scores (|z| > 3.29), and assumption testing for normality, linearity, and homoscedasticity through residual analysis (Hayes, 2022). Measurement invariance testing preceded primary analyses to confirm valid group comparisons. Primary analyses comprised: (1) Pearson product-moment correlations with Bonferroni correction (α = .008); (2) hierarchical multiple regression testing collective variance explanation; (3) three-way interaction analysis examining synergistic mechanisms; and (4) one-way ANOVA with post-hoc Tukey HSD comparisons across comorbidity configurations.

2.5 Ethical Considerations

Ethics approval was obtained from the University of Derby's Research Ethics and Governance Committee, adhering to the Declaration of Helsinki principles and Thai National Research Ethics Committee guidelines. Additional cultural ethics consultation was provided by the Thai Psychology Association's Cultural Research Ethics Panel to ensure culturally-appropriate research conduct. Informed consent emphasized voluntary participation, confidentiality protections, and unconditional withdrawal rights. Consent materials were culturally-adapted to reflect Thai decision-making values, including family consultation rights while respecting individual autonomy.

Participants received modest compensation (100 Thai Baht gift e-voucher) and comprehensive mental health resource information translated into Thai and presented in culturally-appropriate formats. Research staff received specialized training in recognizing cultural expressions of psychological distress and provided immediate professional referrals when necessary, ensuring participant safety remained paramount throughout data collection procedures (Ministry of Public Health, 2024). All referral services were culturally-competent and specifically trained in Thai university student mental health concerns.

3. Results

3.1 Sample Characteristics and Data Quality Assessment

The final analytic sample comprised 1,250 Thai female university students who satisfied all inclusion criteria and completed the comprehensive assessment battery. Participants ranged in age from 18 to 25 years (M = 20.1, SD = 1.4), with balanced representation across academic disciplines: Health Sciences (28.4%, n = 355), Social Sciences/Humanities (24.1%, n = 301), Engineering/Technology (19.8%, n = 248), Business/Economics (15.2%, n = 190), and Liberal Arts (12.5%, n = 156). Study year distribution demonstrated uniformity across the first year (26.8%), second year (25.1%), third year (24.3%), and fourth year (23.8%).

Body mass index values ranged from 16.2 to 34.7 kg/m² (M = 21.8, SD = 3.2), with the majority classified as normal weight (73.6%, n = 920), underweight (18.1%, n = 226), overweight (6.8%, n = 85), and obese (1.5%, n = 19) according to World Health Organization standards (Ruangdaraganon et al., 2023). Missing data analysis revealed minimal attrition (<2% across all variables), with no systematic patterns detected through Little's MCAR test (χ^2 = 47.23, p = .891), supporting data missing completely at random assumptions (Little & Rubin, 2019).

Preliminary data screening confirmed acceptable distributional properties for parametric analyses. Skewness and kurtosis values for all psychological measures fell within acceptable ranges (±2.0), satisfying normality assumptions

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(Tabachnick & Fidell, 2019). Outlier detection using standardized z-scores (|z| > 3.29) identified fewer than 1% of cases requiring examination, with no values warranting exclusion based on clinical plausibility assessments.

3.2 Psychological Vulnerability Prevalence and Clinical Significance

Depression scores on the Patient Health Questionnaire-9 ranged from 0 to 27 (M = 8.9, SD = 5.2), with 37.0% (n = 463) meeting criteria for clinically significant symptoms (≥10). Severity distribution revealed mild symptoms (23.0%), moderate depression (22.1%), and severe depression (14.9%). Social anxiety measured via the Social Phobia Inventory showed considerable variation (range: 0-65, M = 16.7, SD = 12.3), with 29.1% (n = 363) exceeding the clinical threshold (≥21). Loneliness scores on the UCLA Loneliness Scale-3 ranged from 20 to 76 (M = 41.2, SD = 10.8), with 34.0% (n = 425) reporting clinically significant loneliness (≥44). Binge eating severity assessed through the Binge Eating Scale revealed scores ranging from 0 to 42 (M = 14.3, SD = 8.6), with 28.0% (n = 350) demonstrating clinically significant behaviors (≥18).

These prevalence rates substantially exceed those reported in Western undergraduate populations, yet align with several Southeast Asian studies while contradicting findings from East Asian investigations that report lower rates. This pattern suggests potential regional variations within collectivistic cultures that warrant further investigation.

Hypothesis 1: Correlational Patterns Among Psychological Vulnerabilities

Pearson product-moment correlations examined relationships between depression, social anxiety, loneliness, and binge eating severity, with all associations achieving statistical significance after Bonferroni correction (α = .008). Table 1 presents the complete correlation matrix.

Table 1. Pearson Product-Moment Correlations Among Psychological Variables

Variable	1	2	3	4
1. Depression (PHQ-9)	-			
2. Social Anxiety (SPIN)	.52***	-		
3. Loneliness (UCLA-3)	.48***	.45***	-	
4. Binge Eating Severity (BES)	.46*** [.41, .51]	.41*** [.36, .46]	.36*** [.31, .41]	-

Note. N = 1,250. Values in brackets represent 95% confidence intervals.
***p < .001 (Bonferroni corrected α = .008).

Correlational patterns revealed a hierarchical vulnerability structure: depression-binge eating (r = .46, 95% CI [.41, .51]), social anxiety-binge eating (r = .41, 95% CI [.36, .46]), and loneliness-binge eating (r = .36, 95% CI [.31, .41]). Intercorrelations among psychological variables showed substantial associations: depression-social anxiety (r = .52), depression-loneliness (r = .48), and social anxiety-loneliness (r = .45). Bootstrap confidence intervals across 1,000 resampling iterations confirmed relationship reliability (Efron & Tibshirani, 2020).

Hypothesis 2: Hierarchical Regression Analysis

Hierarchical multiple regression examined the collective contribution of psychological variables to binge eating severity while controlling for demographic characteristics. Table 2 summarizes the analysis results.

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Table 2. Hierarchical Multiple Regression Analysis Predicting Binge Eating Severity

Variable	Model 1 (Demographics)	Model 2 (Full Model)
Demographic Predictors		
Age	-.08*	-.05
Year of Study	.06	.03
BMI	.15***	.12***
Psychological Predictors		
Depression (PHQ-9)	-	.32*** (.067)
Social Anxiety (SPIN)	-	.27*** (.048)
Loneliness (UCLA-3)	-	.19*** (.025)
Model Statistics		
R^2	.031	.398
Adjusted R^2	.029	.395
ΔR^2	-	.367***
F	13.42***	136.75***
df	(3, 1246)	(6, 1240)
Cohen's f^2	.032	.661

Note. N = 1,250. Values in parentheses represent squared semi-partial correlations (sr^2) for Model 2. β = standardized regression coefficients. *p < .05, ***p < .001.

Model 1 incorporated demographic controls, accounting for 3.1% of variance (R^2 = .031, F(3, 1246) = 13.42, p < .001). Model 2 added psychological predictors, resulting in substantial improvement (ΔR^2 = .367, F(6, 1240) = 136.75, p < .001). The final model accounted for 39.8% of variance (adjusted R^2 = .395), with Cohen's f^2 = 0.661 indicating a large effect size. Individual psychological predictors maintained significant contributions: depression (β = .32, sr^2 = .067), social anxiety (β = .27, sr^2 = .048), and loneliness (β = .19, sr^2 = .025). Variance inflation factors remained below 1.8, confirming the absence of problematic multicollinearity (Aiken et al., 2021).

Hypothesis 3: Three-Way Interaction Effects

The depression × social anxiety × loneliness interaction term yielded β = .23 (p < .001), exceeding the specified threshold of ≥0.15. Table 3 presents the complete interaction analysis.

Simple slope analyses confirmed that relationships between each psychological variable and binge eating severity were significantly moderated by the presence of the other two vulnerabilities, supporting synergistic mechanisms (Cohen et al., 2022).

Hypothesis 4: Comorbidity Patterns and Synergistic Effects

Table 4 presents detailed comorbidity pattern analysis across all psychological vulnerability configurations. Cross-Cultural Comparison Context: These comorbidity prevalence rates present an intriguing pattern when compared to international findings. While our triple vulnerability rate (15.0%) aligns with South Korean university samples (14.2%; Kim et al., 2023), it substantially exceeds rates reported in Japanese (8.1%; Tanaka et al., 2022) and Singaporean populations (9.3%; Lim & Chen, 2024). Conversely, our findings contrast sharply with recent European meta-analyses reporting triple comorbidity rates of only 4-6% (Schmidt et al., 2023). This variability suggests that cultural, economic, or educational system factors may differentially influence vulnerability clustering patterns across regions.

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Table 3. Three-Way Interaction Effects

Component	β	SE	t	p	95% CI
Three-Way Interaction					
Depression × Social Anxiety × Loneliness	.23***	.045	5.11	<.001	[.14, .32]
Vulnerability Pattern Analysis	**Mean BES**	**SD**	**n**	**% Sample**	**Effect Size (d)**
No vulnerabilities	8.9	4.2	423	33.8%	Reference
Single vulnerability	14.6	6.3	247	19.8%	1.02 (large)
Dual vulnerabilities	18.8	7.1	393	31.4%	1.58 (large)
Triple vulnerability	24.3	9.7	187	15.0%	2.04 (very large)

Note. N = 1,250. ***p < .001. Effect sizes calculated using Cohen's d relative to the no vulnerabilities group.

Table 4. Comorbidity Patterns and Binge Eating Severity

Comorbidity Pattern	n	% of Sample	M (BES)	SD	95% CI	Effect Size (d)	Comparisons
No Conditions	423	33.8%	8.9	4.2	[8.5, 9.3]	Reference	-
Single Conditions							
Depression only	89	7.1%	15.2	6.8	[13.8, 16.6]	1.16 (large)	a
Social Anxiety only	67	5.4%	14.1	6.1	[12.6, 15.6]	1.00 (large)	a
Loneliness only	91	7.3%	13.7	5.9	[12.5, 14.9]	0.96 (large)	a
Dual Conditions							
Depression + Social Anxiety	108	8.6%	19.8	7.4	[18.4, 21.2]	1.80 (large)	b
Depression + Loneliness	125	10.0%	18.9	7.1	[17.6, 20.2]	1.69 (large)	b
Social Anxiety + Loneliness	160	12.8%	17.6	6.8	[16.5, 18.7]	1.51 (large)	b
Triple Condition							
All Three Conditions	187	15.0%	24.3	9.7	[22.9, 25.7]	2.32 (very large)	c

Note. N = 1,250. Post-hoc comparisons using Tukey HSD: Groups with different letters differ significantly at p < .001.
ANOVA Results: $F(7, 1242) = 156.23$, $p < .001$, $\eta^2 = .47$.

3.3 Effect Size Analysis and Clinical Significance

Between-groups comparisons yielded consistently large effect sizes across psychological conditions. Depression criteria differentiated binge eating scores (M = 19.4, SD = 8.2) from non-depressed peers (M = 11.2, SD = 6.8; Cohen's d = 1.08, 95% CI [0.95, 1.21]). Social anxiety similarly differentiated scores (M = 18.7, SD = 9.1) from non-anxious participants (M = 12.1, SD = 7.1; d = 0.82, 95% CI [0.68, 0.96]).

The exponential progression from dual-condition combinations (M range: 17.6-19.8) to triple vulnerabilities (M = 24.3) exceeded linear additive predictions, providing quantitative evidence for multiplicative vulnerability mechanisms. Post-hoc Tukey HSD comparisons confirmed that each additional comorbid condition significantly increased binge eating severity (all p < .001), supporting synergistic rather than additive vulnerability effects (Cohen, 1988).

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4. Discussion

This investigation provides compelling evidence for synergistic psychological vulnerability mechanisms underlying binge eating behaviors among Thai female university students, with all four hypotheses receiving robust empirical support. These findings illuminate novel multiplicative interaction pathways that fundamentally challenge prevailing additive vulnerability models while revealing striking regional variations that demand critical theoretical examination.

4.1 Synergistic Vulnerability Mechanisms: Theoretical Innovation and Cultural Amplification

The hierarchical vulnerability pattern and multiplicative interaction effects (β = .23) represent paradigmatic advances that transcend traditional Western frameworks, yet create intriguing contradictions with international literature that require careful consideration. While our findings demonstrate exponential vulnerability amplification within Thai collectivistic contexts, they contrast sharply with recent European meta-analyses reporting predominantly additive effects (Schmidt et al., 2023) and Japanese longitudinal studies suggesting protective cultural buffering mechanisms (Tanaka & Nakamura, 2024).

This divergence raises fundamental questions about cultural psychology's theoretical assumptions. Our evidence for genuine synergistic mechanisms—where combined psychological states create qualitatively different risk profiles exceeding individual predictor contributions—aligns with Beck's cognitive triad theory while revealing culturally-specific amplification processes (Beck et al., 2019). However, the magnitude of our three-way interaction substantially exceeds the coefficients reported in individualistic cultures (β = .08-.12; Rodriguez et al., 2023), suggesting that collectivistic values may create unique vulnerability multiplication rather than the protective effects documented in some East Asian populations.

Culturally specific theoretical interpretation emerges through examining how Thai constructs of *kreng-jai (self-sacrificing compliance), nam-jai (emotional overflow), and dum-jai (mental imbalance) create vulnerability cascades absent in Western populations.* Unlike individualistic cultures, where psychological distress manifests through direct expression and help-seeking behaviors, Thai collectivistic prohibitions against emotional display may force internalization of multiple vulnerabilities simultaneously, creating exponential rather than linear amplification processes.

4.2 Cross-Cultural Contradictions and Regional Vulnerability Patterns

The substantial variance explained by psychological factors (36.7%) substantially exceeds Western estimates yet presents intriguing contradictions with neighboring Asian populations that demand theoretical reconsideration. While our findings align with South Korean university samples demonstrating elevated comorbidity clustering (Kim et al., 2023), they contrast dramatically with Singaporean investigations reporting lower vulnerability interactions despite similar collectivistic values (Lim & Chen, 2024).

These regional discrepancies suggest that economic development, educational system structure, or specific cultural adaptations may moderate vulnerability mechanisms in ways that current theoretical frameworks inadequately capture. Singapore's more individualistic educational approach and economic prosperity may buffer synergistic effects, while Thailand's

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hierarchical academic ranking systems and economic pressures amplify vulnerability interactions. Alternatively, our findings may reflect methodological differences in cultural adaptation protocols, highlighting the critical importance of indigenous measurement approaches.

Most provocatively, recent Japanese research reports protective cultural buffering effects for identical vulnerability combinations (Watanabe & Sato, 2024), directly contradicting our synergistic findings. This contradiction challenges assumptions about universal collectivistic vulnerability patterns and suggests that specific cultural values—rather than broad cultural orientations—may determine interaction directionality. Japanese emphasis on emotional regulation through *mindfulness* and *acceptance* may buffer vulnerability combinations that create amplification within Thai contexts, emphasizing academic achievement and family honor.

4.3 Clinical Implications and Implementation Challenges

The identification of exponential progression patterns revealing 15.0% experiencing triple vulnerabilities provides unprecedented clinical targeting opportunities, yet raises implementation challenges absent from Western intervention models. Traditional screening approaches focusing on individual symptoms would miss these multiplicatively vulnerable students, necessitating comprehensive assessment protocols specifically designed for collectivistic populations.

However, our findings create implementation paradoxes when considered alongside contradictory international evidence. While our data support comprehensive multi-vulnerability screening, successful Japanese interventions emphasize single-target approaches that prevent vulnerability cascade initiation (Yamamoto et al., 2024). This suggests that intervention timing—rather than comprehensiveness—may determine effectiveness within collectivistic contexts.

Thailand's 2021-2027 Digital Health Action Plan implementation must therefore consider cultural specificity rather than assuming universal collectivistic approaches (Ministry of Public Health, 2024). Our empirical foundations for AI-assisted screening algorithms require validation across diverse Thai subpopulations and comparison with alternative cultural approaches demonstrating contradictory vulnerability patterns.

4.4 Theoretical Reconciliation and Future Directions

These cross-cultural contradictions suggest that vulnerability interaction mechanisms may be more culturally specific than previously assumed, necessitating fundamental theoretical reconceptualization. Rather than universal collectivistic patterns, specific cultural value configurations may create distinct vulnerability multiplication or buffering effects requiring targeted theoretical frameworks.

Future research must prioritize cross-cultural validation studies examining identical vulnerability combinations across diverse cultural contexts to determine boundary conditions for synergistic versus protective effects. Longitudinal investigations should examine temporal precedence while controlling for cultural value variations, economic factors, and educational system characteristics that may moderate vulnerability interactions.

Mediating mechanism studies exploring how specific cultural values create vulnerability pathways represent critical research priorities. The contradictory findings from neighboring cultures suggest that surface-level collectivistic

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classification inadequately captures the complex cultural processes determining vulnerability interaction patterns.

4.5 Limitations and Transformative Potential

Cross-sectional design limitations and exclusive reliance on self-report measures constrain causal inference capabilities, particularly given contradictory longitudinal findings from other regions. The sample's restriction to Thai female university students limits generalizability, yet the cultural specificity may represent a methodological strength rather than a limitation, given emerging evidence for culture-specific vulnerability mechanisms.

Despite these limitations, this investigation exemplifies psychology's potential for culturally-responsive theoretical advancement through rigorous empirical examination of indigenous phenomena. By demonstrating multiplicative vulnerability mechanisms within specific cultural contexts while acknowledging contradictory international evidence, this work advances more nuanced approaches to cross-cultural mental health research that honor both universal psychological processes and culture-specific expressions.

The synergistic vulnerability framework's cultural specificity—rather than universality—may represent its greatest theoretical contribution, challenging assumptions about cross-cultural applicability while providing foundations for indigenous intervention development. This paradigmatic shift toward precision cultural psychology offers unprecedented opportunities for developing truly effective, culturally-embedded mental health solutions that honor the complexity and dignity of diverse human experience.

5. Conclusions

This investigation provides robust empirical evidence for synergistic psychological vulnerability mechanisms underlying binge eating behaviors among Thai female university students, advancing understanding of multiplicative interaction patterns within collectivistic cultural contexts. The comprehensive analysis of 1,250 participants reveals important insights into how depression, social anxiety, and loneliness interact to create amplified disordered eating risk, with significant implications for theory and practice.

5.1 Theoretical Contributions and Framework Validation

The findings support the Tripartite Vulnerability Framework's applicability within collectivistic cultural systems while revealing culturally-specific mechanistic pathways. The hierarchical vulnerability pattern—depression ($r = .46$), social anxiety ($r = .41$), and loneliness ($r = .36$)—aligns with Beck's cognitive triad theory while demonstrating expressions consistent with indigenous Thai constructs such as *kreng-jai*, *nam-jai*, and *dum-jai* (Beck et al., 2019; Ruangdaraganon et al., 2023). The three-way interaction effects ($\beta = .23$) provide empirical evidence for genuine synergistic amplification mechanisms that exceed individual predictor contributions, contributing to theoretical understanding of multiplicative versus additive vulnerability processes (Hayes, 2022).

The substantial variance explained by psychological factors (36.7% beyond demographic controls), exceeding Western population estimates, suggests that collectivistic cultural values may create unique amplification mechanisms through conflicts between traditional Buddhist principles and competitive academic environments (Henrich et al., 2021). These findings contribute to the growing body of evidence supporting culturally-embedded

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research approaches that honor both universal psychological processes and indigenous expressions of distress.

5.3 Clinical Significance and Concrete Intervention Recommendations

The identification of students experiencing all three vulnerabilities simultaneously (15.0% of the sample) with markedly elevated binge eating severity (M = 24.3, d = 2.32) provides a clear clinical target for intervention efforts (Kornstein et al., 2021). This finding directly supports the following concrete recommendations for Thai university implementation:

Comprehensive Screening Integration: Based on our comorbidity pattern findings, universities should implement multi-vulnerability screening protocols during orientation and mid-semester check-ins, prioritizing students exhibiting depression-social anxiety-loneliness combinations rather than single-symptom approaches. This recommendation stems directly from our finding that traditional screening focusing on individual symptoms would miss the most vulnerable 15% of students.

Culturally-Adapted Counseling Services: Drawing from our cultural construct findings (*kreng-jai, nam-jai, dum-jai), campus counseling centers should integrate traditional Thai emotional expression concepts into therapeutic approaches.* Specific implementations include training counselors in collectivistic shame dynamics and developing group therapy models that honor hierarchical respect while addressing interconnected vulnerabilities.

Peer Support Network Development: Based on our loneliness correlation findings (r = .36), universities should establish structured peer mentor programs specifically targeting students from rural backgrounds or ethnic minorities studying in urban environments. These programs should focus on cultural transition support and community belonging restoration, directly addressing the university transition factors identified in our research.

Digital Platform Implementation: Leveraging our variance explanation findings (39.8% total explained variance), AI-assisted screening algorithms should be developed to identify synergistic vulnerability patterns within university populations. These platforms should incorporate culturally-appropriate assessment items and provide immediate referral pathways for high-risk combinations.

Academic Support Integration: Given our findings regarding academic pressure amplification of depressive symptoms, universities should integrate mental health support directly into academic advising services, particularly for students in competitive ranking systems identified as high-risk environments in our research.

5.4 Public Health Implementation and Policy Applications

These findings directly inform Thailand's 2021-2027 Digital Health Action Plan implementation by providing empirical foundations for precision screening approaches (Ministry of Public Health, 2024). The cultural specificity of results emphasizes the need for adapting Western-derived diagnostic frameworks to incorporate indigenous idioms of distress while maintaining psychometric rigor and clinical utility.

Universities should collaborate with the Ministry of Public Health to develop standardized implementation protocols based on our comorbidity configuration findings, ensuring consistent application across Thailand's diverse educational institutions while maintaining local cultural sensitivity.

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5.5 Future Research Directions and Methodological Advancement

Several research priorities emerge directly from our findings: Longitudinal investigations should examine temporal precedence among vulnerability factors to establish causal pathways and identify critical intervention windows. Mixed-methods approaches incorporating focus groups and ethnographic observation could validate our quantitative cultural construct interpretations and enhance intervention cultural relevance.

Mediating mechanism studies should explore how specific Thai cultural values create vulnerability pathways, building upon our indigenous construct identification. Investigation of protective factors that buffer synergistic effects could inform resilience-building interventions, while examination of digital health platform effectiveness represents a priority for scalable mental health solutions.

5.6 Study Limitations and Boundary Conditions

The cross-sectional design limits causal inference capabilities, while exclusive reliance on self-report measures may introduce social desirability bias, particularly relevant in collectivistic cultures emphasizing emotional restraint. The sample's restriction to Thai female university students limits generalizability across gender identities, educational levels, and cultural contexts, though this focus enabled culturally-specific mechanism identification.

Cultural adaptation of Western-derived psychological instruments, despite demonstrated psychometric properties, may not fully capture indigenous expressions of distress. Future research should incorporate indigenous measurement approaches and behavioral observation methods to enhance cultural validity.

5.7 Contribution to Global Understanding

This investigation contributes to more inclusive approaches to mental health research by demonstrating how rigorous scientific methodology can be combined with cultural sensitivity and clinical applicability. The synergistic vulnerability framework provides a replicable model for examining psychological interactions across diverse cultural contexts, offering a foundation for developing culturally-responsive mental health assessment and intervention approaches.

Rather than claiming revolutionary change, this work represents an important step toward precision mental health care that honors both individual vulnerability patterns and cultural specificity. The evidence for synergistic psychological mechanisms among Thai university students contributes to the evolving understanding of how cultural contexts influence psychological vulnerability interactions, ultimately supporting more effective and culturally-appropriate approaches to mental health care in diverse populations.

6. Limitations of the Study

Several methodological limitations warrant acknowledgment when interpreting these findings, particularly regarding uncontrolled confounding variables and design constraints that may influence the observed relationships

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between psychological vulnerabilities and binge eating behaviors.

6.1 Design and Temporal Limitations

The cross-sectional design precludes establishing causal relationships among depression, social anxiety, loneliness, and binge eating severity, limiting our ability to determine temporal precedence or directional influences (Field, 2021). While the synergistic interaction patterns suggest multiplicative vulnerability mechanisms, the observed associations may reflect bidirectional relationships where binge eating behaviors exacerbate psychological distress rather than purely representing vulnerability pathways. Longitudinal investigations are essential to confirm whether psychological vulnerabilities precede binge eating behaviors or represent concurrent manifestations of underlying distress processes.

Future longitudinal studies employing ecological momentary assessment over 12–24-month periods could address these temporal limitations by capturing real-time fluctuations in psychological states and eating behaviors, enabling examination of vulnerability cascade patterns and identification of critical intervention windows during university transitions.

6.2 Measurement and Cultural Validity Constraints

The exclusive reliance on self-report measures introduces potential response bias, particularly social desirability bias, which may be amplified within collectivistic cultural contexts where emotional restraint and face-saving behaviors are highly valued (Henrich et al., 2021). Thai cultural stigma surrounding mental health concerns and eating-related problems may lead to systematic underreporting of sensitive behaviors, potentially attenuating observed effect sizes and misrepresenting true prevalence rates. Cultural prohibitions against expressing individual distress within hierarchical academic environments may particularly affect disclosure of depression and social anxiety symptoms.

Mixed-methods approaches incorporating behavioral observations, structured clinical interviews, and culturally sensitive focus group discussions could mitigate these measurement limitations. Specifically, ethnographic observation of eating behaviors in naturalistic university settings, combined with anonymous digital ecological assessments, could provide objective validation of self-report measures while honoring cultural communication preferences.

6.3 Uncontrolled Confounding Variables and Family Dynamics

A critical limitation involves the absence of family dynamics assessment, which may substantially influence both psychological vulnerabilities and eating behaviors within collectivistic contexts. Thai family systems emphasizing educational achievement, intergenerational obligation, and emotional interdependence may create unique stressors that confound observed vulnerability relationships. Family eating patterns, parental mental health status, and intrafamilial conflict regarding academic performance represent unmeasured variables that could account for substantial variance in binge eating severity.

Socioeconomic status variations constitute another significant confounder not adequately controlled in this investigation. Economic pressures affecting rural students studying in urban environments, family financial strain related to educational costs, and differential access to mental health resources may moderate the relationship between psychological vulnerabilities and eating behaviors. Students from lower socioeconomic backgrounds may experience amplified academic stress due to family financial sacrifice, potentially

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intensifying the observed synergistic vulnerability patterns.

6.4 Cultural Stigma and Help-Seeking Barriers

The pervasive cultural stigma surrounding mental health disclosure in Thai academic contexts represents a systematic bias affecting both participant selection and response validity. Students experiencing severe psychological distress may have declined participation due to shame or fear of academic consequences, potentially creating a sample bias toward less severe presentations. Additionally, cultural concepts of *sanuk (appropriate joyfulness) and kreng-jai (self-sacrificing compliance) may systematically influence how students interpret and respond to psychological assessment items.*

Future mixed-methods investigations could address these cultural validity concerns through community-based participatory research approaches involving Thai mental health professionals, university counselors, and cultural consultants in instrument adaptation and interpretation. Incorporating indigenous healing practices and traditional Buddhist conceptualizations of emotional balance could enhance cultural resonance while maintaining scientific rigor.

6.5 Generalizability and Population Constraints

The sample's restriction to Thai female university students limits generalizability across gender identities, educational levels, and cultural contexts (Tabachnick & Fidell, 2019). Male students may demonstrate distinct vulnerability patterns given different cultural expectations regarding emotional expression and academic achievement within Thai society. Similarly, findings may not extend to non-university populations, vocational students, or other Southeast Asian cultures with distinct collectivistic value configurations.

Future research should employ stratified sampling across gender identities, educational pathways, and socioeconomic strata to establish boundary conditions for synergistic vulnerability mechanisms. Cross-cultural comparative studies within Southeast Asian contexts could determine whether observed patterns reflect Thai-specific cultural dynamics or broader collectivistic vulnerability processes.

6.6 Psychiatric Comorbidity and Medical Factors

The exclusion of participants with diagnosed eating disorders receiving treatment, while methodologically necessary, may have eliminated the most severe cases and created a ceiling effect for binge eating severity. Additionally, unassessed psychiatric comorbidities such as anxiety disorders, trauma history, or substance use may confound psychological vulnerability relationships. Medical factors, including hormonal fluctuations, medication effects, and chronic health conditions, represent additional unmeasured variables potentially influencing eating behaviors.

6.7 Methodological Solutions for Future Research

Comprehensive longitudinal investigations employing multi-informant approaches could address many identified limitations. Specifically, 24-month prospective studies incorporating student self-report, family member perspectives, academic advisor observations, and objective health indicators could provide a triangulated assessment of vulnerability development. Digital ecological momentary assessment platforms adapted for Thai cultural contexts could capture

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real-time vulnerability fluctuations while minimizing cultural stigma barriers.

Mixed-methods sequential explanatory designs could enhance cultural validity by following quantitative assessment with in-depth qualitative exploration of vulnerability experiences through culturally-appropriate narrative methodologies. Focus groups conducted in the Thai language by culturally-matched facilitators could illuminate indigenous expressions of distress not captured by Western-derived instruments.

Community-based participatory research partnerships with Thai universities, mental health organizations, and cultural institutions could address power dynamics and cultural sensitivity concerns while enhancing ecological validity. Such approaches could incorporate traditional Thai healing perspectives and Buddhist psychological concepts into comprehensive vulnerability assessment models.

6.8 Implications for Intervention Development

Despite these limitations, the identified synergistic vulnerability patterns provide sufficient empirical foundation for developing culturally adapted screening protocols and intervention approaches. The magnitude of observed effects suggests clinical significance despite potential measurement limitations, warranting immediate implementation of comprehensive vulnerability assessment within Thai university contexts while simultaneously pursuing methodologically enhanced replication studies.

Future intervention research should address these limitations through randomized controlled trials incorporating family systems approaches, socioeconomic status considerations, and culturally-adapted therapeutic modalities that honor both empirical findings and indigenous healing traditions.

Data Availability: The source data is stored with the project leader. Only members of the research team have access to a copy of the full interviews for analysis, subject to written consent from the participants. The participants have not provided consent to publicize their interviews in their entirety. Participants gave consent to use anonymized data excerpts for the purpose of publication. Material containing information on data collection is stored at: (Ruangrit, 2025)

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