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Latent Patterns and Transitions of Depressive Symptoms in Middle School Students: Stress Types, Life Satisfaction, and Gender as Predictors

Shuhua Wei^{1,#}, Hongkun Ji^{1,#}, Fang Kong² and Bijuan Huang^{1,*}

¹School of Education and Psychology, University of Jinan, Jinan, China

²Jinan Quancheng Middle School in Shandong Province, Jinan, China

*Corresponding Author: Bijuan Huang. Email: huang_bijuan0916@163.com

#These authors contributed equally to this work

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ABSTRACT: Background: Early adolescents (ages 11–15), mainly Chinese middle-school students, face academic tracking pressure for the high-school entrance exam and multiple stressors, with depressive symptoms detected in up to 21.9% of this group. Because this stage is a “critical window” for depression intervention and the Ministry of Education requires “stratified and classified interventions”, systematically identifying the patterns and dynamic transition patterns of adolescent depressive symptoms is of considerable practical and theoretical importance. This study aimed to identify the latent profiles and transitions of depressive symptoms among middle-school students and to examine how different types of stress, life satisfaction, and gender predict these transitions. **Methods:** Using cluster sampling, we recruited 434 middle-school students from Shandong Province, China. The Center for Epidemiological Studies Depression Scale (CES-D), the Middle School Student Stressors Scale, and the Satisfaction with Life Scale (SWLS) were used to assess depressive symptoms, seven types of stress, and life satisfaction, respectively. Two follow-up surveys were conducted one year apart. Latent Profile Analysis (LPA) and Random-Intercept Latent Transition Analysis (RI-LTA) identified the latent depressive-symptom profiles and their transitions, and multinomial logistic regression tested the predictive effects of the stressors, life satisfaction, and gender on these transitions. **Results:** We identified three depressive-symptom profiles among middle-school students: “no depressive symptoms” (n = 317 at T1; 327 at T2), “low depressive symptoms” (n = 95 at T1; 87 at T2), and “moderate depressive symptoms” (n = 23 at both time points). RI-LTA revealed four transition patterns: “asymptomatic stability” (n = 241), “symptom stability” (n = 32), “symptom remission” (n = 82), and “symptom emergence and development” (n = 79); “asymptomatic stability” was the most common and stable. Multiple stressors increased the odds of both “symptom emergence and development” (OR = 1.90–2.57; $p < 0.01$, $p < 0.001$) and “symptom stability” (OR = 1.56–1.66; $p < 0.05$, $p < 0.01$). Life satisfaction predicted transitions in opposite directions: it lowered the risk of “symptom emergence and development” (OR = 0.70; $p < 0.05$) but raised the likelihood of remaining in “symptom stability” (OR = 1.62; $p < 0.05$). Girls were more likely than boys to move into “symptom emergence and development” (OR = 4.24; $p < 0.001$). **Conclusion:** Three depressive-symptom profiles and four transition trajectories were delineated in Chinese middle school students. Stress, life satisfaction, and gender each predict distinct trajectory movement, offering preliminary empirical guidance for tiered and targeted interventions.

KEYWORDS: Depressive symptoms; latent profile analysis; random intercept latent transition analysis; middle school students

1 Introduction

Early adolescence (10–15 years) is a developmental “crossroads” between childhood and youth. During this window, individuals not only undergo rapid physical maturation but also establish long-term trajectories in psychological, cognitive, and social functioning [1]. Middle school students—typically aged 11–15—sit squarely in this critical period. Since the marginal benefits of China’s “Double Reduction” policy have begun to fade, the high-stakes tracking exam for senior high school admission continues to generate intense pressure [2], and the academic and life stress of middle school students has significantly increased, elevating their risk of depression [3]. Feng and Wang [4] conducted a meta-analysis of 34 studies and over 140,000 samples involving depressive symptoms among Chinese middle school students between 2015 and 2024. The results showed that the detection rate of depressive symptoms among Chinese middle school students was as high as 21.9%, indicating that approximately one in every 5 students is at risk of depression. Depressive symptoms are defined as persistent low mood, loss of interest, fatigue, and related impairments that emerge when emotional regulation breaks down [5]. Unlike clinical depression, depressive symptoms do not meet diagnostic thresholds but still impair daily functioning [6]. Although they may be brief or intermittent, they are more than “growing pains”. Without timely intervention, these symptoms can undermine adolescents’ social and academic functioning and, in some cases, escalate to major depression or even suicidal ideation and behavior [7]. Research on developmental psychopathology suggests that individuals in early adolescence still exhibit high neuroendocrine plasticity, making it a “critical window” for low-cost, high-yield interventions for depressive symptoms [8]. *The Special Action Plan for Comprehensively Strengthening and Improving the Mental Health Work of Students in the New Era (2023–2025)*, jointly issued by China’s Ministry of Education and 16 other departments, explicitly calls for implementing a “stratified and classified intervention” approach [9]. Against this backdrop, understanding the latent symptom profiles, transition patterns, and differential risk factors among Chinese middle school students—a typical early-adolescent cohort—can provide empirical guidance for future research and for developing more precise prevention and intervention strategies.

1.1 Heterogeneity and Transition of Depressive Symptoms in Middle School Students

To enable the effective implementation of the “stratified and classified intervention” framework, it is first necessary to accurately identify the individual heterogeneity of depressive symptoms. In recent years, studies employing latent profile analysis (LPA) have preliminarily confirmed that adolescent depressive symptoms are not continuously distributed but cluster into distinct subgroups. For example, Cui et al. [10] identified 4 patterns in a rural adolescent sample: “No Depressive Symptoms”, “Low Depressive Symptoms”, “Transition”, and “High Depressive Symptoms”; Zhang et al. [11] identified 3 patterns based on a sample of adolescents aged 13–18: “No Depression”, “Low Depression”, and “High Depression”. However, the studies cited above subsume middle school students under the broader category of “adolescents”, thereby blurring key psychosocial differences between early adolescence (10–15 years) and late adolescence (16–18 years). Early-adolescent youths undergo rapid physical growth, a cognitive shift from concrete to formal operations, surging self-awareness, and still-immature emotion regulation; as a result, their depressive symptoms are closely linked to academic pressure and peer relationships [12,13]. By contrast, late-adolescent brains exhibit distinct neurodevelopmental characteristics: continued maturation of the prefrontal cortex sharpens cognitive control, long-term planning, and the central developmental tasks shift to identity formation, autonomy, and educational or vocational choices [14,15]. Collapsing these two developmentally distinct groups may mask the unique risk profiles and intervention needs of depressive symptoms in middle school

students—who are predominantly in early adolescence—and thus hinder the delivery of truly targeted, “stratified and classified” interventions.

Developmental Contextualism posits that the interaction between individuals and their contexts exhibits temporal dynamics, and at any given time, members of the same subgroup may diverge onto distinct developmental pathways due to changes in internal and external factors [16]. Therefore, exploring pattern transitions of depressive symptoms in middle school students from a developmental perspective is an important way to clarify when and how depressive symptoms transition. In recent years, emerging random intercept latent transition analysis (RI-LTA) has provided a technical approach to address this challenge. By introducing a random intercept to characterize initial level differences among individuals, this method effectively reduces both model parameter estimation bias and the misclassification bias toward remaining in the initial class, thereby enhancing the precision of transition parameter estimates [17]. RI-LTA facilitates more precise assessment of the dynamic transition trajectories of depressive symptom patterns among middle school students in longitudinal tracking studies.

RI-LTA studies of adolescent depressive symptoms have primarily examined their comorbidity patterns with other disorders. For example, Yang et al. [18] found that among the 4 transition patterns of depression-PTSD comorbidity, nearly half of the individuals exhibited a non-negative state, meaning they maintained low-level symptoms or improved gradually over time. Yang et al. [19] identified 3 patterns of depression-aggression comorbidity: “Depression-dominant co-occurrence”, “Aggression-dominant co-occurrence”, and “Moderate co-occurrence”, among which significant differences in transition patterns were observed. However, most existing studies have focused on elucidating the joint developmental pathways of comorbid mental disorders. Yet these findings reveal little about the developmental trajectory of depressive symptoms in isolation. For instance, when individuals transition from a “Low Depression-Low Anxiety” subgroup to a “High Depression-High Anxiety” subgroup, it is unclear whether the shift reflects changes in depression, anxiety, or their interaction. Indeed, Klein et al. [20] found that adolescents with depressive symptoms face a striking 67% risk of developing depressive disorders within just 12 months, highlighting the urgent need to study depressive-symptom transitions on their own. Nevertheless, there is currently a paucity of research examining the independent transition trajectories of depressive symptoms among middle school students using the RI-LTA framework.

Given this context, we used a person-centered approach: first employing LPA to identify latent patterns of depressive symptoms, then using RI-LTA to explore their transitions. In a longitudinal sample of middle school students assessed at two time points one year apart, we aimed to characterize the initial latent patterns of depressive symptoms and their temporal transition trajectories. This research may provide valuable insights for refining relevant intervention measures.

1.2 The Influence of Different Stress Types and Life Satisfaction on the Transition in Depressive Symptom Patterns among Middle School Students

After identifying the patterns of depressive symptoms and their transitions among middle school students, it is essential to identify the factors that drive or inhibit these transitions. Ecological Systems Theory posits that individuals are embedded in multiple contextual layers, and any developmental outcome results from the combined influence of risk factors and protective factors [21].

According to the Cognitive Appraisal Theory of Stress, when individuals assess that situational demands exceed their capabilities, stress responses are activated, subsequently triggering negative psychological reactions such as depressive mood [22]. Previous studies have shown that different types of stress exert negative effects on depressive symptoms in adolescents [23]. For instance, academic stress [24], family

environment stress [25], peer relationship stress [26,27], sociocultural stress [27], subjective psychosomatic stress [28], and parenting-related stress [29,30] are all positively associated with depressive symptoms in adolescents. On the other hand, life satisfaction, a key indicator of subjective well-being [31], is regarded as a “psychological resource amplifier” by the Broaden-and-Build Theory. Individuals with high life satisfaction can expand their cognitive-coping resources through positive emotions, thereby buffering the effects of stress and significantly reducing the risk of depressive symptoms [32–34].

However, existing research on the predictors of adolescent depressive symptom transitions has three main limitations. First, previous studies have largely been confined to examining single stressors, overlooking the fact that adolescents often face multiple types of stress from school, family, peers, society, and the self. Second, cross-sectional designs cannot reveal how changes in stress and life satisfaction over time influence the transition between patterns of depressive symptoms. Third, although studies employing latent growth models or cross-lagged models have further corroborated findings from cross-sectional research [35–39], these studies still follow a “variable-centered paradigm”, making it difficult to address the core question of how different types of stress or satisfaction levels predict an individual’s transition from one symptom pattern to another. The present study includes seven types of stressors (academic stress, teacher-related stress, family environment stress, parenting stress, peer relationship stress, sociocultural stress, and subjective psychosomatic stress) and life satisfaction as predictor variables within the RI-LTA framework to examine whether they significantly predict transitions in depressive symptom patterns among middle school students.

1.3 Gender Differences in the Transition of Depression Symptom Patterns among Middle School Students

Whether gender differences exist in depressive symptoms among adolescents has long been a central question in adolescent mental-health research. Social Role Theory posits that during socialization, individuals are influenced by society’s specific expectations for different gender roles, leading to pronounced gender differences in social behaviors [40]. These differences may also manifest in the likelihood that males and females move between different depressive-symptom trajectories.

Extensive empirical research supports the existence of gender differences in depressive symptoms among adolescents. For instance, a meta-analysis revealed that early adolescent females face a significantly higher risk of depressive symptoms than males, with this disparity peaking between the ages of 13 and 15 [41]. Tariq et al. [42] observed similar findings in a study involving 425 adolescents. However, Wang et al. [43] found that the prevalence of depressive symptoms among early adolescent males (18.4%) was significantly higher than that among females (15.8%). Thus, findings on gender differences remain mixed.

Despite this inconsistency, in studies examining the heterogeneity of depressive symptoms among adolescents, both Chen et al. [44] and Magson et al. [45] found that females generally exhibited a higher probability of transitioning to the high depressive symptoms group compared to males. Building on this, the present study focuses on middle school students to investigate whether significant gender differences exist in the transition probabilities of latent patterns of depressive symptoms. This exploration aims to clarify inconsistencies in existing empirical findings and provide insights into the gender-specific trajectories of depressive symptom development, thereby to inform gender-tailored prevention.

1.4 Current Study

Using a longitudinal design, we will first apply LPA to identify depressive-symptom profiles among middle school students and then use RI-LTA to examine one-year transitions between these profiles. We

will also test whether multiple stressors, life satisfaction, and gender predict profile transitions. Based on the above arguments, this study proposes the following hypotheses:

Hypothesis 1: *Depressive symptoms among middle school students exhibit substantial heterogeneity.*

Hypothesis 2: *The depressive symptom patterns of some middle school students undergo temporal transitions over time.*

Hypothesis 3: *Individuals with higher stress levels are more likely to be in the “symptomatic stable pattern” or “symptom emergence and development pattern” (risk effect).*

Hypothesis 4: *Life satisfaction can exert a significant negative predictive effect; individuals with higher life satisfaction levels are more likely to be in the “asymptomatic stable pattern” (protective effect).*

Hypothesis 5: *Significant gender differences exist in the transitions of depressive symptom patterns among middle school students; compared with males, females exhibit a higher probability of being in the “symptom emergence and development pattern”.*

2 Participants and Procedures

2.1 Study Participants

This study employed cluster sampling to select 450 students from grades 7 to 9 at a 4-year middle school in Eastern China. Participants completed two rounds of follow-up questionnaires with a one-year interval between measurements. At the first measurement (T1, October 2023), demographic variables such as gender, age, and grade were assessed, along with depressive symptoms, 7 types of stress, and life satisfaction. At the second measurement (T2, October 2024), depressive symptoms were measured.

To ensure middle school students fully understood the questionnaire, we implemented three procedural safeguards. First, before handing out the questionnaires, the researcher read a standard script that (a) explained the purpose of the study, (b) guaranteed anonymity and confidentiality, and (c) instructed students to answer based on their personal feelings about each situation, rather than making value judgments about whether the situation was good or bad. Second, given potential conceptual overlap across dimensions of the scales, we provided brief, plain-language definitions of each dimension prior to questionnaire completion. For example, on the Middle School Student Stressor Scale, family environment stress refers to objective family circumstances or sudden events (e.g., financial difficulties or a relative’s illness), whereas parenting stress denotes specific parental child-rearing behaviors (e.g., the frequency of criticism or strictness of disciplinary rules). Finally, students were informed that they could raise their hand at any time to ask a private, individualized question for clarification if any item was unclear. All questionnaires were completed in a quiet classroom setting.

Based on participants’ responses (e.g., unusually short completion times, failure to pass quality control checks), data from four participants were excluded. Additionally, 12 participants dropped out during the second assessment because of school transfers or leave of absence. Ultimately, 434 valid participants were retained, yielding a valid response rate of 96.4%. After inspection, the final valid sample showed no missing values across all variables. In the final sample, participants had a mean age of 12.82 years (SD = 1.19) at T1, yielding a sex-balanced sample of 219 males (50.5%) and 215 females (49.5%). Grade distribution was as follows: 127 students (29.3%) in Grade 7, 152 students (35.0%) in Grade 8, and 155 students (35.7%) in Grade 9.

Analysis of participant attrition revealed no significant differences between those who dropped out and those who remained in terms of gender ($\chi^2(1) = 1.37, p = 0.24$), age ($\chi^2(4) = 1.69, p = 0.79$), grade ($\chi^2(2) = 0.59, p = 0.74$), T1 main variables (i.e., depressive symptoms, stress, life satisfaction) in this study ($ps > 0.05$). This study was reviewed and approved by the Academic Ethics Committee of the School of Education and Psychology, University of Jinan (Reference No. 202208001). Written informed consent to participate in this study was provided by the participant's legal guardian/next of kin. After obtaining ethical approval, the research team conducted several months of preparatory work—including finalizing the research instruments, coordinating with partner schools, and training investigators—under COVID-19 prevention and control measures such as campus lockdowns. Before data collection began, all participants and their legal guardians received full information on the study's purpose, procedures, potential risks, and their rights; data were gathered only after both provided written informed consent.

2.2 Measures

2.2.1 Center for Epidemiological Studies Depression Scale

This study employed the Chinese version of the Center for Epidemiological Studies Depression Scale (CES-D), originally developed by Radloff [46] and revised by Zhang [47]. The scale comprises four dimensions—depressed affect, positive affect, somatic and retarded activity, and interpersonal relationships—totaling 20 items. It employs a 4-point scoring system, where 0 indicates “never or almost never” and 3 indicates “almost always”. Higher scores indicate greater levels of depressed mood or physical discomfort. The CES-D is primarily used to screen for the frequency of depressive symptoms in the past week among non-clinical populations. It measures state-dependent, transient emotional fluctuations that are susceptible to recent life events and environmental influences, rather than trait-like or stable depressive disorders. In this study, Cronbach's α ranged from 0.73 to 0.87 across 4 dimensions at T1 and T2. Confirmatory factor analysis indicated that the scale exhibited good construct validity at both T1 and T2: $\chi^2/df \leq 2.67$, Comparative Fit Index (CFI) ≥ 0.92 , Tucker-Lewis Index (TLI) ≥ 0.91 , Root Mean Square Error of Approximation (RMSEA) ≤ 0.06 , and Standardized Root Mean Square Residual (SRMR) ≤ 0.05 .

2.2.2 Middle School Student Stressors Scale

This study utilized the Middle School Student Stressor Scale developed by Zheng et al. [48]. The scale consists of 7 dimensions: academic stress, teacher-related stress, family environment stress, parenting stress, peer relationship stress, sociocultural stress, and subjective psychosomatic stress, totaling 39 items. Academic stress refers to pressure caused by exam preparation, grade anxiety, heavy course load, and other school-related events. Teacher-related stress refers to pressure resulting from inadequate teaching methods, or tense teacher-student relationships. Family environment stress is pressure associated with objective family circumstances such as family structural changes, financial hardship, or strained family member relationships. Parenting stress denotes pressure arising from inappropriate parental practices (e.g., physical punishment or excessive indulgence). Peer relationship stress indicates pressure triggered by interpersonal events like misunderstandings, conflicts, social exclusion, or friendship difficulties among peers. Sociocultural stress represents pressure linked to external cultural factors such as negative social trends, inappropriate media content, or undesirable societal customs. Subjective psychosomatic stress refers to pressure rooted in internal disturbances, including emotional fluctuations, weak will, physiological changes, or sleep problems. It employs a 5-point scoring system, where 0 indicates “did not occur or had no impact” and 4 indicates “extremely severe impact”. Higher scores reflect a greater level of perceived stress in the corresponding dimension for middle school students. In this study, Cronbach's α ranged from 0.91 to

0.96 across seven dimensions. Confirmatory factor analysis showed that the scale possessed good construct validity at T1: $\chi^2/df \leq 2.53$, CFI ≥ 0.94 , TLI ≥ 0.94 , RMSEA ≤ 0.06 , SRMR ≤ 0.04 .

2.2.3 Satisfaction with Life Scale

The Chinese version of the Satisfaction with Life Scale (SWLS) developed by Diener et al. [49] and revised by Yan et al. [50] was adopted, comprising 5 items. The scale employs a 7-point Likert scale, where 1 indicates “strongly disagree” and 7 indicates “strongly agree”. A higher total score indicates a higher level of life satisfaction. In this study, Cronbach’s α was 0.80. Confirmatory factor analysis revealed that it showed good construct validity at T1: $\chi^2/df \leq 2.20$, CFI ≥ 0.98 , TLI ≥ 0.98 , RMSEA ≤ 0.05 , SRMR ≤ 0.02 .

2.3 Data Analysis

This study employed SPSS 22.0 (IBM Corp., Armonk, NY, USA) and Mplus 8.3 (Muthén & Muthén, Los Angeles, CA, USA) for data analysis. First, common method bias was assessed via Harman’s single-factor test in SPSS. When the variance explained by the first unrotated common factor falls below the critical threshold of 40%, it indicates that no significant common-method bias is present. Second, tests for measurement invariance in longitudinal data were conducted using Mplus. By comparing models of configural invariance, weak invariance, and strong invariance, and setting the criteria as $\Delta CFI \leq 0.01$ and $\Delta RMSEA \leq 0.015$, we established strong measurement invariance across different time points. Third, Pearson correlation was performed in SPSS to examine the correlations among all key variables. $p < 0.05$ was taken as significant. Fourth, latent profile analyses were conducted in Mplus based on depressive symptom data from T1 and T2, respectively. We determined the optimal number of latent patterns for depressive symptoms at each time point by comprehensively evaluating AIC, BIC, aBIC, p -values from the BLRT/LMR test (<0.05), and Entropy (>0.80). Fifth, a latent transition analysis model with random intercepts was employed to control for stable individual trait differences, estimating the conditional transition probabilities between the identified latent patterns from T1 to T2. Sixth, to examine the predictive roles of stress, life satisfaction, and gender on specific transition patterns, we ran multinomial logistic regressions in SPSS. Using the “asymptomatic stable pattern” as the reference category, we reported adjusted odds ratios (ORs) and their 95% confidence intervals for all other transition patterns. An OR value greater than 1 indicates that the predictor variable increases the likelihood of an individual exhibiting that specific transition pattern (relative to remaining in the asymptomatic stable pattern).

3 Results

3.1 Common Method Bias Test

Harman’s single-factor test was used to examine common method bias in the T1 data. The results showed that the first extracted factor accounted for 25.8% of the total variance, which is below the critical threshold of 40% [51]. This indicates that no severe bias was present.

3.2 Longitudinal Measurement Invariance Test

Using Mplus 8.3, longitudinal measurement invariance testing was conducted for the CES-D Scale. Specifically, the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR) were used as key fit indices, and the model fit results for configural invariance, weak invariance, and strong invariance are presented in Table 1. Although the chi-square test results were significant, they are susceptible to sample size effects. In contrast, ΔCFI and ΔTLI serve as more reliable criteria for assessment [52]; values below 0.01

are considered acceptable. Based on a comprehensive assessment of the fit indices mentioned above, we established longitudinal measurement invariance for depressive symptoms [53]. Note that this study focuses on how middle school students' baseline status (T1) shapes their subsequent symptom trajectories (T2), rather than on the within-subject change in the predictors themselves (e.g., stress types or life satisfaction) over time. Therefore, following the practices of Fong et al. [54] and Zyberaj et al. [55], we used baseline predictor levels in the subsequent multinomial logistic regression analyses.

Table 1: Longitudinal invariance testing of depressive symptoms.

Model	χ^2 (df)	CFI	TLI	RMSEA	SRMR	<i>p</i>	Δ CFI	Δ TLI
Configural invariance	1157.73(689)	0.922	0.911	0.040	0.050	<0.001	-	-
Weak invariance	1209.44(705)	0.916	0.907	0.041	0.054	<0.001	0.006	0.004
Scalar invariance	1247.12(719)	0.912	0.904	0.041	0.053	<0.001	0.004	0.003

Note: df, degree of freedom; CFI, comparative fit index; TLI, Tucker-Lewis index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

3.3 Correlation Analysis

This study used Pearson correlation analysis to examine the relationships among the main variables, with the specific results shown in Table 2. Depressive symptoms at T1 and T2 showed significant positive correlations with academic stress, teacher-related stress, family environment stress, parenting stress, peer relationship stress, sociocultural stress, and subjective psychosomatic stress ($ps < 0.05$), but were not significantly correlated with life satisfaction ($ps > 0.05$). Age showed significant positive correlations with family environment stress, parenting stress, peer relationship stress, sociocultural stress, and T2 depressive symptoms ($ps < 0.05$), and was significantly negatively correlated with life satisfaction ($ps < 0.05$). Gender was significantly negatively correlated with subjective psychosomatic stress ($ps < 0.05$), but showed no significant correlation with T1 or T2 depressive symptoms ($ps > 0.05$). These bivariate correlation patterns offer an initial glimpse of the associations among variables and provide a basis for subsequent in-depth analyses.

Table 2: Descriptive statistics and correlation analysis of major variables.

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Gender	1											
2. Age	-0.06	1										
3. T1 Academic stress	0.01	0.08	1									
4. T1 Teacher-related stress	0.07	0.02	0.39**	1								
5. T1 Family environment stress	-0.02	0.15**	0.34**	0.58**	1							
6. T1 Parenting stress	0.09	0.10*	0.44**	0.59**	0.42**	1						
7. T1 Peer relationship stress	-0.01	0.18**	0.42**	0.28**	0.40**	0.38**	1					
8. T1 Sociocultural stress	0.01	0.14**	0.31**	0.36**	0.44**	0.46**	0.58**	1				
9. T1 Subjective psychosomatic stress	0.13**	0.01	0.26**	0.20**	0.18**	0.25**	0.22**	0.26**	1			
10. T1 Life satisfaction	-0.03	-0.10*	-0.01	0.03	-0.02	-0.03	0.06	-0.02	0.01	1		
11. T1 Depressive symptoms	0.04	0.03	0.17**	0.24**	0.27**	0.18**	0.24**	0.20**	0.21**	-0.03	1	
12. T2 Depressive symptoms	-0.06	0.11*	0.29**	0.11*	0.13**	0.26**	0.20**	0.20**	0.28**	-0.02	0.18**	1
Mean	-	-	4.60	3.09	3.02	2.24	3.24	2.80	4.10	22.00	16.70	17.79
SD	-	-	3.25	4.02	3.57	2.95	3.94	3.67	3.04	6.78	8.56	7.46

Note: * $p < 0.05$, ** $p < 0.01$.

3.4 Comparison of Latent Patterns at Different Time Points

Using the four observed dimensions of the CES-D, we conducted LPA on middle school students' depressive symptoms at each time point. The optimal classification model was determined based on model fit indices such as the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), sample-adjusted BIC (aBIC), and Entropy [56]; details are reported in Table 3.

Table 3: Model fit indices for the latent profile analysis (LPA) of Depressive Symptoms at T1 and T2.

Time	Classes	AIC	BIC	aBIC	Entropy	LMR	BLRT	Probabilities	Number of Classes
T1	1	4981.46	5014.04	4988.66	-	-	-	1	434
	2	4360.66	4413.61	4372.36	0.914	0.000	0.000	0.80/0.20	347/87
	3	4163.71	4237.03	4179.91	0.954	0.010	0.000	0.73/0.22/0.05	317/95/23
	4	4044.34	4138.02	4065.03	0.964	0.027	0.000	0.66/0.22/0.08/0.04	288/96/35/15
	5	3657.68	3771.72	3682.86	1.000	0.203	0.000	0.63/0.12/0.13/0.08/0.04	273/54/57/35/15
T2	1	5008.84	5041.43	5016.04	-	-	-	1	434
	2	4495.41	4548.36	4507.11	0.906	0.007	0.000	0.78/0.22	337/97
	3	4179.40	4252.72	4195.59	0.971	0.003	0.000	0.75/0.20/0.05	327/87/23
	4	4066.86	4160.54	4087.55	0.962	0.050	0.000	0.73/0.18/0.07/0.02	315/80/29/10
	5	3624.43	3738.47	3649.61	1.000	0.231	0.000	0.65/0.12/0.14/0.07/0.02	280/54/61/29/10

Note: AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, Sample-adjusted BIC; LMR, Lo-Mendell-Rubin; BLRT, Bootstrap likelihood ratio test.

At T1, the 4-class model showed smaller AIC, BIC, aBIC, and LMR values than the 3-class model, but the smallest class accounted for <5% of the sample and was therefore dropped. At T2, the 4-class model produced a non-significant LMR test and a class that comprised <5% of the sample, so we retained the 3-class model [57], and after comprehensively considering model parsimony and statistical accuracy, this study ultimately selected the 3-class model for subsequent analysis. Average posterior probabilities (AvePP) for the 3-class model exceeded 0.90 at both T1 and T2, well above the conventional 0.70 threshold [58]. This indicated a high degree of accuracy in individual class membership assignment (see Table 4). Specifically, AvePP values were 0.95–0.99 at T1 and 0.98–0.99 at T2.

Table 4: Average latent class probability distribution of the 3-class model.

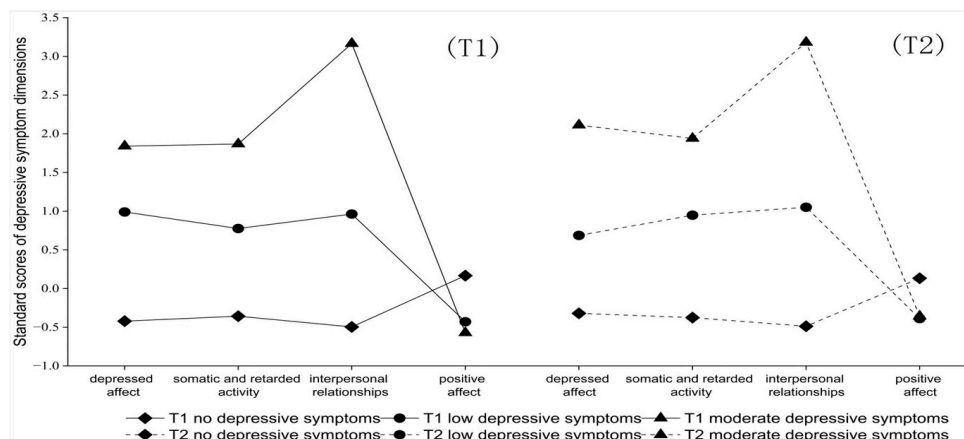
Time		Probability Distribution of the 3-Class Model		
		Class3-1	Class3-2	Class3-3
T1	Class3-1	0.99	0.01	0.00
	Class3-2	0.05	0.95	0.00
	Class3-3	0.00	0.02	0.98
T2	Class3-1	0.99	0.00	0.02
	Class3-2	0.00	0.99	0.01
	Class3-3	0.00	0.01	0.98

Conditional means for all four dimensions clearly distinguished the 3-class model (see Table 5): depressed affect, somatic and retarded activity, interpersonal problems, and positive affect. Overall, positive affect decreased steadily (class3-1 > class3-2 > class3-3), whereas the three negative dimensions increased in the opposite direction (class3-1 < class3-2 < class3-3). These distinct profiles allow us to label the 3 latent patterns with confidence.

Table 5: Conditional Means of the 4 Depression Symptom Dimensions in the 3-class Model.

Pattern	Time Point	Four Dimensions of Depressive Symptoms			
		Depressed Affect	Somatic and Retarded Activity	Interpersonal Relationships	Positive Affect
Class3-1	T1	-0.42	-0.36	-0.50	0.17
	T2	-0.32	-0.38	-0.49	0.13
Class3-2	T1	0.99	0.78	0.96	-0.43
	T2	0.69	0.95	1.05	-0.39
Class3-3	T1	1.84	1.87	3.17	-0.55
	T2	2.11	1.94	3.18	-0.41

Based on the scores of the 3-class model at T1 and T2, the classes were labeled as detailed in Fig. 1. Specifically, “Class 3-1” scored below zero on depressed affect (T1: -0.42, T2: -0.32), somatic and retarded activity (T1: -0.36, T2: -0.38), and interpersonal relationships (T1: -0.50, T2: -0.49), while scoring above zero on positive affect (T1: 0.17, T2: 0.13); we therefore called it the “no depressive symptoms” group. “Class 3-2” had standardized scores slightly above 0 in depressed affect (T1: 0.99, T2: 0.69), somatic and retarded activity (T1: 0.78, T2: 0.95), and interpersonal relationships (T1: 0.96, T2: 1.05), and slightly below 0 in positive affect (T1: -0.43, T2: -0.39); we labeled it the “low depressive symptoms” group. Class 3-3 had standardized scores above 1 in depressed affect (T1: 1.84, T2: 2.11), somatic and retarded activity (T1: 1.87, T2: 1.94), and interpersonal relationships (T1: 3.17, T2: 3.18), and below 0 in positive affect (T1: -0.55, T2: -0.41); we labeled it the “moderate depressive symptoms” group.

**Figure 1:** Results of the latent profile analysis (LPA) of depressive symptoms from T1 and T2.

3.5 Random Intercept Latent Transition Analysis

Unlike traditional LTA, RI-LTA disentangles stable between-person differences from within-person change, yielding more accurate estimates of transition probabilities. This method enhances the robustness of parameter estimation, can be readily extended to incorporate covariates or multilevel structures, and offers a robust tool for tracking transitions in heterogeneous samples [17].

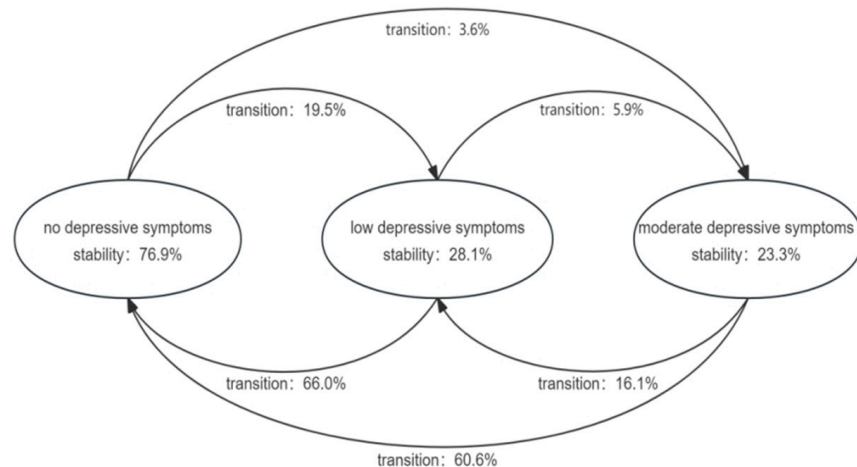
To examine which latent transition analysis method is more suitable for this study, we conducted a comparative analysis of the model fit of the 2 models. The results (see Table 6) indicated that the RI-LTA model had a higher log-likelihood value and a lower BIC value. Therefore, this study used RI-LTA to investigate the latent transition of depressive symptom patterns in middle school students.

Table 6: Model indices of latent transition analysis (LTA) and random intercept latent transition analysis (RI-LTA).

Model	Log-Likelihood	Free Parameters	AIC	BIC	aBIC
LTA	-4136.78	28	8329.55	8443.59	8354.74
RI-LTA	-4076.25	32	8216.49	8346.83	8245.28

Note: AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, Sample-adjusted BIC.

The results of the RI-LTA are shown in Fig. 2. Regarding the stability of transitions across patterns, the “no depressive symptoms” group demonstrated the highest stability, with 76.9% of middle school students remaining in the same group at T2. The “low depressive symptoms” group and the “moderate depressive symptoms” group showed greater variability, with probabilities of remaining in their original groups at T2 being approximately 28.1% and 23.3%, respectively. In terms of transition patterns: for the “no depressive symptoms” group, at T2, 19.5% of middle school students transitioned to the “low depressive symptoms” group, and 3.6% transitioned to the “moderate depressive symptoms” group; for the “low depressive symptoms” group, at T2, 66.0% transitioned to the “no depressive symptoms” group, and 5.9% transitioned to the “moderate depressive symptoms” group; for the “moderate depressive symptoms” group, at T2, 60.6% of students transitioned to the “no depressive symptoms” group, and 16.1% transitioned to the “low depressive symptoms” group.

**Figure 2:** Latent transition probabilities of different depressive symptom patterns.

Across two waves, we identified nine distinct latent transition patterns of depressive symptoms among middle school students. However, the individual proportions of some transition patterns were relatively low (ranging from 0.9% to 2.8%). To prevent small sample sizes from causing unstable estimates in subsequent analytical models or reduced statistical power, we followed the approach of Yang et al. [18] and merged the 9 original patterns into several groups with similar trajectories. Ultimately, these 9 original patterns were categorized into 4 transition patterns: asymptomatic stable pattern (55.5%), symptomatic stable pattern (7.4%), symptom remission pattern (18.8%), and symptom emergence and development pattern (18.3%). The “asymptomatic stable pattern” and “symptomatic stable pattern” denote unchanged symptom status from T1 to T2. The “symptom remission pattern” comprises individuals whose depressive symptoms improved or resolved by T2. The “symptom emergence and development pattern” comprises individuals who were symptom-free or had low symptoms at T1 but showed onset or increase by T2 with details provided in Table 7.

Table 7: Integration of transition patterns of depressive symptom patterns.

Pattern	T1–T2 Trajectories of Depressive Symptoms		N = 434	%
	T1	T2		
Asymptomatic stable pattern	No depressive symptoms	No depressive symptoms	241	55.5%
Symptomatic stable pattern	Low depressive symptoms	Low depressive symptoms	32	7.4%
	Moderate depressive symptoms	Moderate depressive symptoms		
Symptom remission pattern	Moderate depressive symptoms	Low depressive symptoms	82	18.8%
	Moderate depressive symptoms	No depressive symptoms		
	Low depressive symptoms	No depressive symptoms		
Symptom emergence and development pattern	No depressive symptoms	Low depressive symptoms	79	18.3%
	No depressive symptoms	Moderate depressive symptoms		
	Low depressive symptoms	Moderate depressive symptoms		

3.6 The Predictive Effects of Stress, Life Satisfaction, and Gender on Transitions in Depressive Symptom Patterns among Middle School Students

Although gender and life satisfaction did not correlate with depressive symptoms at either wave ($ps > 0.05$), given that correlation analysis only reflects static associations, and this study primarily focuses on the dynamic transitions of depressive symptom patterns, these variables were still included in subsequent analyses. To examine the potential impact of multicollinearity on the regression model, collinearity diagnostics were conducted for the seven stress dimensions, life satisfaction, gender, and age (the control variable). The variance inflation factor (VIF) for all covariates ranged from 1.02 to 1.98, well below the conventional threshold of 5 [59], indicating that serious multicollinearity is absent and that the subsequent multinomial logistic regression analyses can proceed with confidence. After controlling for age, we incorporated different types of stress, life satisfaction, and gender as predictor variables simultaneously and performed multinomial logistic regression analysis. When the odds ratio (OR) > 1 , it indicates that the covariate increases the odds of the event occurring relative to the reference group or baseline level [60].

This study used the “asymptomatic stable pattern” as the reference group and conducted a multinomial logistic regression analysis. The specific results are shown in Table 8. It was found that, compared to the “asymptomatic stable pattern”, higher levels of parenting stress (OR = 1.90, $p < 0.01$) and subjective psychosomatic stress (OR = 2.57, $p < 0.001$) were associated with a greater likelihood of belonging to the “symptomatic stable pattern”; in addition, a higher level of life satisfaction (OR = 1.62, $p < 0.05$) also increased the probability of being in the “symptomatic stable pattern”.

Compared to the “asymptomatic stable pattern”, higher levels of parenting stress (OR = 1.66, $p < 0.01$), sociocultural stress (OR = 1.56, $p < 0.05$), and subjective psychosomatic stress (OR = 1.60, $p < 0.01$) were associated with a greater likelihood of belonging to the “symptom emergence and development pattern”; a higher level of life satisfaction (OR = 0.70, $p < 0.05$) was associated with a lower probability of being in the “symptom emergence and development pattern”; and compared to males, females had a higher probability of belonging to the “symptom emergence and development pattern” (OR = 4.24, $p < 0.001$).

Table 8: 4 types of depressive symptom transition patterns under the influence of predictor variables.

Variables	Symptomatic Stable Pattern			Symptom Remission Pattern			Symptom Emergence and Development Pattern		
	B (SE)	OR	95% CI	B (SE)	OR	95% CI	B (SE)	OR	95% CI
Academic stress	0.12 (0.24)	1.13	[0.70, 1.80]	-0.07 (0.16)	0.93	[0.68, 1.28]	0.29 (0.17)	1.33	[0.96, 1.85]
Teacher-related stress	0.13 (0.24)	1.14	[0.70, 1.84]	0.02 (0.19)	1.02	[0.70, 1.49]	-0.36 (0.21)	0.70	[0.47, 1.04]
Family environment stress	0.18 (0.22)	1.20	[0.77, 1.85]	0.29 (0.18)	1.34	[0.94, 1.91]	0.12 (0.18)	1.13	[0.78, 1.61]
Parenting stress	0.64** (0.24)	1.90	[1.18, 3.07]	0.21 (0.19)	1.24	[0.86, 1.77]	0.51** (0.19)	1.66	[1.14, 2.41]
Peer relationship stress	0.13 (0.26)	1.14	[0.68, 1.89]	0.28 (0.17)	1.33	[0.95, 1.85]	-0.11 (0.19)	0.89	[0.62, 1.29]
Sociocultural stress	-0.90 (0.26)	0.92	[0.55, 1.53]	0.13 (0.18)	1.14	[0.80, 1.62]	0.46* (0.18)	1.56	[1.12, 2.25]
Subjective psychosomatic stress	0.94*** (0.23)	2.57	[1.65, 4.00]	0.24 (0.15)	1.27	[0.95, 1.69]	0.48** (0.16)	1.60	[1.19, 2.21]
Life satisfaction	0.48* (0.23)	1.62	[1.03, 2.57]	-0.10 (0.14)	0.90	[0.69, 1.19]	-0.36* (0.15)	0.70	[0.53, 0.94]
Gender	0.52 (0.45)	1.68	[0.70, 4.03]	-0.18 (0.28)	0.84	[0.48, 1.46]	1.44*** (0.32)	4.24	[2.44, 7.98]

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. (1) Gender: reference group = males. (2) The reference pattern for the dependent variable is the asymptomatic stable pattern.

4 Discussion

This study used a person-centered approach to identify three latent patterns of depressive symptoms among middle school students: “no depressive symptoms”, “low depressive symptoms”, and “moderate depressive symptoms”. Using RI-LTA, the study investigated the transition trends of these depressive symptom patterns. After collapsing similar transitions, the “asymptomatic stable pattern” showed the highest stability and the largest proportion. Furthermore, after controlling for age, this study examined the predictive roles of different stress types, life satisfaction, and gender. It found that different stress types, life satisfaction, and gender all significantly predicted the transition patterns.

4.1 Latent Patterns of Depressive Symptoms in Middle School Students

This study focused on early adolescence (ages 11–15) to identify latent patterns of depressive symptoms among middle school students. The analysis revealed three distinct patterns: “no depressive symptoms”, “low depressive symptoms”, and “moderate depressive symptoms”. This also confirms **Hypothesis 1**, indicating that depressive symptoms among middle school students exhibit substantial heterogeneity.

The findings of this study indicate that during early adolescence, there is a widespread decline in positive affect, a trend that has been preliminarily confirmed by previous studies [61]. However, the underlying mechanisms of this phenomenon, especially its manifestation and causes among early adolescents without depressive symptoms, remain subject to differing interpretations. One view attributes this decline to the latent influence of potential depressive risk or subclinical depressive moods [62]; another perspective emphasizes that it may reflect an inherent adaptive challenge during the developmental transition of early adolescence, independent of depressive symptoms [63]. Using latent profile analysis, we provide preliminary evidence to clarify this debate. The results not only further confirm that individuals with depressive symptoms tend to have lower levels of positive affect, but more importantly, they reveal that even among middle school students classified as “non-depressive”, positive affect remains at a relatively low level. This finding suggests that low positive affect in early adolescence may be a pre-existing and universal developmental characteristic, upon which depressive symptoms further exacerbate and solidify the decline in positive affect.

This may reflect the developmental signature of early adolescence. Once puberty begins, individuals enter a phase of rapid physical growth, yet psychological development—especially the capacity for emotional regulation—remains in a critical transition from immaturity to maturity and is far from fully formed [64]. For middle school students who have just stepped into adolescence, this developmental immaturity is likely to be further magnified. Consistent with the core tenets of Emotion Dysregulation Theory, emotional regulation entails a dynamic integration of “emotion perception → cognitive appraisal → behavioral response”. If cognitive-appraisal bias emerges—an inability to interpret and modulate emotional stimuli rationally—response intensities deviate from adaptive ranges [65]. These biases hinder young adolescents from deploying mature strategies when facing peer conflict, academic competition, and similar stressors. Even when no overt depressive affect is triggered, the continuous drain on psychological resources suppresses the generation and maintenance of positive affect. For those already exhibiting depressive symptoms, these regulatory deficits further amplify the decline in positive affect, creating a vicious cycle of “insufficient emotion regulation, low positive affect, and intensified depressive symptoms”. Therefore, interventions should move beyond merely alleviating negative symptoms and address the developmental interplay of physical and psychological factors in early adolescence. Emotion-regulation strategies grounded in positive psychology should be integrated to systematically enhance adolescents’ regulatory capacities.

4.2 Transition of Depressive Symptom Patterns in Middle School Students

The CES-D captures state symptoms experienced during the past week. Consequently, observed changes may reflect daily mood swings or transient item-response shifts. Nevertheless, the directional and significant transition patterns of depressive symptom classes identified by the RI-LTA in this study indicate that such transitions are not merely the accumulation of random fluctuations.

Specifically, in terms of the transitions between depressive symptom classes, the depressive symptoms of middle school students show a distinct dynamic trend over time, which confirms **Hypothesis 2** of the study, namely that the depressive symptom patterns of some middle school students undergo temporal transitions over time. First, the “asymptomatic stable pattern” (55.5%) accounts for the largest share, indicating that more than half of the middle school students remained in a stable mental-health state at both time-points (assessed over the previous week). Second, within the “symptom remission pattern” (18.8%), 95.1% of the students had returned to an asymptomatic level of depression at T2. This aligns with the Multisystem Resilience Framework, which posits that resilience arises from positive interactions between internal systems and external supports such as the school environment [66]. The neuro-psychological plasticity characteristic of adolescence [67] constitutes the internal foundation for recovery, while school-based mental-health education programs [68] provide crucial external resources. The synergy of these factors drives the shift from symptomatic to asymptomatic within the observed interval. Another 4.9% of students experienced some alleviation of depressive symptoms at T2 but had not yet returned to an asymptomatic state. This may reflect an ongoing recovery process or insufficient external support. Future school-based screening should therefore protect currently asymptomatic students and provide targeted support to those in the symptom-remission pattern to consolidate their gains.

However, our findings also reveal several issues that merit attention. First, within the “symptom emergence and development pattern” (18.3%), 96.1% of students developed low-to-moderate depressive symptoms over time. Because the measure covers only the previous week, this onset may reflect transient emotion-regulation difficulties when coping with recent stressors, coupled with a lack of timely external buffering that temporarily blocks the resilience process. Preventive interventions should therefore build a school-wide, developmental support network that strengthens every student’s resilience before problems emerge. Second, in the “symptom stability pattern” (7.4%), students reported low or moderate depressive symptoms at both time-points. This suggests that, for these students, the symptoms are not momentary fluctuations but rather a more enduring emotional state or difficulty adapting to the environment—i.e., relatively stable risk factors within the resilience framework (such as individual regulatory deficits or malfunctioning support systems). Yet the positive changes observed in the “symptom-remission pattern” show that favorable shifts are possible. Consequently, targeted interventions should be provided for students who exhibit or persist in depressive symptoms.

4.3 The Predictive Role of Different Stress Types, Life Satisfaction, and Gender on the Transition of Depression Patterns

Overall, different types of stress, life satisfaction, and gender are significant predictors for the transition. Specifically, this study found that the effects of different stress types, life satisfaction, and gender on the 4 types of depression transition patterns vary considerably.

4.3.1 Predictive Effect of Different Stress Types on the Transition of Depression Patterns among Middle School Students

Firstly, persistent perceived stress is an important risk factor for the development of depressive symptoms. Previous “variable-centered” research has preliminarily confirmed this conclusion: parenting stress, sociocultural stress, and subjective psychosomatic stress all have significant negative effects on depressive symptoms at subsequent time points [69–71]. Yet these studies examined overall correlations and did not show how stress drives movement across symptom categories. Using a person-centered approach, we found that, compared with the “asymptomatic stable pattern”, individuals in the “symptom emergence and development pattern” experienced higher levels of all three stressors. This directly supports **Hypothesis 3**: individuals with higher stress levels are more likely to fall into the “symptom emergence and development pattern”. This finding can be explained from the perspective of dynamic stress accumulation. According to the Daily Stress Process Model [72], individuals’ subjective perceptions of objective stressors accumulate over time, and when such accumulation reaches a certain threshold, it can predict changes in the classification of depressive symptoms. The findings of the present study lend support to this theoretical framework. For initially asymptomatic or mildly symptomatic individuals, parent-, society-, and self-related stressors gradually erode mental health via this cumulative mechanism, precipitating onset or exacerbation. Of course, it should be noted that we used baseline (T1) perceived stress levels to predict subsequent transitions in depressive symptoms, whereas the core tenet of the Daily Stress Process Model lies in the dynamic cumulative process of stress. Although baseline stress scores most likely reflect the stable load of stress experiences accumulated over a period prior to the study’s initiation, we extrapolate that the state of stress load borne by an individual at a given time point (formed through prior accumulation) constitutes a key factor in predicting their future risk of falling into the “symptom emergence and development pattern” trajectory. Future work should test this with intensive longitudinal designs (e.g., three or more RI-LTA waves or experiential sampling).

Secondly, 2 types of stress exert a “solidifying effect” on the pattern transition of depressive symptoms. Relative to the “asymptomatic stable pattern”, individuals in the “symptomatic stable pattern” are more reactive to parenting and self-related stressors and therefore tend to remain in their original symptom category. This directly supports **Hypothesis 3**: individuals with higher stress levels are more likely to fall into the “symptomatic stable pattern”. This phenomenon can be understood through emotional-security and cognitive-coping pathways. According to Emotional Security Theory, stressors embedded in parental rearing practices can disrupt the family emotional system and erode individuals’ emotional security [73]. For those already experiencing depressive symptoms, although their current state is distressing, it is predictable and familiar; changing it may entail confronting unforeseen risks and heightened insecurity. Driven by self-protection, individuals tend to maintain their existing state, which generates an intrinsic psychological impetus for the solidification of symptoms. Meanwhile, early adolescents’ cognitive regulatory systems are immature. When they are continuously exposed to stress signals such as external negation and emotional neglect, or endure self-related physical and psychological stressors, they are more inclined to adopt maladaptive emotion regulation strategies (e.g., rumination, suppression) rather than cognitive reappraisal or problem-solving strategies [74]. Such persistent cognitive internal friction hinders the development of more sophisticated coping capacities, creating a vicious, self-perpetuating cycle that ultimately anchors depressive symptoms at their original level.

Finally, the present study found that no significant differences were observed between the “asymptomatic stable pattern” and the “symptom remission pattern” in response to the effects of various types of stress. In other words, it is plausible that the remission of depressive symptoms may be independent

of the reduction in stress. However, this hypothesis cannot be directly derived from the results of the current model. Future studies should use intensive longitudinal data with time-varying stress scores to test this hypothesis.

4.3.2 Predictive Effect of Life Satisfaction on the Transition of Depression Patterns among Middle School Students

Students in the “asymptomatic stable pattern” reported higher life satisfaction than those in the “symptom emergence and development pattern”. This further validates **Hypothesis 4**, which posits that life satisfaction has a significant negative predictive effect, such that individuals with higher life satisfaction are more likely to be in the “asymptomatic stable pattern”. This conclusion is generally consistent with previous variable-centered findings that life satisfaction serves as an important protective factor prophylactic depressive symptoms in adolescents [36,37]. The above finding can also be explained by the Broaden-and-Build Theory [32]: in the “asymptomatic stable pattern”, individuals accumulate psychological resources through life satisfaction, thereby strengthening their psychological resilience and acting as a “preventive reserve”. The above findings also provide empirical evidence for achieving targeted interventions through the “stratified and classified intervention”.

Unexpectedly, higher life satisfaction also predicted membership in the “symptomatic stable pattern” rather than the “asymptomatic stable pattern”. From the perspective of the dual-factor model of mental health, the positive and negative dimensions of mental health are relatively independent yet interrelated [75]. Therefore, individuals with high life satisfaction may simultaneously exhibit depressive symptoms. However, why do individuals with high life satisfaction exhibit more stable depressive symptoms? From the perspective of the broaden-and-build theory, life satisfaction serves as a crucial factor in eliciting positive emotions, while positive emotional experiences act as the key mediators in broadening and building enduring psychological resources. Previous work indicates that depressed individuals often show blunted responses to positive stimuli [76]. However, Bylsma et al. [77] discovered that the intensity of positive emotional responses in depressed individuals did not differ significantly from that in non-depressed individuals. Therefore, focusing solely on the intensity of emotional responses does not seem to provide a reasonable explanation. Recent studies have found that individuals with depressive symptoms may prefer or habitually employ certain less effective emotion regulation strategies (such as rumination and avoidance) while less frequently utilizing adaptive strategies (such as reappraisal). This regulatory bias can sustain depressive symptoms despite adequate life satisfaction [78]. Therefore, the current issue may not lie in the generation of positive emotions, but rather in their internalization and stabilization. Fredrickson et al. [79] later pointed out that if an individual’s cognition fails to trigger positive emotions, and positive emotions do not reach a specific threshold (a positive-to-negative emotion ratio below 3:1), it becomes difficult to activate the protective function of the “broaden-and-build” process.

We hypothesize that individuals in the “symptom stable pattern” do not lack a positive cognitive evaluation of life; instead, they experience a cognition-emotion disconnect that prevents life satisfaction from being translated into positive affect. As an exploratory follow-up, we ran a within-group correlation analysis within the “symptom stable pattern” group ($n = 32$) to probe this mechanism. The results revealed no significant correlation between life satisfaction and depressive symptoms at T1 ($r = -0.15$, $p = 0.40$, 95% CI $[-0.46, 0.19]$) or at T2 ($r = -0.30$, $p = 0.10$, 95% CI $[-0.58, 0.06]$). This absence of association is consistent with our theoretical expectation. The study revealed that high levels of life satisfaction predicted a greater likelihood of belonging to the “symptom stable pattern”. We interpret this as an expression of “cognitive-emotional disconnection”, wherein positive cognitive evaluations (high life satisfaction) fail to

effectively translate into the emotional momentum required to alleviate depressive symptoms. Therefore, it is logical that within individuals already in a “symptom stable pattern”, the association between life satisfaction and depressive symptom levels is only weak and non-significant. However, due to the limitations of not directly measuring emotional regulation and momentary emotions, future research could employ instantaneous assessment techniques such as experiential sampling or diary methods to conduct more formal examinations of this inferred dynamic process. Such designs would clarify the real-time interplay between cognitive evaluations and emotional experience.

4.3.3 Gender Differences in Depression Pattern Transitions among Middle School Students

We also examined gender differences in the transition of depressive-symptom patterns among middle school students. Compared to the “asymptomatic stable pattern”, the probability of females being in the “symptom emergence and development pattern” was significantly higher than that of males. This corroborates prior findings, indicating that the probability of females developing depressive symptoms is significantly higher than that of males [44,45]. This also validates **Hypothesis 5**: significant gender differences exist in the transitions of depressive symptom patterns among middle school students; compared with males, females exhibit a higher probability of being in the “symptom emergence and development” pattern. This difference may stem from multiple factors. From the perspective of psychological development characteristics, females in the junior high school stage are more inclined to internalize emotions in response to various stressful events, making them prone to emotional exhaustion due to negative events [80]. Culturally, traditional gender roles expect greater emotional restraint from females, hampering emotional expression [81], whereas boys often release stress externally, reducing depressive accumulation.

It is noteworthy that, compared to the “asymptomatic stable pattern”, this study did not find a significant gender difference in the “symptom stable pattern”. Thus, gender effects do not persist across all symptom-pattern transitions. Previous studies have found that as individuals’ depression symptom levels gradually increase, the gender differences in symptom manifestations between males and females in certain aspects may also diminish [82,83]. These findings carry important implications for tiered interventions targeting depressive symptoms among junior high school students. At the primary prevention stage, special attention should be given to the emotional internalization tendencies observed in female students. Interventions should aim to reduce their risk of developing a “symptom emergence and progression pattern” by challenging traditional gender role expectations and providing training in emotional expression skills. For students exhibiting a “stable symptom pattern”, intervention programs should move beyond gender-specific approaches and instead focus on addressing shared risk factors—such as academic stress management, building robust social support systems, and enhancing psychological resilience—thereby achieving the goal of precision-oriented mental health interventions.

4.4 Limitations and Implications

The study’s novelty is its use of RI-LTA to identify latent depressive symptom patterns and transitions among middle school students and to examine the unique effects of seven stress dimensions, life satisfaction, and gender on these transitions. Nevertheless, several limitations remain. First, this study only examined depressive symptoms among middle school students in the eastern regions of China; future research could expand to include samples from the central and western regions—especially economically underdeveloped areas in the west—to deepen our understanding of these issues. Second, the study’s time span is relatively short, and it did not conduct multiple rounds of longitudinal follow-up; future studies could consider extending the time span to more deeply reveal the transition patterns of depressive symptoms among middle

school students; Meanwhile, this study used only baseline-level predictors, thus limiting inferences about their dynamic associations with categorical shifts in depressive symptoms. Future three-or-more-wave designs should first test longitudinal measurement invariance to ensure that the scales' psychometric properties remain stable over time, allowing unbiased estimates of dynamic effects. Third, in the logistic regression analysis, some transition patterns with fewer participants were merged, resulting in the inability to capture more granular findings; future research could examine in greater detail the effects of different predictor variables on pattern transitions. Fourth, this study only explored the effects of different types of stress, life satisfaction, and gender on transitions between depressive symptom patterns; future research could further incorporate other demographic factors or potential influencing factors (such as online environment, social support, psychological resilience, etc.) to more comprehensively investigate the dynamic mechanisms of depressive symptoms among middle school students. Fifth, the associations identified herein are not amenable to causal interpretation because of the potential bidirectionality between depressive symptoms and stress perception. Future studies should adopt causal-inference designs—such as cross-lagged panel models or longitudinal network analyses—that, with larger samples and multi-wave data, can rigorously establish temporal precedence and unpack mediating pathways, thereby clarifying the mechanisms behind phenomena like gender differences.

This study's identification of 3 patterns and 4 transition patterns of depressive symptoms, as well as the key predictors of each transition, provides targeted support for classified and stratified intervention of middle school students' depressive symptoms. Specifically, it optimizes early screening precision—helping identify potential high-risk groups that traditional screening overlooks, and avoiding over-intervention of low-risk students; it enhances intervention effectiveness by guiding targeted measures for different patterns (e.g., gender-specific emotion training for symptom emergence females, parent workshops for high parenting stress students); and it enables sustainable dynamic intervention—by tracking symptom transitions and adjusting strategies in real time (e.g., shifting from prevention to early intervention for students moving from no symptoms to low symptoms), avoiding rigid “one-time intervention”. These implications make depressive symptom prevention and intervention more precise and efficient, better safeguarding middle school students' mental health.

5 Conclusions

The depressive symptoms of middle school students fall into 3 patterns: “no depressive symptoms”, “low depressive symptoms”, and “moderate depressive symptoms”. Due to sample size considerations, after conducting the RI-LTA, this study grouped the 9 identified transition patterns into 4 patterns with similar trajectories. Among them, the “asymptomatic stable pattern” accounts for the largest proportion of students and exhibits the strongest stability. Different types of stress, life satisfaction, and gender play significant predictive effects in the pattern transitions of middle school students' depressive symptoms, and these predictive effects vary greatly across the transition paths of different transition patterns.

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Ethics Approval: The studies involving human participants were reviewed and approved by the Academic Ethics Committee of the School of Education and Psychology, University of Jinan (Reference No. 202208001). Written informed consent to participate in this study was provided by the participant's legal guardian/next of kin.

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