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Gender and Age Differences in Behaviours Related to Mathematics Anxiety Across Six Asian Countries

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Abstract

Mathematics anxiety has become a growing concern, impacting not only academic performance but also daily life. This study investigates mathematical anxiety across genders and age groups in Asia using the five-dimensional Anxiety Towards Mathematics Scale. A total of 2,831 responses were collected from six countries: Pakistan (38.3 %), Iran (10.8 %), Thailand (5.5 %), India (16.1 %), Malaysia (18.1 %), and the United Arab Emirates (11.2 %). Most participants (61.8 %) were between 16 and 20 years old, with females representing 58.7 % of the sample and males 41.2%. A confirmatory factor analysis (CFA) validated the five-factor structure of mathematical anxiety, encompassing anxiety towards evaluation, temporality, understanding mathematical problems, numbers and operations, and real-life mathematical situations. The model demonstrated excellent fit (χ^2 (242, N = 2,829) = 1,887.08, $p < .001$; CFI = 0.99; TLI = 0.99; RMSEA = 0.049; SRMR = 0.11). Significant gender differences were observed, with females experiencing higher anxiety in daily mathematical situations, while males showed greater anxiety towards numbers and operations. Age differences were also notable, particularly in anxiety related to temporality, where participants aged 16-20 exhibited lower anxiety compared to those aged 21-23. These findings emphasise the diverse impacts of mathematical anxiety across demographic groups, suggesting that tailored strategies are crucial to addressing the specific needs of different populations. We recommend that educational institutions and policymakers develop targeted interventions to address gender- and age-specific challenges.

Keywords: Asia, Age Variation, Gender Differences, Mathematics Anxiety, Mathematics.

1. Introduction

Learning and achievements in mathematics are affected by several factors. Occasionally, people with specific mathematical learning disabilities face cognitive barriers (Dowker et al., 2016). Still, for many others, the primary obstacle is mathematics anxiety, a debilitating emotional response characterised by fear, tension, and avoidance of numerical tasks (Ramirez et al., 2018; Sokolowski et al., 2019). Globally, mathematics anxiety has been identified as a critical barrier to mathematical achievement worldwide. Research indicates that approximately 14 % of the variance in mathematical performance can be attributed to Mathematics Anxiety, with highly anxious individuals underperforming relative to their actual abilities (Van Mier et al., 2019; Vos et al., 2023). Beyond academic settings, mathematics anxiety influences career choices, working memory efficiency, and even everyday activities like financial decision-making (Ashcraft, Krause, 2007; Maloney, Beilock, 2012). Despite its pervasive impact, mathematics anxiety manifests differently across gender and age groups, with studies consistently reporting higher anxiety levels among females (Else-Quest et al., 2010; Xie et al., 2024) and peak intensity during adolescence (Ashcraft, Moore, 2009; Hill et al., 2016). However, much of this evidence derives from Western contexts, leaving a gap in understanding how cultural and educational systems in Asia shape mathematics anxiety-related behaviours.

Mathematics Anxiety is not merely a dislike of mathematics but a physiological and cognitive stress response that impairs performance (Ukwujie, Eteng-Uket, 2024; Ali et al., 2019). Neuroimaging studies reveal that Mathematics Anxiety triggers hyperactivity in brain regions associated with fear (e.g., the amygdala) while suppressing areas responsible for numerical reasoning (Ashcraft et al., 2007; Young et al., 2012). This disruption exacerbates avoidance behaviours, creating a vicious cycle: anxious students disengage from mathematics, reducing competency and perpetuating anxiety (Abraham et al., 2017; Mutodi, Ngirande, 2014; Wang et al., 2020). Cross-sectional data suggest that mathematics anxiety emerges as early as age 6–7 (Aarnos, Perkkilä, 2012) and escalates with curricular complexity, peaking in secondary school (Si et al., 2016; Van Mier et al., 2019). Notably, mathematics anxiety's effects are not uniform; gender differences in anxiety levels, though absent in early childhood, become pronounced by adolescence, with girls reporting 0.3 standard deviations higher Mathematics Anxiety than boys (Ashcraft, Moore, 2009; Bakker et al., 2019).

Globally, females exhibit higher mathematics anxiety than males, a gap magnified by societal stereotypes framing mathematics as a "male domain" (Dowker et al., 2016; Vos et al., 2023). For instance, girls as young as second grade show stronger negative correlations between mathematics anxiety and performance (Van Mier et al., 2019), while boys often face heightened anxiety in numerical tasks (Baloglu, Koçak, 2006). Age further moderates these trends; gender

differences in mathematics anxiety are negligible in elementary school but widen significantly in middle school (Xie et al., 2024). Cultural factors may explain discrepancies. In Confucian-influenced systems, parental pressure on males to excel in Science, Technology, Engineering, and Mathematics (STEM) fields may increase their anxiety (Ashcraft, Krause, 2007). In contrast, in other Asian contexts, gendered pedagogical practices may disproportionately affect females (Sarfo et al., 2020).

Despite the global relevance of mathematics anxiety, Asian populations remain underrepresented in the literature (Morsanyi et al., 2016). Existing studies often rely on single-country samples, which can obscure regional variations in educational practices (e.g., rote learning vs. conceptual emphasis) and societal attitudes (Wang et al., 2020; Castelvecchi, 2020). For example, while Chinese students outperform Western peers in computational tasks (Imbo, LeFevre, 2009), their mathematics anxiety profiles remain understudied (Xie et al., 2024). Similarly, the interplay between mathematics anxiety-related behaviours (e.g., procrastination, help-seeking) and cultural norms – such as collectivist values that discourage academic help-seeking – is poorly understood (Ali et al., 2019). This study addresses these gaps by examining gender and age differences in mathematics anxiety-related behaviours across six Asian countries. By comparing avoidance patterns, coping strategies, and performance outcomes, we aim to disentangle universal mechanisms of Mathematics Anxiety from culturally specific manifestations. Our findings will inform the development of tailored interventions to mitigate the impact of mathematics anxiety in diverse educational settings.

2. Method

Participants

A total of 2,831 responses were collected from Asian countries, with 38.3 % from Pakistan, 10.8 % from Iran, 5.5 % from Thailand, 16. 1% from India, 18.1 % from Malaysia, and 11.2 % from the United Arab Emirates. Regarding the age of the participants, 0.01% reported being between 12 and 15 years old, 61.8 % between 16 and 20 years old, 37.9 % between 12 and 23 years old, and 0.2 % between 24 and 20 years old. The distribution was 58.7 % Female and 41.2% Male. See Table 1 for details.

Table 1. Sample descriptions of data from the mathematics anxiety survey (n = 2,831)

Country	Region collected	Gender (n)		Mean age (SD)
		Male	Female	
India	Puducherry	47	203	20.39 (1.70)
	Uttar Pradesh	76	131	19.41 (2.47)
Iran	Qom	75	80	19.09 (2.27)
	Tehran	79	71	19.04 (2.31)
Malaysia	Online	279	231	19.97 (2.15)
Pakistan	Faisalabad	40	116	20.60 (1.42)
	Lahore	148	183	20.00 (1.88)
	Rawalpindi	83	121	20.03 (1.40)
	Sargodha	168	226	19.77 (1.54)
Thailand	Bangkok	82	73	20.63 (1.77)
United Arab Emirates	Online	89	228	19.94 (1.70)

Instruments

An online questionnaire was published, containing sociodemographic questions such as age, gender, and location of residence. Furthermore, the questionnaire contained the following measures:

Anxiety Towards Mathematics Scale (Muñoz, Mato-Vazquez, 2007): This instrument consists of 24 items regarding people's anxiety towards Mathematics. The items portrayed aspects such as anxiety towards evaluation (11 items), anxiety towards temporality (4 items), anxiety towards understanding mathematical problems (3 items), anxiety towards numbers and mathematical operations (3 items), and anxiety towards mathematical situations in daily life (3 items). Each item was rated on a five-point scale, ranging from "Strongly Disagree" to "Strongly

Agree." Several studies, including García-Santillán et al. (2018) and Sarfo et al. (2020), have reported a high reliability for this scale, with a Cronbach's alpha of 0.97. Consistently, our findings also showed strong internal consistency, with Cronbach's alpha values exceeding 0.90 across all sites.

Data Collection Procedure

We obtained the ethical approval for the project from the Institutional Review Board of the International Network Center for Applied Research (INCFAR-IRB/009/01-2020). Collaborators who required additional local or institutional ethical clearance were permitted to obtain it independently. Furthermore, they were allowed to translate the study protocol and instruments into their respective national or native languages when necessary. Also, participating sites were expected to recruit at least 150 community-based participants from their local populations. In three other countries – Malaysia, Egypt, and the United Arab Emirates – this requirement was relaxed due to the use of online data collection methods.

Data analysis

First, we conducted a confirmatory factor analysis for the five-factor model proposed by Muños and Mato-Vázquez (2007) using R software (R Core Team, 2019) and the lavaan package (Rossel, 2012) with the WLSMV estimator. The goodness of fit of the model was assessed using the following combination of fit statistics: chi-squared (χ^2), Tucker-Lewis Index (TLI), comparative fit index (CFI), root mean square error of approximation (RMSEA), and the standardised root mean square residual (SRMR). In line with Brown's (2015) recommendations, the cut-off values for CFI and TLI are close to 0.90, 0.08 for RMSEA, and 0.08 for SRMR, indicating a good fit for any given model.

Then, means and standard deviations were calculated to perform an independent t-test comparing males and females regarding mathematical anxiety. Furthermore, we conducted a one-way between-subjects ANOVA to test differences between age categories.

3. Results

The goodness-of-fit statistics for the confirmatory factor analysis were as follows: $\chi^2(242, N = 2{,}829) = 1{,}887.08$, $p < .001$; CFI = 0.99; TLI = 0.99; RMSEA = 0.049 (90 % CI [0.047, 0.051]); SRMR = 0.11. A path diagram of the confirmatory factor analysis can be seen in Figure 1.

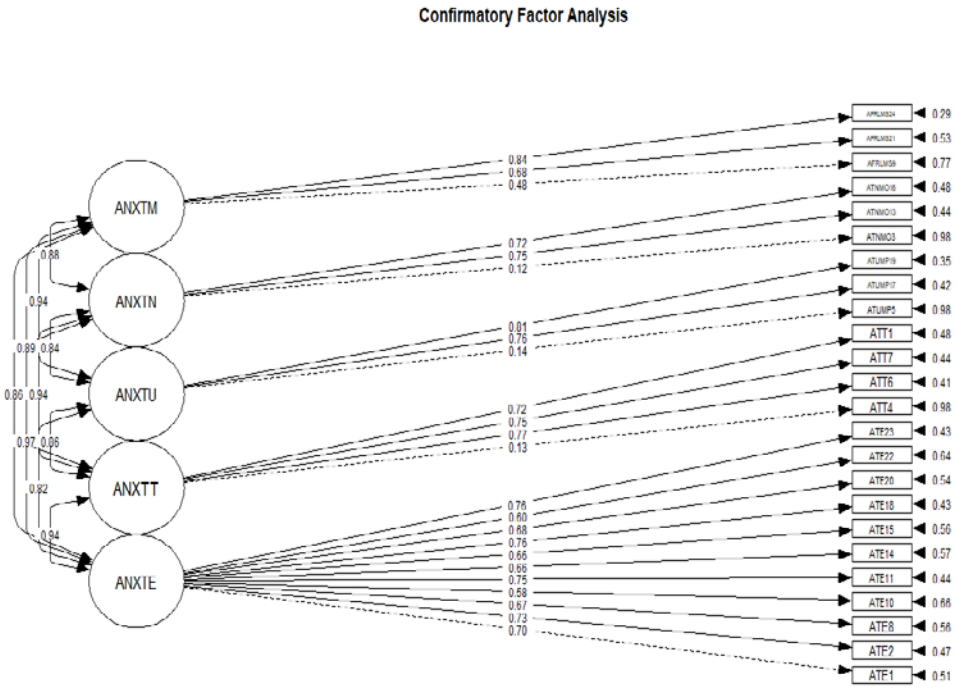

Fig. 1. Path diagram of the Confirmatory Factor Analysis of the Mathematical Anxiety Scale
Notes: ATE = anxiety towards evaluation; ATT = Anxiety towards temporality; ATUMP = Anxiety towards the understanding of mathematical problems; ATNMO = Anxiety towards numbers and mathematical operations; AFRLMS = Anxiety towards mathematical situations in daily life.

An independent-sample t-test was conducted to compare mathematics anxiety factors in males and females. There was a significant difference in the scores of males in anxiety towards numbers and mathematical operations, and anxiety towards mathematical situations in daily life, compared to females (Table 2). Females had higher scores in anxiety towards mathematical situations in daily life, and males had higher scores in anxiety towards numbers and mathematical operations.

Table 2. Independent t-test between males and females for mathematical anxiety factors

Categories of Mathematics Anxiety	Sex	N	Mean	SD	t-test
Anxiety towards evaluation	Males	1,167	3.15	0.90	t(2,579.11) = 0.31, p = 0.76
	Females	1,662	3.14	0.94	
Anxiety towards temporality	Males	1,143	3.15	1.08	t(2,786) = 0.70, p = 0.48
	Females	1,645	3.12	1.06	
Anxiety towards the understanding of mathematical problems	Males	1,143	2.88	1.06	t(2,786) = 1.19, p = 0.23
	Females	1,645	2.83	1.08	
Anxiety towards numbers and mathematical operations	Males	1,143	3.02	1.01	t(2,786) = -2.54, p = .01, d = 0.10, Hedge's g = 0.10
	Females	1,645	3.12	1.03	
Anxiety towards mathematical situations in daily life	Males	1,167	2.85	0.99	t(2,827) = 2.35, p = .02, d = 0.09, Hedge's g = 0.09
	Females	1,662	2.76	1.00	

A one-way between-subjects ANOVA was conducted to compare mathematical anxiety factors in age categories. There was a significant difference of anxiety towards temporality for the three conditions [F(2, 2,786) = 3.13, p < 0.05], but no significant differences in: anxiety towards evaluation [F(2, 2,827) = 0.15, p = 0.86]; anxiety towards the understanding of mathematical problems [F(2, 2,786) = 1.36, p = 0.26]; anxiety towards numbers and mathematical operations [F(2, 2,786) = 0.50, p = 0.61]and anxiety towards mathematical situations in daily life [F(2, 2,827) = 0.81, p = 0.45]. Post hoc analyses (Table 3) using the Bonferroni post hoc criterion for significance indicated that people with 16-20 years (M = 3.10 and SD = 1.08) presented lower levels of anxiety towards temporality than those with 21-23 years (M = 3.20 *and* SD = 1.05, p < 0.05).

Table 3. Post-Hoc analysis of differences between age categories using Bonferroni correction for mathematical anxiety towards temporality

Age Categories		16-20	21-23	24-30
16-20	Mean difference	-	-0.10*	0.21
	p-value	-	< .05	1
21-23	Mean difference		-	0.31
	p-value		-	1
24-30	Mean difference			-
	p-value			-

4. Discussion

This study examined gender and age differences in mathematics anxiety across six Asian countries (India, Iran, Malaysia, Pakistan, Thailand and the United Arab Emirates), contributing to the growing body of cross-cultural research on mathematics anxiety. Our findings reveal patterns in the expression of mathematics anxiety, reinforcing some established trends while challenging others. Consistent with global meta-analyses (Else-Quest et al., 2010; Xie et al., 2024), our results indicate that females reported significantly higher levels of anxiety towards mathematical situations in daily life than males. This result aligns with studies suggesting that societal stereotypes framing mathematics as a "male domain" exacerbate anxiety in girls (Dowker et al., 2016; Vos et al., 2023). However, we observed an unexpected reversal in anxiety towards numbers and mathematical operations, where males scored higher. This finding contrasts with Western findings but mirrors regional studies in Iran and India, where boys face heightened pressure to excel in STEM, potentially increasing task-specific anxiety (Ashcraft, Krause, 2007; Abraham et al., 2017).

Notably, gender differences were absent in anxiety towards evaluation, temporality, and problem understanding, diverging from prior work (Rodríguez et al., 2020). These results suggest that specific dimensions of mathematics anxiety may be more culturally invariant, while others (e.g., numerical operations) are sensitive to contextual factors, such as pedagogical practices or parental expectations (Baloglu, Koçak, 2006). For instance, in Iran, where female participants exhibited lower anxiety towards numbers and mathematical operations than males, the legacy of mathematician Maryam Mirzakhani's success may have mitigated girls' anxiety (Castelvecchi, 2020). Our ANOVA results revealed that anxiety towards temporality varied significantly by age, with the 16–20 age group reporting lower levels than the 21–23 cohort. These findings support developmental theories positing that mathematics anxiety escalates with curricular complexity (Si et al., 2016; Van Mier et al., 2019). However, the lack of age differences in other mathematics anxiety dimensions (e.g., evaluation, daily-life anxiety) contrasts with studies highlighting adolescence as a peak period for mathematics anxiety (Ashcraft, Moore, 2009). One explanation is that older students in our sample (mostly undergraduates) may have developed coping strategies, whereas younger participants (ages 12–15) were underrepresented. Future research should prioritise broader age sampling to clarify these trends.

The absence of gender gaps in evaluation anxiety across all countries challenges the universality of "stereotype threat" effects (Sokolowski et al., 2019). For example, in Malaysia and the United Arab Emirates, where math instruction often emphasises collaborative learning, evaluation anxiety may be mitigated for both genders (Ali, Hassan, 2019). Conversely, in Pakistan and India, where rote memorisation is prevalent (Mutodi, Ngirande, 2014), males' higher anxiety towards numbers and mathematical operations scores may reflect frustration with abstract problem-solving. While our CFA confirmed the robustness of the mathematics anxiety scale, the SRMR value (0.11) suggests room for refinement in measuring cross-cultural equivalence. Additionally, the uneven sample distribution (e.g., 38.3 % from Pakistan) limits the generalisability of the findings. Future studies should employ stratified sampling and qualitative methods to explore how teacher-student interactions or parental attitudes mediate mathematics anxiety (Dowker et al., 2016). This study highlights that mathematics anxiety is not a monolithic construct, but rather a mosaic of culturally and developmentally shaped anxieties. By identifying context-specific patterns across Asia, we move closer to developing equitable, evidence-based strategies for reducing the global burden of mathematics anxiety.

5. Conclusion

This study highlights significant variations in mathematics anxiety across gender and age groups. Females reported higher anxiety in everyday mathematical contexts, while males showed greater anxiety towards numbers and operations. Age differences also emerged, with younger participants experiencing lower anxiety related to temporality compared to older peers. These findings have important practical implications. Educators should consider gender- and age-specific patterns of mathematics anxiety when designing classroom strategies and support systems. Tailored interventions, such as differentiated instruction, peer mentoring, or targeted anxiety-reduction programs, could enhance students' confidence and performance in mathematics.

From a policy perspective, these insights call for integrating emotional and psychological well-being into national mathematics curricula. Policies that promote teacher training in emotional

intelligence and mental health literacy could foster more inclusive and responsive learning environments for mathematics. Additionally, future research should investigate the underlying causes of gendered and age-related experiences of mathematics anxiety across diverse cultural contexts in Asia. Longitudinal and qualitative studies could provide deeper insights into how mathematics anxiety develops and changes over time, guiding more effective, evidence-based educational practices and interventions.

6. Strengths and Limitations

This study offers valuable contributions to the literature on mathematics anxiety by examining gender and age-related differences across six Asian countries. Notably, it is among the few recent cross-national investigations to explore mathematics anxiety within this region. The findings reveal significant gender differences – females reported higher anxiety in daily mathematical situations, whereas males showed greater anxiety related to numbers and operations. Age-related patterns were also observed, particularly regarding anxiety about temporality. These insights enhance our understanding of the complex ways in which mathematics anxiety manifests across demographic groups and cultural contexts.

Despite these strengths, the study has some limitations. The use of small, exploratory community samples limits the generalisability of the findings to the broader national populations. Additionally, online data collection in countries such as Malaysia and the United Arab Emirates may have introduced selection bias by excluding individuals without reliable internet access, potentially underrepresenting specific student demographics. Therefore, while the results provide a meaningful cross-cultural perspective, they should be interpreted with caution.

7. Declaration

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of the International Network Center for Applied Research (INCFAR-IRB/009/01-2020).

Consent for publication

All authors have reviewed and approved the final version of the manuscript for publication.

Informed consent statement

Informed consent was obtained from all subjects involved in the study. For participants under 18 years of age, informed consent was obtained from their legal guardians/parents.

Conflicts of interest

The authors declare no conflicts of interest.

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Authors' contributions

All authors (JOS, AG-S, HR, VSM, MD, OS, PSD, SZ, FZ, RZ, SM, FA, NIM, HW, FOE, AT, JCS, JUA, MSH, MH, ZV, RVSB, TAA, and DKA) contributed to the conceptualisation, methodology, data collection, writing – original draft preparation, and review management and editing. The quantitative analysis was overseen by JOS, AG-S and RVSB, and the manuscript preparation was supervised by JOS. All authors have read and agreed to the published version of the manuscript.

Data availability statement

The data presented in this study are available on reasonable request from the corresponding author.

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