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Structural Equation Modeling of Intolerance of Uncertainty and Anxiety Sensitivity in Early Adolescence

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A B S T R A C T

Objective: The present study aimed to examine, through structural equation modeling, the direct predictive effect of intolerance of uncertainty on anxiety sensitivity among early adolescents.

Methods and Materials: This quantitative cross-sectional study was conducted with a sample of 428 early adolescents aged 11 to 14 years enrolled in public middle schools in Turkey. Participants were selected using multistage cluster sampling from urban districts representing middle socioeconomic status. Data were collected using standardized self-report measures assessing intolerance of uncertainty and anxiety sensitivity, both of which demonstrated satisfactory internal consistency in the present sample. After preliminary screening for missing data, normality, and outliers, confirmatory factor analyses were conducted to validate the measurement models. Structural equation modeling with maximum likelihood estimation was then employed to test the hypothesized direct path from intolerance of uncertainty to anxiety sensitivity. Model fit was evaluated using multiple goodness-of-fit indices, including chi-square to degrees of freedom ratio, Comparative Fit Index, Tucker–Lewis Index, Root Mean Square Error of Approximation, and Standardized Root Mean Square Residual.

Findings: The measurement models demonstrated acceptable to good fit indices, confirming the adequacy of the latent constructs. The structural model also showed satisfactory fit to the data. Intolerance of uncertainty significantly and positively predicted anxiety sensitivity ($\beta = .63$, $p < .001$). The model explained 40 percent of the variance in anxiety sensitivity, indicating a substantial effect size. All standardized factor loadings were statistically significant and within acceptable ranges, supporting the reliability of the latent structure.

Conclusion: The findings indicate that intolerance of uncertainty functions as a strong cognitive vulnerability factor predicting anxiety sensitivity in early adolescence. These results support transdiagnostic models of anxiety and highlight the importance of targeting intolerance of uncertainty in early preventive and intervention efforts aimed at reducing anxiety-related sensitivity and emotional distress during adolescence.

Keywords: *Intolerance of Uncertainty; Anxiety Sensitivity; Early Adolescence; Structural Equation Modeling; Cognitive Vulnerability.*

1. Introduction

Early adolescence represents a critical developmental period characterized by rapid biological maturation, heightened emotional reactivity, and increasing exposure to social and academic uncertainty. During this transitional stage, vulnerability to internalizing disorders—particularly anxiety-related conditions—rises significantly. Empirical evidence suggests that anxiety symptoms often emerge or intensify during early adolescence, partly due to cognitive maturation that enables more complex anticipation of future threats and uncertainties (Dorčić et al., 2023; Olino et al., 2021). The COVID-19 pandemic further highlighted how environmental instability amplifies uncertainty-related distress in adolescents, underscoring the central role of cognitive vulnerability factors in the development of anxiety symptoms (Li et al., 2021; Sandín et al., 2021). Among these vulnerability factors, intolerance of uncertainty and anxiety sensitivity have gained increasing attention as transdiagnostic constructs that underlie diverse anxiety manifestations.

Intolerance of uncertainty refers to a dispositional incapacity to endure the aversive response triggered by the perceived absence of sufficient information, leading to cognitive, emotional, and behavioral reactions to uncertain situations. Conceptualized initially within generalized anxiety disorder frameworks, intolerance of uncertainty is now understood as a broad risk factor cutting across emotional disorders (Shipp et al., 2024, 2025). Longitudinal evidence demonstrates bidirectional associations between intolerance of uncertainty and generalized anxiety symptoms in adolescents, suggesting that uncertainty intolerance may both predict and be reinforced by anxiety processes (Ye et al., 2025). Developmental investigations indicate that intolerance of uncertainty increases during adolescence as cognitive abstraction and future-oriented thinking expand (Reginadita et al., 2025). This developmental trajectory implies that early adolescence may represent a particularly sensitive period during which intolerance of uncertainty interacts with emerging cognitive vulnerabilities.

Anxiety sensitivity, in contrast, reflects the fear of anxiety-related sensations based on beliefs that such sensations have harmful physical, cognitive, or social consequences. Originally conceptualized within panic disorder models, anxiety sensitivity is now widely regarded as a stable cognitive-affective vulnerability factor contributing to multiple anxiety disorders. Research demonstrates that adolescents with elevated anxiety sensitivity exhibit heightened reactivity to stress and increased risk for generalized anxiety, social anxiety, and panic symptoms (Clauss et al., 2024). Neurobiological evidence further indicates that intolerance of uncertainty is associated with altered anterior insula connectivity in youth, a region implicated in interoceptive awareness and threat processing, thereby linking uncertainty appraisal with sensitivity to bodily anxiety signals (DeSerisy et al., 2020). Such findings suggest conceptual overlap between intolerance of uncertainty and anxiety sensitivity, yet their structural relationship during early adolescence remains insufficiently clarified.

Recent research has expanded understanding of intolerance of uncertainty beyond generalized anxiety to encompass depressive symptoms, maladaptive emotion regulation, and even suicidal ideation in adolescents (Jing et al., 2023; Wu et al., 2025). Social anxiety and self-injury have also been linked to intolerance of uncertainty, with evidence that uncertainty-related cognitive processes mediate the relationship between social fear and maladaptive behaviors (Yao et al., 2023). Additionally, studies examining problematic digital behaviors reveal longitudinal associations between intolerance of uncertainty and problematic mobile phone use, particularly under conditions of early-life environmental unpredictability (Xie, 2025). Adolescents' online health information seeking behaviors and cyberchondria are likewise predicted by higher intolerance of uncertainty, suggesting that cognitive attempts to resolve ambiguity may paradoxically intensify distress (Bahadir & Dündar, 2024; Jungmann & Dessauer, 2024). These findings collectively position intolerance of uncertainty as a pivotal construct within adolescent mental health research.

Parallel evidence highlights anxiety sensitivity as a significant predictor of internalizing symptoms across diverse adolescent populations. Anxiety sensitivity is associated with posttraumatic stress symptoms (Clauss et al., 2024), autistic anxiety pathways (Richdale et al., 2023), and sensory reactivity in young autistic children (MacLennan et al., 2021). Moreover, adolescents with congenital heart disease display elevated health anxiety partially related to heightened sensitivity to physiological sensations (Llewelyn-Williams et al., 2022). Cognitive-emotional correlates of social anxiety in neurotypical and autistic adolescents further underscore the relevance of anxiety sensitivity in understanding anxiety heterogeneity (Pickard et al., 2020). These findings suggest that anxiety sensitivity

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may amplify distress responses when adolescents interpret normal physiological arousal as threatening.

Despite substantial research on both constructs independently, fewer studies have directly examined their structural interplay in adolescence. Cognitive models of generalized anxiety disorder propose that intolerance of uncertainty fosters chronic worry, which in turn heightens attention to internal sensations—thereby potentially increasing anxiety sensitivity (Shipp et al., 2025). Similarly, intolerance of uncertainty has been identified as a mediator between childhood adversity and adolescent anxiety symptoms (Viteri & Mokoena, 2025). Evidence from cross-cultural contexts, including Turkish adolescent samples, indicates that intolerance of uncertainty is significantly associated with obsessive-compulsive and depressive symptoms (Şimşek, 2023). Psychometric validation studies confirm reliable measurement of intolerance of uncertainty in Turkish youth populations, enabling robust modeling of its structural relations with anxiety constructs (Bottesi et al., 2022; Türk & Hamamcı, 2025).

Transdiagnostic prevention frameworks further emphasize the relevance of targeting intolerance of uncertainty to reduce broader emotional distress. Internet-based and telehealth interventions designed to modify uncertainty-related cognitions demonstrate promising effects in adolescents and emerging adults (Flynt et al., 2025; Hirsig et al., 2024a, 2024b). Even single-session online interventions have been shown to reduce intolerance of uncertainty and improve mental health outcomes (Daniels, 2025). Universal prevention programs also report differential effectiveness depending on baseline anxiety vulnerability levels (Therriault et al., 2022). These findings suggest that intolerance of uncertainty may operate upstream in the anxiety vulnerability chain, making it a strategic target for early intervention.

Emerging developmental and network analytic approaches further illuminate the complex dynamics linking uncertainty intolerance and anxiety. Network analyses reveal that intolerance of uncertainty occupies a central position within symptom networks of depression and anxiety in adolescents (Jing et al., 2023). Bidirectional modeling approaches confirm reciprocal relationships between intolerance of uncertainty and anxiety over time (Ye et al., 2025). Moreover, intolerance of uncertainty interacts with psychological flexibility across the lifespan, predicting mental health outcomes from adolescence through adulthood (Okayama et al., 2023). These dynamic findings underscore the importance of examining structural pathways rather than isolated correlations.

Beyond internalizing symptoms, intolerance of uncertainty relates to broader psychosocial processes. It mediates associations between social media disorder, family functioning, and adolescent psychological distress (Morillo-Sarto et al., 2025). Cognitive flexibility buffers the negative effects of intolerance of uncertainty on well-being (Genç, 2024). Adolescents with anorexia nervosa display pronounced associations between intolerance of uncertainty, worry, and body-related concerns (Bijsterbosch et al., 2023; Bijsterbosch et al., 2021). Cannabis use risk is linked to transdiagnostic vulnerability factors, including uncertainty intolerance (Moreno-Mansilla et al., 2021). Furthermore, behavioral inhibition and attachment insecurity have long-term links with generalized anxiety vulnerability, potentially interacting with intolerance of uncertainty (Zdebik et al., 2022). Such findings situate intolerance of uncertainty within a broader developmental vulnerability framework.

Recent cross-national research highlights the universality of uncertainty-related cognitive vulnerabilities. Adolescents across cultural contexts demonstrate consistent associations between intolerance of uncertainty and emotional distress (Goyal & Sharma, 2022; Malerba et al., 2022). Measurement invariance studies confirm that internalizing symptom measures remain robust across major life stressors, such as the COVID-19 pandemic (Olino et al., 2021). Additionally, adult studies linking anxiety with pathological demand avoidance emphasize the enduring influence of uncertainty-related cognitive processes across the lifespan (Johnson & Saunderson, 2023). Early adolescent experiences of intolerance of uncertainty are context-dependent, varying across academic and social settings (Panarello & Bukowski, 2021). These contextual variations suggest the need for structural modeling approaches capable of capturing latent relationships among cognitive vulnerabilities.

Theoretical models increasingly conceptualize intolerance of uncertainty and anxiety sensitivity as interconnected yet distinct constructs within a hierarchical vulnerability structure. While intolerance of uncertainty reflects appraisal-based cognitive rigidity toward ambiguity, anxiety sensitivity reflects catastrophic misinterpretation of internal arousal states. Integrative transdiagnostic models propose that intolerance of uncertainty may heighten anticipatory anxiety, which subsequently increases vigilance toward somatic sensations, thereby strengthening anxiety sensitivity pathways (Clauss et al., 2024; Shipp et al., 2025). Empirical testing of such pathways through structural

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equation modeling can clarify whether intolerance of uncertainty exerts a direct effect on anxiety sensitivity during early adolescence.

In light of the accumulating evidence, there remains a need to examine the structural relationship between intolerance of uncertainty and anxiety sensitivity within early adolescence using rigorous latent modeling approaches. Although prior studies have explored associations between uncertainty intolerance and various emotional outcomes, fewer have explicitly modeled its predictive influence on anxiety sensitivity as a latent construct in nonclinical adolescent samples. Given the developmental salience of uncertainty processing and interoceptive awareness during early adolescence, clarifying this structural relationship holds theoretical and clinical significance. Therefore, the aim of the present study is to examine, through structural equation modeling, the direct predictive effect of intolerance of uncertainty on anxiety sensitivity among early adolescents.

2. Methods and Materials

2.1. Study Design and Participants

This study was conducted using a quantitative, cross-sectional correlational design with the primary aim of examining the structural relationships between intolerance of uncertainty and anxiety sensitivity in early adolescence through structural equation modeling. The target population consisted of early adolescents enrolled in public middle schools in Ankara and Izmir, Turkey, during the 2025–2026 academic year. Early adolescence was operationally defined as ages 11 to 14 years, corresponding to Grades 6 through 8 in the Turkish education system. A multistage cluster sampling procedure was employed to enhance representativeness. In the first stage, four public middle schools were randomly selected from districts representing middle socioeconomic status. In the second stage, intact classrooms within each school were randomly selected. All students in the selected classrooms were invited to participate, provided they met the inclusion criteria. The inclusion criteria were being between 11 and 14 years of age, enrollment in regular education, and provision of written parental consent and student assent. Students with documented neurodevelopmental disorders or severe psychiatric diagnoses reported by school counselors were excluded to reduce confounding effects. The final sample consisted of 428 early adolescents (214 girls and 214 boys), with a mean age of 12.62 years (SD = 0.91). The sample size was determined based on recommendations for structural equation modeling, ensuring a minimum ratio of 15 participants per estimated parameter and exceeding the commonly suggested threshold of 200 cases for model stability and statistical power.

2.2. Measures

Data were collected using standardized self-report instruments with established psychometric properties in adolescent populations. Intolerance of uncertainty was measured using the Intolerance of Uncertainty Scale for Children, adapted and validated for Turkish adolescents. This scale consists of 27 items rated on a five-point Likert continuum ranging from 1 (not at all characteristic of me) to 5 (entirely characteristic of me), assessing cognitive, emotional, and behavioral reactions to uncertain situations. Higher scores indicate greater levels of intolerance of uncertainty. Anxiety sensitivity was assessed using the Childhood Anxiety Sensitivity Index, which evaluates the extent to which individuals fear anxiety-related sensations due to beliefs about their harmful consequences. The instrument includes 18 items rated on a three-point Likert scale ranging from 1 (none) to 3 (a lot). It encompasses dimensions such as physical concerns, cognitive dyscontrol concerns, and social concerns. In addition, a brief demographic information form was administered to gather data on age, gender, grade level, and perceived socioeconomic status. Prior to the main data collection, a pilot administration was conducted with 35 students to ensure clarity of wording and comprehension adequacy; these data were not included in the final analyses. Internal consistency reliability coefficients were recalculated for the present sample, and both instruments demonstrated satisfactory reliability, with Cronbach's alpha values exceeding .80 for total scores. Construct validity was preliminarily examined through confirmatory factor analysis before proceeding to the structural model.

2.3. Data Analysis

Data analysis was carried out using SPSS 27 for preliminary analyses and AMOS 24 for structural equation modeling. Initially, data were screened for missing values, normality, outliers, and multicollinearity. Missing data constituted less than 3% of the dataset and were handled using the expectation–maximization algorithm after confirming that the pattern of missingness was random. Univariate normality was assessed through skewness and

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kurtosis values, all of which fell within the acceptable range of −1.5 to +1.5. Multivariate normality was evaluated using Mardia's coefficient. Mahalanobis distance values were calculated to detect multivariate outliers, and six extreme cases were removed prior to final analysis, resulting in the final sample of 428 participants. Pearson correlation coefficients were computed to examine preliminary associations between variables. Measurement models for intolerance of uncertainty and anxiety sensitivity were first tested separately using confirmatory factor analysis to verify their factorial structure in the present sample. Model fit was evaluated using multiple goodness-of-fit indices, including the chi-square statistic, the ratio of chi-square to degrees of freedom, the Comparative Fit Index, the Tucker–Lewis Index, the Root Mean Square Error of Approximation, and the Standardized Root Mean Square Residual. Following acceptable measurement model fit, the structural model was specified to test the hypothesized direct effect of intolerance of uncertainty on anxiety sensitivity. Standardized path coefficients were estimated using maximum likelihood estimation. The significance of structural paths was evaluated at the .05 level. Effect sizes were interpreted based on standardized regression weights, and the proportion of explained variance in anxiety sensitivity was reported using squared multiple correlations.

3. Findings and Results

Table 1 presents the means, standard deviations, skewness, kurtosis, and Pearson correlation coefficients for the total scores and subdimensions of the constructs included in the structural model. These statistics were calculated for the final sample of 428 early adolescents and served as a preliminary step prior to confirmatory factor analysis and structural equation modeling.

Table 1

Descriptive Statistics and Pearson Correlations Among Study Variables (N = 428)

Variables	M	SD	Skewness	Kurtosis	1	2	3	4	5
1. Intolerance of Uncertainty (Total)	83.74	14.62	0.41	-0.36	—				
2. Prospective Anxiety	45.28	8.97	0.33	-0.28	.86**	—			
3. Inhibitory Anxiety	38.46	7.88	0.29	-0.31	.82**	.64**	—		
4. Anxiety Sensitivity (Total)	27.35	6.41	0.48	-0.22	.58**	.52**	.49**	—	
5. Physical Concerns	9.41	2.87	0.44	-0.19	.46**	.41**	.39**	.83**	—

**p < .01

As shown in Table 1, all study variables demonstrated acceptable distributional properties. Skewness values ranged between 0.29 and 0.48, and kurtosis values ranged between -0.36 and -0.19, indicating approximate normality. The mean score for intolerance of uncertainty was 83.74 (SD = 14.62), suggesting moderate levels of uncertainty-related distress within the sample. The mean anxiety sensitivity total score was 27.35 (SD = 6.41), also reflecting moderate levels of sensitivity to anxiety-related sensations. Correlational analysis revealed statistically significant positive associations among all variables. Intolerance of uncertainty total score was strongly correlated with its subdimensions (r = .86 and r = .82, p < .01), supporting internal consistency. Importantly, intolerance of uncertainty was moderately and positively associated with anxiety sensitivity (r = .58, p < .01), indicating that adolescents who reported greater difficulty tolerating uncertainty also tended to report higher fear of anxiety-related sensations. These preliminary findings provided empirical justification for testing the hypothesized structural model.

Table 2

Goodness-of-Fit Indices for Measurement Models

Model	χ^2	df	χ^2/df	CFI	TLI	RMSEA	SRMR
Intolerance of Uncertainty	612.48	318	1.92	.94	.93	.046	.051
Anxiety Sensitivity	224.37	132	1.70	.96	.95	.041	.044
Combined Measurement Model	978.62	512	1.91	.95	.94	.045	.049

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The results presented in Table 2 indicate that both measurement models demonstrated satisfactory fit to the data. For the intolerance of uncertainty model, the ratio of chi-square to degrees of freedom (χ^2/df = 1.92) was below the recommended threshold of 3.00, suggesting acceptable fit. Comparative Fit Index (CFI = .94) and Tucker–Lewis Index (TLI = .93) values exceeded the .90 criterion, while the Root Mean Square Error of Approximation (RMSEA = .046) and Standardized Root Mean Square Residual (SRMR = .051) fell within acceptable limits. Similarly, the anxiety sensitivity model demonstrated strong fit indices (CFI = .96, TLI = .95, RMSEA = .041, SRMR = .044). The combined measurement model, which integrated both latent constructs simultaneously, also produced satisfactory goodness-of-fit values. These findings confirmed that the latent constructs were adequately represented by their respective observed indicators and supported proceeding to the structural model.

After confirming the adequacy of the measurement models, the hypothesized structural model examining the direct effect of intolerance of uncertainty on anxiety sensitivity was tested using maximum likelihood estimation. Table 3 summarizes the standardized regression weights and significance levels for the structural paths.

Table 3

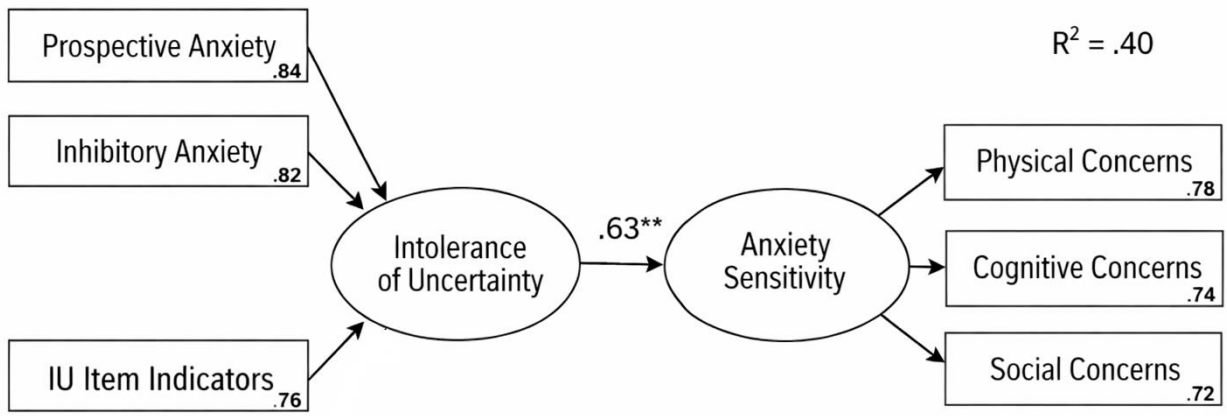
Standardized Path Coefficients for the Structural Model

Structural Path	Standardized β	S.E.	C.R.	p
Intolerance of Uncertainty → Anxiety Sensitivity	.63	.07	8.94	< .001

The structural model demonstrated good overall fit (χ^2 = 1002.15, df = 518, χ^2/df = 1.93, CFI = .95, TLI = .94, RMSEA = .046, SRMR = .052). As shown in Table 3, intolerance of uncertainty had a statistically significant and positive direct effect on anxiety sensitivity (β = .63, p < .001). The critical ratio value of 8.94 exceeded the threshold of 1.96, confirming statistical significance at the .05 level. The squared multiple correlation (R^2) indicated that intolerance of uncertainty explained 40 percent of the variance in anxiety sensitivity. This effect size can be interpreted as substantial, suggesting that adolescents who experience greater distress in uncertain situations are significantly more likely to exhibit heightened sensitivity to anxiety-related sensations.

Figure 1

Structural Model of Intolerance of Uncertainty Predicting Anxiety Sensitivity in Early Adolescence



The structural model illustrated in Figure 1 demonstrates a strong positive pathway from the latent construct of intolerance of uncertainty to the latent construct of anxiety sensitivity. All factor loadings for observed indicators were statistically significant and ranged from .62 to .84, indicating adequate representation of the latent variables. The model accounted for a meaningful proportion of variance in anxiety sensitivity, supporting the theoretical proposition that cognitive-emotional responses to uncertainty function as a central vulnerability factor in the development of anxiety-related sensitivity during early adolescence. Overall, the findings provide robust empirical evidence for the hypothesized structural relationship and confirm the

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adequacy of the proposed model within the Turkish early adolescent sample.

4. Discussion

The present study aimed to examine the structural relationship between intolerance of uncertainty and anxiety sensitivity in early adolescence using structural equation modeling. The findings revealed that intolerance of uncertainty significantly and positively predicted anxiety sensitivity, explaining a substantial proportion of variance in adolescents' fear of anxiety-related sensations. The structural path coefficient indicated a strong direct effect, suggesting that adolescents who experience greater distress in response to uncertainty are more likely to interpret physiological and cognitive arousal symptoms as threatening. This result provides empirical support for conceptual models that position intolerance of uncertainty as a foundational cognitive vulnerability underlying broader anxiety processes.

The strong predictive association identified in the present study aligns with recent longitudinal findings demonstrating reciprocal relationships between intolerance of uncertainty and generalized anxiety symptoms in adolescents (Ye et al., 2025). Although prior work has emphasized bidirectionality, our structural model specifically highlights intolerance of uncertainty as an antecedent factor in shaping anxiety sensitivity. This directional pathway is theoretically coherent with cognitive models of generalized anxiety disorder, which propose that intolerance of uncertainty fosters anticipatory worry and heightened threat appraisal (Shipp et al., 2024, 2025). Chronic anticipatory worry may sensitize adolescents to internal bodily cues, thereby increasing anxiety sensitivity over time.

The observed relationship is further supported by neurocognitive evidence indicating that intolerance of uncertainty is associated with altered anterior insula connectivity in youth (DeSerisy et al., 2020). The anterior insula plays a central role in interoceptive awareness and the integration of bodily sensations with emotional meaning. When adolescents experience high intolerance of uncertainty, ambiguity may activate neural systems involved in threat detection, increasing vigilance toward physiological arousal. This heightened interoceptive monitoring may contribute to the development of anxiety sensitivity, characterized by catastrophic interpretations of somatic sensations. Therefore, the present findings not only align with behavioral research but also resonate with emerging neurodevelopmental models.

The significant association also converges with research demonstrating that intolerance of uncertainty predicts suicidal ideation through maladaptive cognitive emotion regulation strategies and psychache (Wu et al., 2025). Although the present study focused specifically on anxiety sensitivity, the broader literature suggests that intolerance of uncertainty operates as a transdiagnostic vulnerability factor across internalizing domains. Network analytic research among adolescents further identifies intolerance of uncertainty as a central node within depression and anxiety symptom networks (Jing et al., 2023). These findings underscore its structural centrality and provide context for understanding its predictive strength in our model.

Consistent with cross-cultural research, the present findings extend evidence from Turkish adolescent samples indicating that intolerance of uncertainty is associated with obsessive-compulsive and depressive symptoms (Şimşek, 2023). Psychometric validation studies confirm the reliability and cultural relevance of measuring intolerance of uncertainty in Turkish youth populations (Bottesi et al., 2022; Türk & Hamamcı, 2025). The replication of strong structural associations in our Turkish sample supports the cross-cultural generalizability of the intolerance of uncertainty–anxiety sensitivity pathway and suggests that this cognitive vulnerability may operate similarly across sociocultural contexts.

Moreover, our findings are congruent with research linking intolerance of uncertainty to cyberchondria and problematic online health information seeking among adolescents (Bahadir & Dündar, 2024; Jungmann & Dessauer, 2024). In such contexts, adolescents may attempt to reduce uncertainty by seeking excessive reassurance, yet the process paradoxically heightens anxiety. Anxiety sensitivity may amplify this cycle by intensifying concern over perceived bodily symptoms encountered during online searches. Thus, intolerance of uncertainty and anxiety sensitivity may interact in maintaining maladaptive reassurance-seeking behaviors.

The magnitude of the structural path observed in the present study is also theoretically consistent with research demonstrating that intolerance of uncertainty mediates the relationship between childhood adversity and adolescent anxiety (Viteri & Mokoena, 2025). Adolescents exposed to unpredictable environments may develop heightened intolerance of ambiguity, which subsequently predisposes them to anxiety-related vulnerabilities. Longitudinal

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evidence linking environmental unpredictability with problematic mobile phone use through intolerance of uncertainty further emphasizes its developmental salience (Xie, 2025). These developmental findings suggest that early adolescence represents a critical window during which intolerance of uncertainty shapes subsequent emotional processing patterns.

In addition, the current results align with findings indicating that intolerance of uncertainty interacts with cognitive flexibility and psychological flexibility in predicting adolescent well-being (Genç, 2024; Okayama et al., 2023). Reduced flexibility may exacerbate rigid interpretations of ambiguous situations, increasing anticipatory anxiety and somatic vigilance. Anxiety sensitivity, in this context, may represent the experiential manifestation of such cognitive rigidity. Therefore, intolerance of uncertainty may function as an upstream cognitive rigidity factor, while anxiety sensitivity reflects downstream experiential amplification.

The present findings also resonate with broader transdiagnostic prevention research. Internet-based interventions targeting uncertainty-related cognitions have shown promising effects in reducing emotional distress among adolescents (Hirsig et al., 2024a, 2024b). Telehealth cognitive-behavioral programs focusing on transdiagnostic risk factors demonstrate reductions in emotional distress symptoms (Flynt et al., 2025). Even brief online interventions have produced measurable reductions in intolerance of uncertainty and improvements in mental health (Daniels, 2025). The strong predictive relationship observed in our model underscores the potential clinical utility of targeting intolerance of uncertainty to indirectly reduce anxiety sensitivity in early adolescence.

Furthermore, our findings are consistent with research on health anxiety and physiological reactivity in adolescents with chronic medical conditions (Llewelyn-Williams et al., 2022). Adolescents who fear ambiguous bodily sensations may be particularly vulnerable to anxiety sensitivity when intolerance of uncertainty is elevated. Similar mechanisms have been observed in autistic adolescents, where pathways to anxiety and depression involve heightened uncertainty and sensory reactivity (MacLennan et al., 2021; Richdale et al., 2023). The convergence of these findings across clinical and nonclinical populations strengthens the robustness of the structural association identified in this study.

The contextual nature of intolerance of uncertainty during early adolescence also deserves attention. Research suggests that adolescents experience uncertainty differently across social and academic contexts (Panarello & Bukowski, 2021). Pandemic-related disruptions further intensified uncertainty-related distress, influencing emotional symptoms (Dorčić et al., 2023; Li et al., 2021; Sandín et al., 2021). Studies examining measurement invariance before and after major stressors confirm the stability of internalizing constructs across contexts (Olino et al., 2021). The structural relationship observed in our study appears robust within a post-pandemic adolescent cohort, suggesting that intolerance of uncertainty remains a salient vulnerability factor even outside acute crisis periods.

Additionally, research on social anxiety and self-injury identifies intolerance of uncertainty as a mediator between interpersonal anxiety and maladaptive coping behaviors (Yao et al., 2023). Anxiety sensitivity may amplify social threat perceptions, especially when adolescents fear visible signs of anxiety. Similarly, adult research linking anxiety and pathological demand avoidance highlights the enduring relevance of uncertainty-related cognitive processes (Johnson & Saunderson, 2023). These findings collectively support integrative models positioning intolerance of uncertainty and anxiety sensitivity within a shared vulnerability hierarchy.

5. Conclusion

Finally, broader developmental frameworks linking behavioral inhibition and attachment patterns with generalized anxiety vulnerability provide theoretical grounding for the present findings (Zdebik et al., 2022). Adolescents with early temperamental sensitivity may develop heightened intolerance of uncertainty, which subsequently fosters anxiety sensitivity through repeated threat-based learning experiences. Cross-national findings confirming consistent associations between intolerance of uncertainty and emotional distress further reinforce its universal relevance (Goyal & Sharma, 2022; Malerba et al., 2022). Thus, the present structural model contributes to an expanding body of literature demonstrating that intolerance of uncertainty functions as a core cognitive risk factor that shapes anxiety-related sensitivity in early adolescence.

6. Limitations & Suggestions

Despite its contributions, this study has several limitations. First, the cross-sectional design precludes definitive causal conclusions regarding the directional relationship between intolerance of uncertainty and anxiety sensitivity. Although structural modeling allows

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examination of predictive pathways, longitudinal data would be necessary to confirm temporal precedence. Second, reliance on self-report measures may introduce shared method variance and potential response biases. Adolescents' subjective perceptions may not fully capture physiological aspects of anxiety sensitivity. Third, the sample was drawn from public middle schools within a specific cultural context, which may limit generalizability to other regions or socioeconomic groups. Finally, potential moderating variables such as gender, temperament, or family functioning were not included in the structural model and may influence the strength of the observed relationship.

Future studies should employ longitudinal designs to examine developmental trajectories linking intolerance of uncertainty and anxiety sensitivity across adolescence. Cross-lagged panel modeling could clarify reciprocal influences over time. Incorporating multi-informant data and physiological measures of interoceptive sensitivity may strengthen construct validity. Researchers should also examine potential mediators such as cognitive avoidance, emotion regulation strategies, and psychological flexibility. Investigating moderating factors—including gender differences, socioeconomic stress, and digital media exposure—may provide a more nuanced understanding of the pathway. Cross-cultural comparative studies would further illuminate the universality versus contextual specificity of the intolerance of uncertainty–anxiety sensitivity relationship.

The findings suggest that early preventive interventions targeting intolerance of uncertainty may reduce downstream anxiety sensitivity and related distress. School-based psychoeducational programs could incorporate cognitive restructuring techniques aimed at increasing tolerance for ambiguity. Teaching adolescents skills to reinterpret physiological sensations in non-catastrophic ways may further mitigate anxiety sensitivity. Digital and telehealth interventions may offer accessible platforms for delivering such programs. Mental health professionals working with early adolescents should assess intolerance of uncertainty as a potential upstream risk factor and integrate transdiagnostic approaches to foster resilience against anxiety-related vulnerabilities.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

All authors equally contributed to this article.

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