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Who's Afraid of the Big Bad Math? Structure and Correlates of Math Anxiety in Preschool Children[1]

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Math anxiety (MA) is a phenomenon that has garnered the attention of researchers and practitioners due to its negative effects on various educational outcomes in

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math learning and the motivation for learning math. However, previous research has predominantly focused on primary and secondary school students, while preschool-aged children have been largely overlooked. This gap is particularly relevant in the Serbian context, where early childhood education is undergoing continuous reforms and where mathematics readiness is increasingly recognized as a key predictor of later academic success. Therefore, this research aims to examine the structure and correlates of MA in preschool children from Serbia. Study 1, involving 258 children aged 4 to 6 (50% boys), investigated the nature and structure of the Young Children Math Anxiety Scale (YCMAX). Study 2, conducted with 205 children aged 4 to 6 (48.8% boys), investigated the relationships between MA aspects (Worry and Somatization), gender, age, and children's readiness for learning math. This was done by applying the correlation analysis with the Mathematics School Readiness Test, designed to assess (pre)math skills in preschool-aged children. The CFA results indicate that the Young Children Math Anxiety Scale is an adequate instrument for measuring this type of anxiety and that, even at this age, negative relationships between MA and various (pre)math skills can be identified. The study discusses the potential benefits of using this scale by practitioners in preschool institutions and the specificities of the relationships between MA and various math abilities and children's age in the preschool (non)evaluative contexts.

Keywords: math anxiety, preschool age, math readiness, worry, somatization

Introduction

Math anxiety (MA) is a globally prevalent issue that affects people of all ages across the world (Foley et al., 2017; Luttenberger et al., 2018). Previous meta-analyses have shown that the relation between MA and math achievement emerges in childhood and remains significant into adulthood (Barroso et al., 2021; Zhang et al., 2019). The effects of MA extend far beyond performance in math-related tasks. It can significantly impact learning efficiency and shape the decisions about educational pathways and career choices, leaving lasting marks on the individual's academic and professional life (Luttenberger et al., 2018). Studies point to global negative relations between MA and motivation (Wang et al., 2015; Wang et al., 2018), self-esteem (Xie et al., 2019), and self-confidence (Irhamna et al., 2020).

While a significant number of studies has investigated the relationship between MA and math performance in adolescents and adults (e.g., Hill et al., 2016; Milovanović & Kodžopeljić, 2018; Wigfield & Meece, 1988), there is a limited focus on this relationship in preschool-aged children (Ganley & McGraw, 2016; Radević & Milovanović, 2024). Math learning readiness (MLR), or the ability to engage with foundational math concepts, is critical in preparing preschool-aged children for formal schooling (Betts et al., 2020). Math readiness deficits appear before children enter school, often affected by home environments lacking sufficient math enrichment (Mejias et al., 2019). Emerging evidence suggests that MA may compromise math readiness by impacting children's engagement with early math tasks (DePascale et al., 2023).

These findings underscore the importance of identifying and addressing math readiness and early MA to ensure that children are adequately prepared for math learning.

Math anxiety: Conceptualization, developmental patterns, and measurement

Wigfield and Meece (1988) defined math anxiety as the tension that interferes with number manipulation and successful solving of math tasks across various academic and everyday situations. The definitions of MA typically emphasize two core components: negative emotional responses and their disruptive effects on performance during the tasks requiring math skills, whether in academic or everyday contexts (dos Santos Carmo et al., 2019). MA encompasses multiple dimensions that interfere with individual's math performance. The cognitive component involves negative and ruminating thoughts about one's ability to succeed in math, while the affective dimension refers to emotional distress, including fear, dread, or unease when engaging with math (Wigfield & Meece, 1988). MA also manifests behaviourally, with individuals avoiding math-related activities, through skipping classes or avoiding math-intensive subjects. Finally, somatic symptoms include physiological responses like sweating, increased heart rate, or stomach discomfort when faced with math tasks (Finlayson, 2014). Together, these dimensions highlight the complex nature of MA and its impact on math performance. Research on MA in preschool-aged children indicates that it is most often observed through physiological and cognitive symptoms, as these aspects are easier to capture in research, while emotional manifestations may still be present but remain less accessible due to young children's limited ability to articulate complex feelings (Ganley & McGraw, 2016; Harari et al., 2013). For preschool children, cognitive symptoms often manifest as worry or negative beliefs about math tasks, while physiological signs include inner tension, transpiration, sweating, stomach aches, and higher muscle tonicity (Geist, 2015).

MA in adults varies, but studies suggest it affects a substantial portion of the population. Around 20% of adults report experiencing significant levels of MA, which can impact daily tasks such as managing finances or making decisions that require numerical reasoning (Barroso et al., 2021). Studies indicate that the highest prevalence of MA occurs among high school students. In a meta-analysis, the prevalence of MA among upper secondary education students in Europe ranged from 16% to 37%, depending on the measurement tool used (Zhang et al., 2019). Another study found that 33% of secondary school students stated that they felt incapable when attempting to solve math tasks (Hart & Ganley, 2019). Research indicates that between 10% and 20% of children in primary schools exhibit MA, although this prevalence can vary depending on the region and age group (Devine et al., 2018; George

& Mitchell, 2022; Rossi et al., 2022). Large-scale international assessments such as PISA and TIMSS consistently demonstrate that MA is a widespread phenomenon among adolescents. The analyses of earlier PISA cycles showed that a substantial proportion of 15-year-old students across 65 countries reported feelings of tension, worry, or helplessness when confronted with mathematics tasks (OECD, 2013; Balt et al., 2022). Recent PISA 2022 data show that about 30% of 15-year-old students in 65 countries report high levels of mathematics anxiety (OECD, 2023). Although TIMSS does not specifically measure MA, its affective indicators reveal clear developmental patterns (Ina et al., 2019): in the 2019 cycle, 41% of eighth-grade students (compared to 20% of fourth-graders) reported disliking mathematics, while 44% of eighth-graders (vs. 23% of fourth-graders) expressed low confidence in their mathematical abilities. However, younger children, in preschool and early primary school, tend to report lower levels of MA compared to older children, possibly due to their limited exposure to formal math assessments and the related stressors (e.g., Milovanović, 2021). Previous research findings indicate the presence of MA in children aged four to six (Petronzi et al., 2019), six to seven (Harari et al., 2013), as well as in late childhood (Sorvo et al., 2017). Moreover, the longitudinal study revealed that most young children exhibited low levels of MA during preschool (Szczygieł & Pieronkiewicz, 2022). In this study, about 22–36% of the children experienced moderate levels of MA, while high MA was exceptionally rare, identified in only 0–3% of participants. Identifying MA in preschool-aged children is particularly important, as it is just beginning to emerge at that age, allowing for timely intervention and prevention of its progression in later stages of education.

MA tends to be more prevalent in females than males across various age groups and contexts. Studies have consistently shown that women report higher levels of MA than men, a trend observed in primary school children, secondary school adolescents, and adults (Caviola et al., 2017; Milovanović & Branovački, 2021; Sadiković et al., 2018; Xie et al., 2019). However, relatively few studies have focused on gender differences in MA at the preschool age. Studies suggest little to no gender difference in MA among younger children. For instance, early research has shown that boys and girls exhibit similar levels of anxiety in the early grades, as societal expectations and pressures are not as pronounced during these developmental stages (Van Mier et al., 2019). Gender differences become the most apparent during secondary school, with girls consistently reporting higher levels of MA than boys (Hill et al., 2016). This trend aligns with the period when social and academic pressures intensify, and stereotypes about gender and math ability may have a greater impact. During this time, girls' MA levels are significantly higher, which has been linked to their decreased confidence and engagement with math. In later years, the gender gap in MA tends to narrow. While women may still report slightly higher levels of anxiety, these differences are less pronounced compared to adolescents (Cipora et al., 2015). This reduction is attributed to greater autonomy in course selection, increased confidence, and reduced exposure to high-pressure math environments (Ashcraft & Krause, 2007; Ashcraft & Moore, 2009; Eidlin-Levy et al., 2023). To minimize the impact of societal pressures on girls, it is crucial to assess and address this issue during the preschool years, when external pressure in form of grades and performance comparisons have not yet emerged.

Several instruments are commonly used to assess MA in preschool period. One of the most widely employed tools is the *Young Children's Math Anxiety Scale* (YCMAX), specifically designed for young children in preschool or kindergarten (Lu et al., 2021). It includes two dimensions, "Worry" and "Somatization", which measure cognitive and physiological aspects of MA. Another frequently used tool is the *Early Elementary School Abbreviated Math Anxiety Scale* (EES-AMAS), a shorter version of the well-known AMAS, adapted for use with younger children, including those in early primary school (Primi et al., 2020). Additionally, the *Children's Anxiety in Math Scale* is commonly applied to assess MA in younger children and has shown good reliability and validity (Jameson, 2013). Among these tools, YCMAX is the most widely cited and used for measuring MA in preschool-aged children. It is particularly effective due to its focus on cognitive aspects, such as worry and rumination, and physiological reactions, like different types of somatization. This focus is important because younger children often struggle to articulate their emotions in a detailed way, making these measurable symptoms more accessible for researchers and practitioners (Lu et al., 2021).

Math anxiety and math learning readiness in preschool children

Math learning readiness refers to the child's ability to understand and engage in basic math concepts, which form the foundation of more complex math learning (Mejias et al., 2019). It includes skills like number recognition, counting, understanding basic shapes, and the ability to solve simple math problems. MLR in preschool is about acquiring these cognitive skills and also involves child's emotional and motivational readiness to engage with school tasks (Józsa et al., 2022). Research has consistently demonstrated that mathematics anxiety is negatively associated with mathematical thinking even in preschool children, meaning that higher levels of MA are linked to lower preparedness to engage with math tasks (Siegler & Ramani, 2024). The development of foundational mathematical abilities in kindergarten is therefore crucial, as these skills not only support later achievement in mathematics but also contribute to broader learning outcomes, including reading comprehension and overall cognitive growth (Mejias et al., 2019). By laying the groundwork for more advanced mathematical competencies, early math skills exert long-term effects on academic success and future employment opportunities (Mejias et al., 2019). Importantly, children with lower levels of mathematical learning readiness are at a greater risk of experiencing ongoing difficulties in acquiring math skills, which may, in turn, intensify the impact of MA over time (Betts et al., 2020). By addressing early math readiness skills before formal schooling has begun, interventions aimed at MA could significantly reduce the risk of future learning difficulties and provide a more equitable educational foundation for all students.

The cognitive interference theory posits that a high level of anxiety results in unsuccessful problem solving. According to this theory, MA, through the mediating role of executive functions, self-efficacy, and learning motivation, interferes with the efficiency of various problem-solving abilities, leading to low mathematical achievement or complete avoidance of mathematical content (Ashcraft & Krause, 2007; Suárez-Pellicioni et al., 2016). This form of anxiety compromises the ability to process information in working memory, and inefficient cognitive processing further contributes to weaker performance in solving mathematical problems (Ramirez et al., 2013). In other words, the relationship between mathematics anxiety and achievement is often explained through some mediating variables, with a clear emphasis on the fact that higher MA leads to lower mathematical achievement. From a broader affective-motivational perspective, the Control-Value Theory of Achievement Emotions (Pekrun, 2006; Pekrun & Perry, 2014) provides an integrative framework for understanding MA. This theory posits that achievement emotions arise from learners' appraisals of control (i.e., perceived competence) and value (i.e., perceived importance) of academic tasks. MA emerges when students perceive low control over mathematical outcomes, but attach high value to success, which leads to negative emotional and motivational consequences, such as reduced self-efficacy, avoidance behaviour, and lower achievement. Taken together, these perspectives suggest that mathematics anxiety represents a multifaceted phenomenon shaped by both the cognitive limitations and affective-motivational appraisals, jointly undermining students' engagement, persistence, and performance in mathematics.

There is limited research on the relationship between MLR and MA in preschool-aged children. Available studies suggest a tendency for MA to have a negative effect in early engagement and persistence in math-related activities. For example, studies indicate that children with higher levels of MA often exhibit avoidance behaviours and lower engagement in exploratory math tasks, which can negatively impact their readiness to acquire foundational math skills, such as number recognition and counting (DePascale et al., 2023). Svraka et al. (2024) examined the influence of generalized anxiety, gender, and family socioeconomic status on math achievement among kindergarten children aged 5 to 7. Their findings revealed a significant negative correlation between generalized anxiety and math performance in the preschool population, with higher levels of anxiety exerting a stronger detrimental effect on girls compared to boys. Despite this, no significant gender differences in overall math achievement were observed at this age. Moreover, Short et al. (2019) concluded that MA varied even among preschool children. However, further research is needed to explore how this variability is related to early math development, as previous findings indicate no significant relationship between MA and counting, numerical mapping, or problem-solving tasks (Short et al., 2019). Further studies addressing this topic at preschool age are necessary in order to obtain more detailed insights.

The Current Study

Previous studies have revealed a lack of research on MA, readiness for learning math, and the relationship between these constructs in preschool-aged children. Research on this topic cannot be found for the Serbian population of pre-schoolers. The construct of MA, as well as its long-standing definition, is grounded in research conducted on older students and adults and is associated with more complex math procedures. Consequently, little is known about the origins and nature of MA in the early years. In this context, the present study is focused on the manifestations of MA and readiness for learning math in preschool-aged children, as well on the relationship between MA and readiness for learning math.

In line with the identified research problem, the following objectives were formulated:

1. to examine the components of MA in preschool children through the assessment of the factor structure of the Young Children's Mathematical Anxiety Questionnaire (YCMAX; Lu et al., 2019), using confirmatory factor analysis (Study 1), and
2. to investigate the relationship between MA, gender, age, and the indicators of readiness for learning math in preschool-aged children, and the MA effects on MLR (Study 2).

Based on the findings of Lu et al. (2021), it is expected that the structure of this instrument will be best explained by two factors – Worry and Somatization – as children typically express anxiety through worry and physical symptoms. Consistent with previous research (Petronzi et al., 2019; Van Mier et al., 2019) conducted on preschool-aged children, no significant differences in the level of MA are anticipated with respect to the examined sociodemographic factors, gender, and age, as these factors play a relatively minor role in shaping anxiety among younger children. Finally, in keeping with the results of prior studies (Short et al., 2019; Svraka et al., 2024), a significant and negative correlation is expected between both dimensions of MA and the examined indicators of readiness for learning math.

STUDY 1

Method

Sample and Procedure

The initial step in the assessment involved asking children whether they knew what mathematics was and how they would describe it, which is important since children who lack basic understanding of the concept may not be able to meaningfully interpret or respond to subsequent questions about mathematics. Following the affirmative responses, the final sample of children participating in the study was formed. The study involved 256 children, aged 4 to 6 (M = 5.61, SD = 0.60), from private and public preschools in Serbia. The sample was evenly distributed by gender, with an equal proportion of boys and girls (50% each).

The study was approved by the institutional Ethics committee of Department of Psychology, Faculty of Philosophy, University of Novi Sad. Groups of children were recruited by distributing consent forms to parents, and this procedure was carried out only in the kindergartens with which the authors had previously established collaboration in the context of earlier research. Before the study, parental consent was obtained in writing, and verbal assent was secured from the children during an initial conversation at the start of testing. Assessments were conducted individually within preschool facilities under distraction-free conditions. Data were collected by trained examiners, including psychology and pedagogy students, and employees in preschools that had approved participation in the research. Study 1 took place between October and December 2023.

Instrument

Young Children's Math Anxiety Scale (YCMAX; Lu et al., 2019) measures MA in preschool-age children, specifically those enrolled in preschool programs (4–5 years old) and pre-primary school preparation programmes (6–7 years old). It consists of 11 items that measure the indicators of worry (8 items, e.g., "*Do you ever feel nervous when you do math*?") and physical symptoms (3 items, e.g., "*Does math make your head hurt?*"), reflecting anxiety in children of this age group. These two subscales are distinct in the original study (Lu et al., 2019), named as Worry (α = .82) and Somatization (α = .68), both showing satisfactory reliability indicators. Among kindergarteners, the use of a 3-point scale produced results that were both more internally consistent and psychometrically valid (Mantzicopoulos et al., 2013), than 4- or 5-point Likert scales, so responses were coded on the Likert scale as 1 – *No*, 2 – *A little bit*, and 3 – *A lot*. The Serbian version of the YCMAX is presented in Appendix 1.

Analyses and Results

Factor Structure of the YCMAX Questionnaire

All analyses were conducted in AMOS v.21 (IBM Corp., 2021). To confirm the factor structure of the YCMAX questionnaire, confirmatory factor analysis (CFA) was conducted. Fit indices were calculated using the maximum likelihood method. The tested models included a unidimensional model (Model 1), the original two-dimensional model with correlated factors (Model 2), and a two-dimensional model with a higher-order factor, i.e., a general factor of MA (Model 3).

Table 1
Fit Indices for the YCMAX structural model

	AIC	*BIC*	*CFI*	*TLI*	*RMSEA*	*CI*	χ^2 (*p*)	*df*	χ^2/df
Model 1	230.15	233.41	0.78	0.72	0.10	0.09-0.12	148.28 (.00)	44	3.73
Model 2	170.90	174.26	0.93	0.91	0.06	0.04-0.08	83.90 (.00)	42	1.95
Model 3	200.53	203.84	0.89	0.86	0.07	0.06-0.09	101.48 (.00)	43	2.36

Note. AIC – Akaike Information Criterion; *BIC* – Bayesian Information Criterion; *CFI* – Comparative Fit Index; *TLI* – Tucker–Lewis Index; *RMSEA* – Root Mean Square Error of Approximation; CI – confidence intervals for RMSEA; χ^2 – chi-square value, *df* – degrees of freedom; *p* – p-value.

Based on confirmatory factor analysis (Table 1), Model 2, the original model with two correlated factors, demonstrated better-fit indices than the other two tested models. Most parameters in Model 2 fell within the range of acceptable values: CFI and TLI > .90, RMSEA < .08, and $\chi 2/df < 3$ (Akkaike, 1973; Kline, 2010; Schwarz, 1978). Fit indices were interpreted in light of more relaxed fit criteria, which is not unexpected given the young age of the participants; preschool children often have difficulty differentiating between nuanced items compared to adults, making some degree of model misfit unsurprising. Although the χ^2 test was significant, the overall model fit was evaluated based on a combination of indices (CFI, TLI, RMSEA), which indicated an adequate fit. The structure of the YCMAX is presented in Figure 1.

CFA results indicate that, as in the originally proposed solution, two factors emerge: Somatization and Worry. The items loaded on the two factors as expected, suggesting the proposed two-factor solution. The Somatization factor (α = .73) encompasses the items characterized by the indicators of physical sensations that may be caused by anxiety, while the Worry (α = .72) factor is best described through various indicators reflecting the cognitive aspect of anxiety, manifested as worry in different situations involving numbers and math. The correlation between the two dimensions of MA is moderate and positive (r = .58, p < .01).

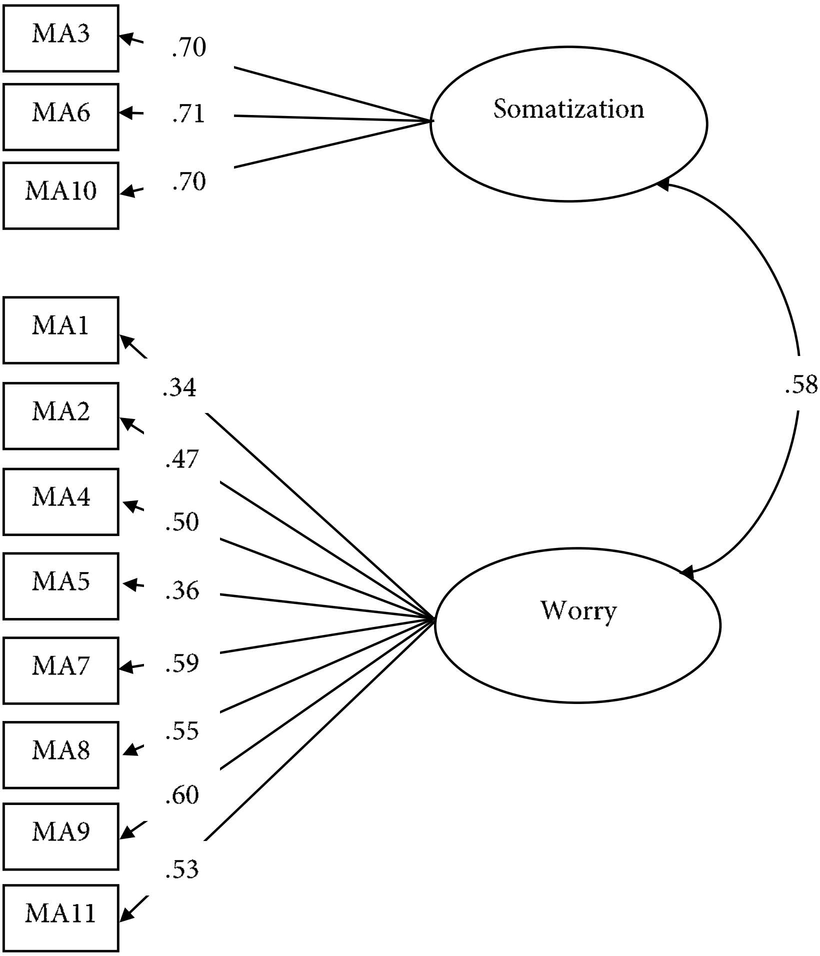

Figure 1. Factor structure of the YCMAX: CFA results.
All loadings are significant at $p < .01$.

Descriptive Statistics

Descriptive statistics for both YCMAX scales are presented in Table 2. It can be concluded that both YCMAX dimensions deviate from the normal distribution in a positively skewed and leptokurtic manner (Tabachnik & Fidell, 2021), implying that a small number of children reported high somatic symptoms and worrying thoughts. Also, Worry is a more pronounced dimension of MA than Somatization in preschool children ($t(255) = 2.73$, $p < .01$).

Table 2
Descriptive statistics for the YCMAX in Study 1

	Min	Max	M	SD	Sk	zSk	Ku	zKu
Somatization	3.00	9.00	3.72	1.35	2.18	14.34	4.22	13.93
Worry	8.00	24.00	10.48	2.64	1.06	6.97	0.48	1.58

Note. M – mean; *SD* – standard deviation; *Sk* – skewness; *Ku* – kurtosis; *zSk/Ku* – standardized values of skewness and kurtosis.

As a general conclusion of Study 1, it can be stated that the YCMAX is a reliable instrument for assessing MA in preschool children, and that the construct of MA at this age is primarily reflected in its cognitive dimension, with worry emerging as the most salient manifestation, whereas somatic symptoms appear to be a less representative component.

Study 2

Method

Sample and procedure

The second study involved 205 children, 48.8% boys and 51.2% girls, aged 4 to 6 years (M = 5.80, SD = 0.45), from private and public preschools in Serbia. The data collection procedure was identical to that in Study 1. The study took place between March and June 2024.

Instruments

Young Children's Math Anxiety Scale (YCMAX; Lu et al., 2019) was distributed to children as in Study 1. Both scales were formed as summative scores according to the scoring key that was originally proposed, and which was confirmed in Study 1. In line with the established scoring of the YCMAX and to ensure comparability across different studies, we used summative scores. Although CFA results indicated some variation in item loadings, the overall pattern supported a coherent factor structure, making sum scores an appropriate and theoretically consistent scoring approach. Sum scores may perform similarly to factor scores when items load strongly on a single scale and loadings are not extremely heterogeneous (Kline, 2023). In Study 1, all items loaded significantly on their respective factors (p < .01). Given the strong and statistically significant factor loadings, we opted for summative scoring, which ensures comparability with prior research.

The Mathematical School Readiness Test (MSRT; Mejias et al., 2019) measures children's competencies by assessing their grasp of visual and numerical symbols commonly expected at the beginning of formal schooling. The test includes five tasks organized progressively from simpler to more complex, aligning with the developmental stages of children's understanding of math concepts and operations. It consisted of the following math skills:

number identification, number writing, number comparison, counting, and arithmetic problem-solving. The MSRT comprised five tasks designed to capture different aspects of early mathematical competence. The first task (8 items), *Identifying visual number symbols*, required the children to distinguish between Arabic digits and non-numeric symbols (e.g., letters or special characters), thereby assessing basic symbolic number recognition. The second task (10 items), *Writing numbers to dictation*, measured transcoding skills, as the children were asked to write down numbers that were verbally dictated by the examiner. The third task, *Comparing visual number symbols* (12 items), focused on symbolic magnitude processing by asking the children to decide which of the two digits represented the larger number. The fourth task, *Counting resulting from the counting of visual collections*, combined counting and transcoding, as children had to enumerate a small set of objects and then write the corresponding (4 items) Arabic numeral. Finally, the fifth task, *Solving basic arithmetic problems* (18 items), assessed the ability to perform simple addition and subtraction operations, thereby tapping into the children's emerging calculation skills. Scoring was performed in such a way that for each individual task the child received a score of 1, and, for an incorrect answer, a score of 0. For each scale, the sum of the correct and incorrect answers represented the final score (Mejias et al., 2019). The test was translated using the principle of back translation with the permission of the author of the original test. The test was administered individually, with the permission from the author of the original test, and the completion took about 20 minutes.

Results

Descriptive Statistics for the Used Measures

Descriptive statistics for both the YCMAX and MSRT scales are presented in Table 3. It can be concluded that both MA scales and number identification and counting deviate from the normal distribution.

Table 3
Descriptive statistics for the YCMAX and MSRT scales

	Min	Max	*M*	*SD*	*Sk*	*zSk*	*Ku*	*zKu*	α
Somatization	3.00	9.00	3.54	0.96	2.40	14.12	6.51	19.14	.72
Worry	8.00	24.00	10.16	2.44	1.76	10.35	4.15	12.20	.73
Number identification	0.00	8.00	7.71	0.99	-4.78	-28.11	26.63	78.32	.71
Number writing	0.00	10.00	7.16	2.73	-0.99	-5.82	0.10	0.29	.72
Number comparison	2.00	12.00	10.05	1.90	-1.10	-6.47	1.38	4.06	.72
Counting	1.00	4.00	3.84	0.46	-3.35	19.70	11.84	34.82	.78
Arithmetic problem solving	0.00	18.00	13.11	6.48	-1.12	-5.58	-0.25	-0.73	.73

Note. M – mean; *SD* – standard deviation; *Sk* – skewness; *Ku* – kurtosis; α – reliability coefficient; *zSk/Ku* – standardized values of skewness and kurtosis.

These results suggest that, while both subscales capture the aspects of MA in young children, responses are skewed toward the lower anxiety levels. Moreover, these results indicate that most children in the sample demonstrated strong abilities of counting and number identification, with limited variability in performance, which may affect sensitivity to individual differences in these domains. It also may indicate that these tasks were too easy for the children. As in Study 1, Worry is a more pronounced dimension of MA than Somatization in preschool children ($t(203) = 3.76$, $p < .01$).

Correlates of MA in Preschool Children: Age, Gender, and Math Readiness

Given the deviation of variables from a normal distribution, the relationships with gender, age, and math readiness were established using the Spearman correlation (Table 4).

The correlations reveal that both dimensions of MA are negatively associated with children's age, counting, solving arithmetic problems, and number identification. Worry negatively correlated with number writing, while Somatization did not correlate significantly with this math skill. Number comparison and the children's gender were not significantly related to the dimensions of MA. As a general conclusion of Study 2, it can be stated that both dimensions of MA could compromise pre-math skills in preschool-aged children, but the intensity decreases with age in this developmental stage.

Table 4
Correlations between the YCMAX, MSRT, age, and gender

	Somatization	Worry
Gender	-.07	-.05
Age	-.17*	-.15*
Number identification	-.16*	-.18**
Number writing	-.09	-.17*
Number comparison	-.13	-.13
Counting	-.17*	-.19**
Arithmetic problem solving	-.20**	-.24**

Note. * $p < .05$. ** $p < .01$.

The examination of the relationships between the dimensions of MA and MLR was additionally tested using structural equation modelling (SEM). However, adequate model fit indices were not obtained. When SEM does not provide an acceptable model fit, often due to weak intercorrelations among latent variables or insufficient sample size, multiple regression analysis can serve as a more parsimonious and statistically appropriate alternative. The scores on the MA subscales were used as predictor variables, and the scores on the MLR subscales as criterion variables. Unlike SEM, which requires strong covariance structures to estimate latent relationships, multiple regression focuses on the observed variables and allows for testing direct effects between the predictors and outcome variables without imposing complex model constraints. Therefore, a regression analysis could be suitable for verifying specific hypothesized effects when the structural model fails to meet fit criteria (Hair et al., 2019). Consequently, the effects of MA on MR were examined using multiple regression analysis (Table 5).

Table 5
The effects of MA on MLR – regression analysis

	Number identification		Number writing		Number comparison		Counting		Arithmetic problem solving	
	β	*t*	β	*t*	β	*t*	β	*t*	β	*t*
Somatization	-.09	-1.18	-.03	-0.40	-.02	-0.26	-.08	-1.02	-.12	-1.53
Worry	-.16	-2.86**	-.15	-2.54*	-.04	-0.54	-.17	-2.33*	-.18	-2.35*
	F = 7.60**		F = 4.57*		F = 1.15		F = 5.17**		F = 6.63**	
	R^2 = .07		R^2 = .04		R^2 = .02		R^2 = .05		R^2 = .06	

Note. **β – partial effect of predictor;** t – t-test value; F – F-test value; R^2 – coefficient of multiple determination.

The results of multiple regression analysis showed that the worry dimension of mathematics anxiety was a significant negative predictor of several early numeracy skills, whereas somatization was not significantly related to any of the assessed outcomes, probably due to the absence of variance. Specifically, higher levels of worry were associated with poorer performance in number identification, number writing, counting, and arithmetic problem solving. These models explained between 4% and 7% of the variance in early mathematical performance. In contrast, the somatization dimension did not significantly predict any of the numeracy outcomes, suggesting that the cognitive component of anxiety rather than the physiological one plays a more prominent role in children's early mathematical achievement.

Discussion

The present study provides a meaningful contribution to the limited but growing body of literature on math anxiety in early childhood, focused on preschool-aged children. The two-pronged research approach included an examination of the nature of the Young Children's Math Anxiety Scale and an exploration of its correlates with age, gender, and readiness for learning mathematics. These findings offer valuable insights into the nature of MA at a developmental stage where formal schooling has not yet begun, but foundational math experiences are increasingly emphasized.

Study 1 confirmed that the YCMAX is a reliable and valid tool for measuring MA in preschool-aged children. Confirmatory factor analysis results indicated that the best-fitting model was the original two-factor solution, consisting of Worry and Somatization as correlated, but distinct dimensions. These findings are consistent with the theoretical framework proposed by Lu et al. (2021) and reaffirm that young children experience and express math-related anxiety in both cognitive (e.g., thoughts of failure, fear of doing math) and somatic (e.g., stomach ache, tension, headache) forms. Worry emerged as the more dominant dimension, while Somatization was less prominent, and both showed a positively skewed and leptokurtic distribution. This suggests that cognitive manifestations of anxiety, such as ruminative thoughts or nervousness about math tasks, are more commonly reported by children at this age than physiological symptoms. This might be due to young children's limited interoceptive awareness or their developing ability to verbalize somatic experiences (Ganley & McGraw, 2016). Nevertheless, the presence of both dimensions, even in a population not yet subject to evaluative academic settings, underscores the early onset and multidimensionality of MA and supports the need for age-appropriate diagnostic tools like the YCMAX. These findings are further supported by research indicating that young children can distinguish between emotional and physical discomfort in academic contexts, even if their verbal articulation is limited (Carey et al., 2019). Furthermore, the internal consistencies for both subscales were satisfactory, giving support to the idea that the scale items are coherent and suitable for use with preschool populations. Given that there are few validated instruments for this age group, these findings have important implications for early detection and prevention efforts within preschool settings.

Study 2 examined the associations between MA and several key developmental and cognitive variables: age, gender, and readiness for learning mathematics. One of the most robust findings across both dimensions of MA is their negative association with age, suggesting that MA tends to decrease slightly as children grow older within the preschool period. This could reflect the developmental trajectory of self-regulation and emotional coping, whereby older preschoolers may be better equipped to manage anxiety-inducing situations or may simply become more accustomed to math-related tasks through repeated exposure. This is consistent with the findings of Szczygieł and Pieronkiewicz (2022), who reported that while most preschoolers exhibited low MA, moderate levels were present in a non-negligible minority, with symptoms decreasing over time. In contrast, no significant gender differences were observed in either dimension of MA, which is in line with the hypothesis that such differences tend to emerge later, typically during primary school or adolescence, when societal and educational pressures begin to impact boys and girls differentially (Hill et al., 2016; Van Mier et al., 2019). At the preschool level, children have not yet been subjected to overt academic comparison, grading, or cultural stereotypes about gender and math ability, which might explain the absence of gender-based differences in this study.

Perhaps the most impactful findings in Study 2 relate to the negative correlations between MA and various indicators of math readiness. Specifically, higher scores on both Worry and Somatization were associated with lower performance in number identification, counting, and arithmetic problem-solving**.** These results support the assumption that, even in early childhood, MA is associated with the difficulties in engaging with math-related activities; however, caution is warranted in drawing causal interpretations, as it is also possible that lower performance in these domains fosters mathematics anxiety. In particular, the Worry subscale was also negatively correlated with number writing, suggesting that cognitive interference, such as anxious rumination or lack of confidence, might play a critical role in limiting the children's performance, even on basic tasks. These findings are aligned with previous research results suggesting that emotional responses to math tasks, particularly anxiety, can undermine working memory capacity, task persistence, and attention regulation (DePascale et al., 2023; Devine et al., 2018). Children experiencing higher MA may avoid engaging in math tasks, approach them with low motivation, or perform below their cognitive potential due to psychological distress, which is consistent with the cognitive interference theory (Ashcraft & Krause, 2007; Suárez-Pellicioni et al., 2016). From the broader perspective of the Control-Value Theory of Achievement Emotions (Pekrun, 2006; Pekrun & Perry, 2014), such outcomes can be explained by students' low perceived control over mathematical tasks, combined with the high value they place on success, which results in negative emotions that further hinder motivation and performance. Interestingly, the only math readiness skill not significantly associated with MA was number comparison, which may suggest that some foundational numerical abilities, particularly those involving visual or basic quantity discrimination, are less emotionally salient or demanding for preschoolers. Alternatively, it may be the case that the task format was less likely to trigger anxiety responses compared to more overtly symbolic or verbally mediated tasks like arithmetic or counting. It should also be acknowledged that range restriction may have influenced the observed correlation patterns, as some of the scales demonstrated limited variability, thereby potentially attenuating the strength of associations. The findings of the multiple regression analysis indicate that, among the two examined dimensions of MA, only worry emerged as a significant negative predictor of early numeracy performance. Specifically, higher levels of worry were associated with poorer outcomes in number identification, number writing, counting, and arithmetic problem solving, whereas somatization showed no significant associations with any of the assessed mathematical tasks. These results are consistent with the assumptions of the cognitive interference theory (Ashcraft & Krause, 2007; Suárez-Pellicioni et al., 2016), which posits that anxiety-related cognitive intrusions, such as ruminative thoughts, consume working memory resources necessary for effective problem solving. The absence of significant effects for somatization may indicate that physiological arousal is less influential in early childhood, when the metacognitive and evaluative aspects of anxiety are still developing. Furthermore, from the perspective of the Control-Value Theory of Achievement Emotions (Pekrun, 2006; Pekrun & Perry, 2014), the negative association between worry and math performance may be interpreted as a consequence of children's low perceived control over math outcomes combined with the high value they attribute to success. This imbalance generates negative achievement emotions that reduce motivation, self-efficacy, and engagement during mathematical activities. Taken together, these findings support the view that worry represents the primary mechanism through which MA interferes with early numeracy development, emphasizing the need for early interventions that target maladaptive thought patterns and promote positive emotional regulation in learning contexts. However, it should be noted that somatization scores showed limited variance, likely reflecting floor effects. Thus, the non-significant findings should not be interpreted as evidence of a negligible role of physiological arousal, but rather as insufficient statistical sensitivity to detect such effects at this developmental stage. Future studies with more sensitive measures are needed to clarify this mechanism.

Practical implications and study limitations

These findings hold important practical implications for educators, curriculum designers, and psychologists working with preschool-aged children. First, the fact that MA is detectable and meaningfully linked to performance before the beginning of formal schooling suggests that early screening and intervention may be essential to prevent long-term academic difficulties. The validated use of the YCMAX enables practitioners to identify at-risk children who might otherwise be overlooked due to the informal nature of learning in preschool settings. Screening preschool children identified as vulnerable for anxiety can significantly contribute to the implementation of some interventions aimed at reducing MA (Balt et al., 2022). This issue remains an open question, as researchers and practitioners have yet to systematically explore preventive programmes targeting MA in the preschool age group.

Second, interventions designed to improve children's math experiences must go beyond cognitive instruction and address the emotional and motivational aspects of learning. This could involve implementing playful, low-stress math activities, integrating emotional regulation training, and providing positive reinforcement for math engagement. Supporting math confidence and reducing early anxiety may create a more equitable learning environment for children from less math-enriched home backgrounds (Mejias et al., 2019).

Although the study has its strengths, it also faces certain limitations, particularly due to its cross-sectional design, which restricts any causal inferences. It remains unclear whether anxiety leads to lower math readiness or whether early difficulties in mathematics foster anxiety, a reciprocal relation that should be considered when interpreting the present findings. Longitudinal research is needed to disentangle these relationships and to examine the developmental trajectory of MA over time. Furthermore, the sample was limited to children attending preschools in Serbia, which may affect generalizability. Cultural norms, educational practices (Terry et al., 2023), and parental beliefs about math (Jerković & Milovanović, 2020) likely play a role in shaping emotional responses to math, and these factors warrant further cross-cultural investigation.

Additionally, while the study utilized validated measures, self-reporting or observational limitations may still exist due to the developmental constraints in children's self-awareness and expressive capacities. Future studies might benefit from incorporating multi-method assessment approaches, such as physiological measures, parental reports, or teacher ratings, in order to gain more holistic understanding of MA in this age group. A further limitation concerns the range restriction observed in some tasks, as the test appeared to be relatively easy for the children in our sample, which likely reduced variability and may have attenuated correlations. In addition, the structural model demonstrated only an 'acceptable' fit, which should be interpreted in light of the young age of the participants, as preschool children are less able to differentiate between nuanced items compared to older populations, making stringent model fit criteria more difficult to achieve.

In conclusion, this study provides the first and compelling evidence from Serbia that MA is a meaningful and measurable construct even among children as young as four. The validated structure of the YCMAX and its demonstrated associations with early math skills underscore the importance of recognizing and addressing MA before formal schooling begins. These findings pave the way for the development of early preventive interventions, highlighting the value of creating emotionally supportive environments for math learning in preschool years. By identifying and supporting children with early signs of MA, educators and psychologists can foster more positive math trajectories and help prevent the entrenchment of math-related difficulties later in life.

References

Akaike, H. (1970). Statistical predictor identification. *Annals of the Institute of Statistical Mathematics, 22*(1), 203–217. https://doi.org/10.1007/bf02506337

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review, 14*(2), 243–248. https://doi.org/10.3758/BF03194059

Ashcraft, M. H., & Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational Assessment, 27*(3), 197–205.

Balt, M., Börnert-Ringleb, M., & Orbach, L. (2022). Reducing Math Anxiety in School Children: A Systematic Review of Intervention Research. *Frontiers in Education, 7*. https://doi.org/10.3389/feduc.2022.798516

Barroso, C., Ganley, C. M., McGraw, A. L., Geer, E. A., Hart, S. A., & Daucourt, M. C. (2021). A meta-analysis of the relation between math anxiety and math achievement. *Psychological Bulletin, 147*(2), 134–168. https://doi.org/10.1037/bul0000307

Betts, A., Thai, K., Jacobs, D., & Li, L. (2020). *Math Readiness: Early Identification of Preschool Children Least Ready for Formal Mathematics Instruction in School.* The IAFOR International Conference on Education – Hawaii 2020 Official Conference Proceedings, 487–506. https://doi.org/10.22492/issn.2189-1036.2020.40

Carey, E., Devine, A., Hill, F., & Szűcs, D. (2017). Differentiating anxiety forms and their role in academic performance from primary to secondary school. *Plos One, 12*(3), e0174418. https://doi.org/10.1371/journal.pone.0174418

Caviola, S., Primi, C., Chiesi, F., & Mammarella, I. C. (2017). Psychometric properties of the Abbreviated Math Anxiety Scale (AMAS) in Italian primary school children. *Learning and Individual Differences, 55*, 174–182. https://doi.org/10.1016/j.lindif.2017.03.006

Cipora, K., Szczygieł, M., Willmes, K., & Nuerk, H.-C. (2015). Math Anxiety Assessment with the Abbreviated Math Anxiety Scale: Applicability and Usefulness: Insights from the Polish Adaptation. *Frontiers in Psychology, 6*. https://doi.org/10.3389/fpsyg.2015.01833

DePascale, M., Butler, L. P., & Ramani, G. B. (2023). The relation between math anxiety and play behaviors in 4- to 6-year-old children. *Journal of Numerical Cognition, 9*(1), 89–106. https://doi.org/10.5964/jnc.9721

Devine, A., Hill, F., Carey, E., & Szűcs, D. (2018). Cognitive and emotional math problems largely dissociate: Prevalence of developmental dyscalculia and mathematics anxiety. *Journal of Educational Psychology, 110*(3), 431–444. https://doi.org/10.1037/edu0000222

dos Santos Carmo, J., Gris, G., & dos Santos Palombarini, L. (2019). Mathematics Anxiety: Definition, Prevention, Reversal Strategies and School Setting Inclusion. *Inclusive Mathematics Education,* 403–418. https://doi.org/10.1007/978-3-030-11518-0_24

Eidlin-Levy, H., Avraham, E., Fares, L., & Rubinsten, O. (2023). Math anxiety affects career choices during development. *International Journal of STEM Education, 10*(1), Article 49. https://doi.org/10.1186/s40594-023-00441-8

Finlayson, M. (2014). Addressing math anxiety in the classroom. *Improving Schools, 17*(1), 99–115. https://doi.org/10.1177/1365480214521457

Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The Math Anxiety-Performance Link. *Current Directions in Psychological Science, 26*(1), 52–58. https://doi.org/10.1177/0963721416672463

Ganley, C. M., & McGraw, A. L. (2016). The Development and Validation of a Revised Version of the Math Anxiety Scale for Young Children. *Frontiers in Psychology, 7*. https://doi.org/10.3389/fpsyg.2016.01181

Geist, E. (2015). Math anxiety and the "math gap": How attitudes toward mathematics disadvantages students as early as preschool. *Education*, *135*(3), 328–336.

George, L., & Mitchell, L. (2022). Exploring mathematics anxiety among primary school students: Prevalence, mathematics performance and gender. *International Electronic Journal of Mathematics Education, 17(*3), em0692. https://doi.org/10.29333/iejme/12073

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.

Harari, R. R., Vukovic, R. K., & Bailey, S. P. (2013). Mathematics Anxiety in Young Children: An Exploratory Study. *The Journal of Experimental Education, 81*(4), 538–555. https://doi.org/10.1080/00220973.2012.727888

Hart, S. A., & Ganley, C. M. (2019). The nature of math anxiety in adults: Prevalence and correlates. *Journal of Numerical Cognition, 5*(2), 122–139. https://doi.org/10.5964/jnc.v5i2.195

Hill, F., Mammarella, I. C., Devine, A., Caviola, S., Passolunghi, M. C., & Szűcs, D. (2016). Maths anxiety in primary and secondary school students: Gender differences, developmental changes and anxiety specificity. *Learning and Individual Differences, 48*, 45–53. https://doi.org/10.1016/j.lindif.2016.02.006

IBM Corp. (2021). *IBM SPSS Statistics for Windows, Version 28.0*. IBM Corp

Ina V. S. Mullis, Michael O. Martin, Pierre Foy, Dana L. Kelly, & Bethany Fishbein. (2020). *TIMSS 2019 highlights: International results in mathematics and science* (TIMSS & PIRLS International Study Center, Lynch School of Education). Skolporten. https://www.skolporten.se/app/uploads/2020/12/timss-2019-highlights-1.pdf

Irhamna, I., Amry, Z., & Syahputra, H. (2020). Contribution of Mathematical Anxiety, Learning Motivation and Self-Confidence to Student's Mathematical Problem Solving. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal, 3*(4), 1759–1772. https://doi.org/10.33258/birle.v3i4.1343

Jameson, M. M. (2013). The Development and Validation of the Children's Anxiety in Math Scale. *Journal of Psychoeducational Assessment, 31*(4), 391–395. https://doi.org/10.1177/0734282912470131

Jerković, I., & Milovanović, I. (2020). Mediation effects of mathematics anxiety in the relationship between father's involvement in teaching and student's mathematics achievement in early primary school. *Psiholoska istrazivanja, 23*(1), 43–61. https://doi.org/10.5937/psistra23-24633

Józsa, K., Amukune, S., Zentai, G., & Barrett, K. C. (2022). School Readiness Test and Intelligence in Preschool as Predictors of Middle School Success: Result of an Eight-Year Longitudinal Study. *Journal of Intelligence, 10*(3), 66. https://doi.org/10.3390/jintelligence10030066

Kline, R. B. (2010). *Principles and practice of structural equation modeling*. Guilford.

Lu, Y., Li, Q., Patrick, H., & Mantzicopoulos, P. (2019). "Math Gives Me a Tummy Ache!" Mathematics Anxiety in Kindergarten. *The Journal of Experimental Education, 89*(2), 362–378. https://doi.org/10.1080/00220973.2019.1680518

Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. *Psychology Research and Behavior Management, 11*, 311–322. https://doi.org/10.2147/prbm.s141421

Mantzicopoulos, P., Patrick, H., & Samarapungavan, A. (2013). Science Literacy in School and Home Contexts: Kindergarteners' Science Achievement and Motivation. *Cognition and Instruction, 31*(1), 62–119. https://doi.org/10.1080/07370008.2012.742087

Mejias, S., Muller, C., & Schiltz, C. (2019). Assessing Mathematical School Readiness. *Frontiers in Psychology, 10*. https://doi.org/10.3389/fpsyg.2019.01173

Milovanović, I. (2018). Math anxiety and achievement at early elementary stage: the role of parental involvement in teaching. *Annual Review of the Faculty of Philosophy Novi Sad,* 43(1), 271–287. https://doi.org/10.19090/gff.2018.1.271-287

Milovanović, I. (2021). *Činioci i efekti matematičke anksioznosti na ranom osnovnoškolskom uzrastu* [Factors and effects of math anxiety in early elementary school age]. Unpublished doctoral thesis. Faculty of Philosophy, University of Novi Sad.

Milovanović, I., & Branovački, B. (2021). Adaptation and Psychometric Evaluation of Modified Abbreviated Math Anxiety Scale for Children in Serbia. *International Journal of Science and Mathematics Education, 19*(3), 579–598. https://doi.org/10.1007/s10763-020-10066-w

Milovanović, I., & Kodžopeljić, J. (2018). Factor structure and convergent validity of the Math Anxiety Questionnaire for high school students. *Nastava i vaspitanje, 67*(1), 113–128. https://doi.org/10.5937/nasvas1801113m

OECD. (2013). *PISA 2012 results: Ready to learn – Students' engagement, drive and self-beliefs (Volume III).* OECD Publishing. https://doi.org/10.1787/9789264201170-en

OECD. (2023). *PISA 2022 Results (Volume I): The State of Learning and Equity in Education.* OECD Publishing. https://doi.org/10.1787/53f23881-en

Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review, 18(*4), 315–341. https://doi.org/10.1007/s10648-006-9029-9

Pekrun, R., & Perry, R. P. (2014). Control-value theory of achievement emotions. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International handbook of emotions in education* (pp. 120–141). Routledge. https://doi.org/10.4324/9780203148211

Petronzi, D., Staples, P., Sheffield, D., & Hunt, T. (2019). Acquisition, Development and Maintenance of Maths Anxiety in Young Children. In: I. C. Mammarella, S. Caviola, & A. Dowker (Eds.), *Mathematics Anxiety*. (pp. 77–102). Routledge. https://doi.org/10.4324/9780429199981-5

Primi, C., Donati, M. A., Izzo, V. A., Guardabassi, V., O'Connor, P. A., Tomasetto, C., & Morsanyi, K. (2020). The Early Elementary School Abbreviated Math Anxiety

Scale (the EES-AMAS): A New Adapted Version of the AMAS to Measure Math Anxiety in Young Children. *Frontiers in Psychology, 11*. https://doi.org/10.3389/fpsyg.2020.01014

Radević, L., & Milovanović, I. (2024). Current Trends in Math Anxiety Research: a Bibliometric Approach. *International Journal of Science and Mathematics Education, 22*(6), 1345–1362. https://doi.org/10.1007/s10763-023-10424-4

Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2013). Math anxiety, working memory, and math achievement in early elementary school. *Journal of Cognition and Development, 14*(2), 187–202. https://doi.org/10.1080/15248372.2012.664593

Rossi, S., Xenidou-Dervou, I., Simsek, E., Artemenko, C., Daroczy, G., Nuerk, H., & Cipora, K. (2022). Mathematics–gender stereotype endorsement influences mathematics anxiety, self-concept, and performance differently in men and women. *Annals of the New York Academy of Sciences, 1513*(1), 121–139. https://doi.org/10.1111/nyas.14779

Sadiković, S., Milovanović, I., & Oljača, M. (2018). Another psychometric proof of the abbreviated math anxiety scale usefulness: irt analysis. *Primenjena psihologija, 11*(3), 301–323. https://doi.org/10.19090/pp.2018.3.301-323

Schwarz, G. (1978). Estimating the Dimension of a Model. *The Annals of Statistics, 6*(2). https://doi.org/10.1214/aos/1176344136

Short, D., McLean, J., & Cunningham, C. (2019, June). Effects of attitudes, mindset, and anxiety on children's maths performance: A pilot study [Poster presentation]. *2nd conference of the Mathematical Cognition and Learning Society*, Ottawa, Canada.

Siegler, R. S., & Ramani, G. B. (2024). Early math anxiety and numerical cognition in preschool children. *Frontiers in Psychology, 15*, 1335952. https://doi.org/10.3389/fpsyg.2024.1335952

Sintawati, M., & Abdurrahman, G. (2019, May). Correlation between teaching readiness with math anxiety of primary pre-service teacher. *First International Conference on Progressive Civil Society (ICONPROCS 2019)* (pp. 187-192). Atlantis Press.

Sorvo, R., Koponen, T., Viholainen, H., Aro, T., Räikkönen, E., Peura, P., Tolvanen, A., & Aro, M. (2019). Development of math anxiety and its longitudinal relationships with arithmetic achievement among primary school children. *Learning and Individual Differences, 69*, 173–181. https://doi.org/10.1016/j.lindif.2018.12.005

Suárez-Pellicioni, M., Núñez-Peña, M. I., & Colomé, À. (2016). Math anxiety: A review of its cognitive consequences, psychophysiological correlates, and brain bases. *Cognitive, Affective, & Behavioral Neuroscience, 16(*1), 3–22. https://doi.org/10.3758/s13415-015-0370-7

Svraka, B., Álvarez, C., & Szücs, D. (2024). Anxiety predicts math achievement in kindergarten children. *Frontiers in Psychology, 15*. https://doi.org/10.3389/fpsyg.2024.1335952

Szczygieł, M., & Pieronkiewicz, B. (2021). Exploring the nature of math anxiety in young children: Intensity, prevalence, reasons. *Mathematical Thinking and Learning, 24*(3), 248–266. https://doi.org/10.1080/10986065.2021.1882363

Terry, J., Ross, R. M., Nagy, T., Salgado, M., Garrido-Vásquez, P., Sarfo, J. O., ... & Rahajeng, U. W. (2023). Data from an international multi-centre study of statistics and mathematics anxieties and related variables in university students (the SMARVUS Dataset). *Journal of Open Psychology Data, 11*(1), 5–20. https://doi.org/10.5334/jopd.80

Tabachnick, B. G. & Fidell, L. S. (2021). *Using Multivariate Statistics, 7th ed*. Pearson.

Van Mier, H. I., Schleepen, T. M. J., & Van den Berg, F. C. G. (2019). Gender Differences Regarding the Impact of Math Anxiety on Arithmetic Performance in Second and Fourth Graders. *Frontiers in Psychology, 9*. https://doi.org/10.3389/fpsyg.2018.02690

Wang, Z., Lukowski, S. L., Hart, S. A., Lyons, I. M., Thompson, L. A., Kovas, Y., Mazzocco, M. M. M., Plomin, R., & Petrill, S. A. (2015). Is Math Anxiety Always Bad for Math Learning? The Role of Math Motivation. *Psychological Science, 26*(12), 1863–1876. https://doi.org/10.1177/0956797615602471

Wang, Z., Shakeshaft, N., Schofield, K., & Malanchini, M. (2018). Anxiety is not enough to drive me away: A latent profile analysis on math anxiety and math motivation. *Plos One, 13*(2), e0192072. https://doi.org/10.1371/journal.pone.0192072

Wigfield, A., & Meece, J. L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80*(2), 210–216. https://doi.org/10.1037//0022-0663.80.2.210

Xie, F., Xin, Z., Chen, X., & Zhang, L. (2018). Gender Difference of Chinese High School Students' Math Anxiety: The Effects of Self-Esteem, Test Anxiety and General Anxiety. *Sex Roles, 81*(3–4), 235–244. https://doi.org/10.1007/s11199-018-0982-9

Zhang, J., Zhao, N., & Kong, Q. P. (2019). The Relationship Between Math Anxiety and Math Performance: A Meta-Analytic Investigation. *Frontiers in Psychology, 10*. https://doi.org/10.3389/fpsyg.2019.01613

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Ko se boji matematike još? Struktura i korelati matematičke anksioznosti kod dece predškolskog uzrasta

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Matematička anksioznost (MA) predstavlja fenomen koji je privukao pažnju istraživača i praktičara zbog svojih negativnih efekata na različite obrazovne ishode u učenju matematike i motivaciji za učenje matematike. Međutim, prethodna istraživanja pretežno su se fokusirala na učenike osnovnoškolskog i srednjoškolskog uzrasta, dok su deca predškolskog uzrasta u velikoj meri zanemarena. Ovaj jaz je posebno relevantan u domaćem kontekstu, gde se obrazovanje u ranom detinjstvu kontinuirano reformiše, a spremnost za učenje matematike se sve više prepoznaje kao ključni prediktor kasnijeg školskog uspeha. Stoga je cilj ovog istraživanja bio usmeren na ispitivanje strukture i korelata MA kod predškolske dece u Srbiji. Studija 1, sprovedena na uzorku od 258 dece uzrasta od 4 do 6 godina (50% dečaka), bila je usmerena na ispitivanje strukture *skale matematičke anksioznosti za mlađu decu* (YCMAX). Studija 2, sprovedena na uzorku od 205 dece uzrasta od 4 do 6 godina (48,8% dečaka), bila je usmerena na ispitivanje odnosa između aspekata MA (zabrinutost i somatizacija), pola, uzrasta i spremnosti dece za učenje matematike, primenom korelacione analize putem *testa spremnosti za učenje matematike*, kreiranim za procenu (pred)matematičkih veština kod predškolske dece. Rezultati CFA ukazuju na to da je *skala matematičke anksioznosti za mlađu decu* adekvatan instrument za merenje ove vrste anksioznosti i da se, čak i na ovom uzrastu, mogu identifikovati negativne veze između MA i različitih (pred)matematičkih veština. Studija diskutuje i o potencijalnim benefitima primene ove skale od strane praktičara u predškolskim ustanovama, kao i o specifičnostima odnosa između MA i različitih matematičkih sposobnosti i uzrasta dece u predškolskom (ne)evaluativnom kontekstu.

Ključne reči: matematička anksioznost, predškolski uzrast, spremnost za učenje matematike, zabrinutost, somatizacija

Appendix 1

YCMAX: the Serbian version

Sada ću ti pročitati nekoliko rečenica u vezi sa brojevima i matematikom. Kada ti pročitam rečenicu, ti ćeš mi odgovoriti na pitanja koliko si nervozan/nervozna ili zabrinut/zabrinuta. Možeš da budeš malo nervozan/nervozna ili zabrinut/zabrinuta (*malo* – 2), mnogo nervozan/nervozna ili zabrinut/zabrinuta (*mnogo* – 3), ili da uopšte ne budeš nervozan/nervozna ili zabrinut/zabrinuta (*ne* – 1). Ti samo treba da mi kažeš da li si nervozan/nervozna i koliko – ne, malo ili mnogo – kada ti pročitam rečenicu.

Pitanja:	Odgovori		
Da li osećaš neku nervozu kad radiš zadatke sa brojevima?	1	2	3
Da li osećaš neku nervozu kad pogrešiš u nekom zadatku sa brojevima?	1	2	3
Da li te od matematike nekad zaboli glava?	1	2	3
Da li osećaš nervozu kad vidiš knjigu ili svesku sa brojevima?	1	2	3
Da li si zabrinut/a jer je matematika teška za tebe?	1	2	3
Da li ti se plače kad pomisliš na matematiku?	1	2	3
Da li si nervozan/nervozna kad dođe vreme da radiš zadatke sa brojevima?	1	2	3
Da li si nervozan/nervozna kada radiš zadatke s brojevima pred drugarima u vrtiću?	1	2	3
Da li si nervozan/nervozna kad ne možeš da rešiš neki zadatak iz matematike?	1	2	3
Da li te od matematike nekad boli stomak?	1	2	3
Da li si nervozan kada vaspitač/ica organizuje neku igricu gde se koristi matematika?	1	2	3