Edukacja 2024, 1(168)
DOI 10.24131/3724.240102
ISSN 0239-6858

Fear of taking math exams in the time of COVID-19

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Abstract

Mathematics exam results play a critical role in shaping students' future educational pathways. Understanding the factors that negatively impact math achievement and attitudes towards mathematics, particularly in the context of general anxiety, has become increasingly important, especially during the COVID-19 pandemic and the shift to remote education. This study aimed to explore the mechanisms through which general anxiety influences math achievement, specifically in the context of high-stakes qualifying exams, among Polish adolescents. Analysing data from a unique sub-sample of panel participants (N=110), we found that math achievement in this group was directly influenced only by math anxiety, while general anxiety affected math achievement indirectly through its impact on math anxiety. We recommend addressing not only the overall exam-related anxiety but also the specific fear of mathematics to help reduce math anxiety among youth.

Keywords: **Math anxiety, test anxiety, general anxiety, math achievement.**

Obawy związane z egzaminami z matematyki w czasie pandemii COVID-19

Streszczenie

Osiągnięcia matematyczne determinują dalsze wybory edukacyjne. Istnieje potrzeba lepszego zrozumienia czynników, jakie wpływają na obniżenie osiągnięć i postaw wobec matematyki w połączeniu z lękiem ogólnym, zwłaszcza w czasach pandemii COVID-19 i edukacji online. Celem badania było ustalenie mechanizmów, poprzez które lęk ogólny wpływa na osiągnięcia matematyczne (egzamin maturalny z matematyki) wśród polskich młodych dorosłych. Korzystając z unikalnej podpróby młodych dorosłych (N = 110), stwierdziliśmy, że osiągnięcia matematyczne w tej grupie zależą bezpośrednio tylko od lęku przed matematyką, podczas gdy lęk ogólny wpływa na osiągnięcia w tym zakresie pośrednio poprzez lęk przed matematyką. Zaleca się zmniejszenie lęku przed matematyką wśród młodzieży, a nie wyłącznie skupienie się na dobrym zdaniu całego egzaminu.

Słowa kluczowe: **Lęk przed matematyką, lęk testowy, lęk ogólny, osiągnięcia matematyczne.**

INTRODUCTION

If someone is afraid to take exams in general and also becomes anxious in various new stressful situations, this could impact their passing or failing any exam, especially more difficult ones like the mathematics exam at the end of secondary school. The time of the COVID-19 pandemic brought a new situation to education in general, as students had to attend classes online. For those who were in the last year of secondary school, this could have increased their anxiety before taking the final and most important exams of their lives. Additionally, being the Polish cohort whose secondary school education was supposed to last only three years (lyceum), they experienced breaks in learning. During their first year of secondary education, schools were closed for about two months due to a widespread teachers' strike (Ziółkowski, 2020). Then later, in the middle of their second year and followed by the entire third year until the end of school, they were affected by the COVID-19 pandemic, being taught only remotely for almost the entire period of March 2020 to May 2021.

As such, it was not easy for students to prepare stress-free for their final exams as they could have if the COVID-19 pandemic had not occurred and there were no earlier breaks due to strikes. Especially in the context of preparing for the math exam, additional anxiety could have been experienced due to the inability to pass it as they would have wished. Students could have been afraid to take this exam and/or all exams in general at the end of the school year, as well as fear other issues, including the COVID-19 situation.

In this paper we would like to show how in the time of COVID-19, a group of secondary school students in one Polish city – Kraków – were surveyed before exams, including their fear/anxiety concerning exams, and especially math exam. An additional aim was to determine, how overall anxiety and fear of exams and of mathematics had an impact on the scores they received on their final math examination. For many students, passing this exam with a high score is the passport to apply to their first-choice faculty in higher education.

First, we present a short overview of the theoretical findings on math anxiety and related anxieties in our research. Next we show the data and methodology, present the conceptual framework verified in the analysis, and finally, the results with conclusions and a discussion.

STATE OF THE ART

The importance of mathematics in daily life is undeniable and emphasized by the most influential international socio-economic development agencies, such as the Organisation for Economic Co-operation and Development (OECD). "Nurturing excellence in mathematics, reading or science, or in all three domains, is crucial for a country's development as these students will be in the vanguard of a competitive, knowledge-based global economy" (OECD, 2014, p. 9). Mathematical achievements determine further educational choices, as well as career progress and earnings (e.g., Rose & Betts, 2001). At the same time, research is alarming about the significant decline in mathematical achievement in many countries, including the United States, China and Brazil (e.g., Kastberg, Chan & Murray, 2016; OECD, 2016). Therefore, it is crucial to understand the impact of the factors lowering math achievement and, indirectly, attitudes towards mathematics. One such factor is negative affect, and understanding its impact mechanism should be in the spotlight of educators and other stakeholders.

On the other hand, anxiety is considered to be one of the most common causes of poor school performance, regardless of the culture and age of the student. Seipp's meta-analysis (1991) found that high-anxious students averaged almost half a standard deviation lower (d=-.043) than their low-anxious counterparts on the achievement scale. The averaged effect sizes are highly heterogeneous and the mean effect size may be underestimated due to the frequently claimed nonlinear relationship between anxiety and performance (Seipp, 1991). Anxiety before an examination is completely natural, and in fact, anxiety is an adaptive mechanism. The problem, however, arises when the level of anxiety increases and exceeds the optimal level. According to Sansgiry and Sail (2006), the negative effects of anxiety on students' performance could be explained by the interference model and the learning-deficit model (Tobias, 1985; Wine, 1980). The interference model recognizes the causes of low performance as distraction and perturbation due to task-irrelevant cognitions and negative thoughts during examinations. Typically, it is harder for an anxious student to overcome distractions and it takes more time to refocus on the task. Therefore, an increased cost is experienced by highly anxious students in completing a cognitive task compared with their peers. On the other hand, too low levels of anxiety are also detrimental, thus a moderate level of anxiety is considered best, as students are more motivated to do better in school, and thus obtain a higher achievement (Cruz et al., 2015). According to the learning deficit model, students are anxious because they are aware of their ineffectiveness from the study and preparation stage to the test stage.

Irrespective of the mechanism generating these relationships, the impact on students remains undeniable, as anxiety problems are one of the most frequent mental health problems among children, with a prevalence exceeding 40% (Cartwright-Hatton et al., 2006). One of the specific constructs tested in the context of learning and student achievement is test anxiety. Traditionally, test anxiety is associated with heightened levels of physiological arousal, which leads to a disturbance in information processing (memory recall, information use) during testing situations (e.g., Wine, 1971). However, a meta-analysis by Roos and colleagues (2001) indicates only a medium-sized positive relationship between self-reported test anx-

iety and physiological arousal. Therefore, the newer theories complement the biological and psychological bases of test anxiety by the interaction of educational context (Lowe et al., 2008), demographic characteristics and environmental contingencies, e.g., educational expectations (Segool & von der Embse, 2014). Thus, much research has been devoted to the influence of test anxiety on students' performance. The results of these studies are summarized by a meta-analysis conducted by von der Embse and colleagues (2018). Results indicated that test anxiety has significant and negative influence on a wide range of educational performance outcomes, including typical classroom tests (e.g., class test or quiz; from r = -.16 in secondary school to r =-.25 middle school), grade point average (GPA) (r = -.17), intelligence (IQ) (up to r = -.24 for verbal abilities), and finally standardized exams (r = -.26).

Math anxiety is another key factor in lowering mathematical achievement and can be defined as a negative emotion that responds to mathematics-related situations perceived as threatening to self-esteem (Cemen, 1987). Such a reaction can be triggered by various causes: environmental (e.g., previous negative mathematics experiences or lack of parental support), individual (e.g., low self-esteem, negative attitude towards mathematics) and situational (e.g., the way of learning in the classroom). Research suggests that math anxiety can be problematic at any stage of education, from primary school onwards (e.g., Gunderson et al., 2018). The negative influence of math anxiety and student achievement has been found in many empirical studies (e.g., Ma, 1999; Miller & Bichsel, 2004). However, the size of the math anxiety effect varies from study to study due to the role of different factors moderating this relationship. The classic meta-analysis indicates an average effect size of r = -.27 (Ma, 1999), while the latest research reports an overall mean ES of about –.3 (Zhang, 2019) and r =-.28 (Barroso et al., 2021). Therefore, in general, the effect of math anxiety on student achievement can be considered significant, negative and small-to-moderate in size (Cohen, 1988, 1992). Math anxiety can influence outcomes directly, but also indirectly by influencing students' attitudes and the choices of specific educational pathways. For example, students with consistently low math anxiety during middle through secondary school are more likely to choose STEM subjects during postsecondary education than students who are highly anxious from middle to secondary school (Ahmed, 2018). The role of educators is crucial in decreasing students' levels of anxiety, especially as studies suggests that a solid foundation in mathematical skills and knowledge is beneficial for relieving math anxiety and improving math performance (Beilock & Willingham, 2014).

While much research has addressed the negative effects of math anxiety on mathematical achievement, little is known about the nature of this mechanism. It is not known to what extent mathematics anxiety is a specific construct and to what extent it shares variance with other, more general types of anxiety, i.e., anxiety in general and test anxiety, both described above. In some studies, after controlling for generalized anxiety and test anxiety, the relationship between math anxiety and student performance disappears (e.g., Ganley & McGraw, 2016), while in others, it is still statistically significant (e.g., Hill et al., 2016). If math anxiety is a predictor of student achievement and is a specific construct, then despite the control of other forms of anxiety, it should show a statistically significant relationship with the standardized test results. Szczygieł (2020) conducted one of the few studies testing this hypothesis. She found that math anxiety is specific to mathematics and cannot be identified with general or test anxiety. Note that this research was conducted on a sample of Polish students, although it concerned younger children (primary schools), and the stakes for the test performance were not as high as in the study in this paper.

The secondary school qualifying exam in Poland is a classic example of a high-stakes test due to its serious consequences for the further educational career of a student, as it is a standardized indicator determining admission to higher education. The effects of this examination apply not only to students and their families, but also to schools and teachers (secondary school rankings). Therefore, this study better reflects the high-stakes nature of the test and better grasps the nature of the test anxiety.

DATA AND METHODS

1. Procedure

Data for the current study were collected within a panel research project on adolescents' activities over their life course ("the Jagiellonian Panel"). Quantitative data were collected using self-reporting questionnaires sent to individual e-mail addresses. The invitation to be enrolled in the Jagiellonian Panel was sent at the beginning of 2021 by e-mail (via schools electronic communications system) to all secondary school students in the city of Cracow (N=6,744).

Additionally, there were Facebook campaigns and advertisements on the websites of schools, the university and the project ambassadors to promote the idea of being a member of the Jagiellonian Panel community and to accept the invitation.

The invitations were directed to persons born in 2002 (these individuals officially became adults at 18 years of age in Poland in 2020), as they no longer needed the permission of parents/guardians to participate in the study. There are currently about 204 young adults (born in 2002) in the Jagiellonian Panel. An interdisciplinary team of experts from the Jagiellonian University prepared the overall tool. The tool was discussed and tested during focus group interviews. As a result, the study was designed in an optimal and acceptable way for young respondents. Its aim is to conduct long-term monitoring on various aspects of their lives, such as education, work, attitudes and opinions. The participants who voluntarily registered to take part

in the Jagiellonian Panel provided all required consents and were given GDPR regulations to secure all ethical aspects of the study. Informed consents were obtained from all study subjects (persons aged 18+) before sending them the online questionnaires.

After registration, participants were sent individual links by e-mail or text messages to complete the questionnaires, which were administered through a professional online survey software program. Personal data (name, e-mail, phone number for contacting them in the future) were separated from the survey results and not used for any further purpose. All personal data was secured and encrypted. The participants first had to decide to enroll in the Jagiellonian Panel and then to agree to participate in the surveys without any additional financial incentive, but they always had the option to withdraw, or to refuse answering. However, the response rates of – already – two waves were very high (76% – wave 1 – before the exam in April/beginning of May 2021, and 95% – wave 2 – in July 2021, when the exam results were announced).

The authors confirm that all research methods of this study were conducted in accordance with relevant national guidelines and international regulations. All research protocols were approved by the Ethical Review Committee (FERB) of the Jagiellonian University, Kraków, Poland (24/03/2020). The authors also confirm that informed consents were obtained from all subjects (all were adults over 18 years of age).

2. Participants

A total of 204 adolescents are in the panel, however, for this paper we used data from only 110 of them who completed the questionnaires twice, as some still are in the education system and will take the completion exams at the end of school in 2022. The final study sample consisted of 105 adolescents, all aged 19 years, of which 39.1% were male and 60.9% female. The participants of this analysis are distributed among 25 schools, so the results are not clustered around only a few schools.

3. Measures

3.1. Mathematics Achievement

In the Polish education system, the maturity exam (secondary school completion examination) is officially known as the "matura". The matura exam is taken at the end of secondary school education, generally in May, with retakes available in August. This exam is not mandatory, although Polish pupils are required to pass this exam in order to apply for higher education studies (high-stakes test). The matura exam in 2021 consisted of written exams from obligatory as well as additional voluntarily selected subjects. Polish higher education institutions accept students primarily on the basis of matura results. In 2021, the matura exam had three compulsory examinations at the basic level in the following subjects: a) Polish language, b) modern language: this could be French, Italian, English, Russian, German, or Spanish, and c) mathematics. The results are provided in percentages from 0% to 100% as well as the position of the individual in relation to all of the results.

3.2. General anxiety

The General Anxiety Disorder-7 (GAD-7) (Spitzer et al., 2006) questionnaire was used to examine participants' anxiety symptoms over the previous two weeks. GAD-7 has seven items describing a number of the most salient diagnostic features of GAD (i.e., feeling nervous, anxious, or on edge, and worrying too much about various things).

The wording of the items is as follows:

Over the last 2 weeks, how often have you been bothered by any of the following problems?

- Feeling nervous, anxious or on edge.
- Not being able to stop or control worrying.
- Worrying too much about different things.
- Trouble relaxing.
- Being so restless that it is hard to sit still.
- Becoming easily annoyed or irritable.
- Feeling afraid as if something awful might happen.

Items are rated on a 4-point Likert-type scale from 0 (not at all) to 3 (almost every day). The result of the Cronbach's α from our data was 0.92.

3.3. Mathematics anxiety

Mathematics anxiety was measured using the Abbreviated Math Anxiety Scale (Hopko et al., 2003). AMAS consists of 9 items, to which participants respond using a 5–point scale for indicating how anxious certain math situations would make them feel, with 1 representing low anxiety and 5 representing high anxiety.

The scale includes the following items:

- Having to use the tables in the back of a math book.
- Thinking about an upcoming math test 1 day before.
- Watching a teacher work an algebraic equation on the blackboard.

- Taking an examination in a math course.
- Being given a homework assignment of many difficult problems that is due the next class meeting.
- Listening to a lecture in math class.
- Listening to another student explain a math formula.
- Being given a "pop" quiz in math class.
- Starting a new chapter in a math book.

The Cronbach's α from our data was 0.82.

3.4. Test anxiety

Test anxiety was assessed with the short form of the Test Anxiety Inventory (TAI) (Taylor & Deane, 2002). This questionnaire is a self-reporting measure consisting of 5 items answered with a 4-point rating scale from (1) "almost never" to (4) "almost always".

The scale includes the following items:

- During test I feel very tense.
- I wish examinations did not bother me so much.
- I seem to defeat myself while working on important test.
- I feel very panicky when I take an important test.
- During examinations I get so nervous that I forget facts I really know.

A higher total score on this scale indicates a greater number of test anxiety symptoms. The Cronbach's α from our data was 0.89.

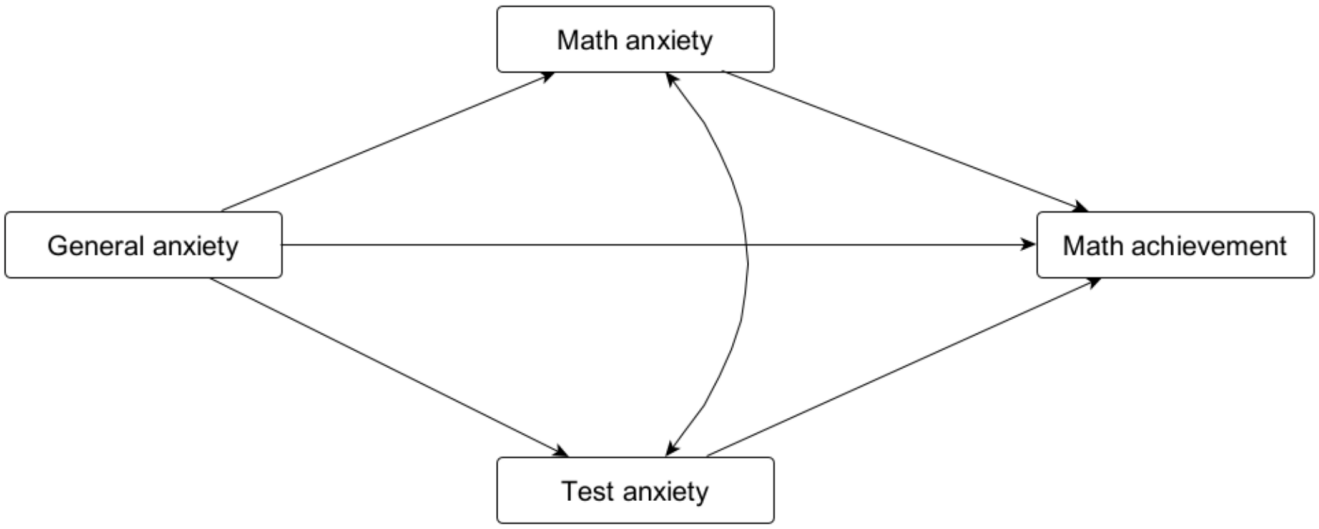
3.5. Statistical analyses

Means and standard deviations or percentages, as appropriate, were calculated for all study variables. Cronbach's alpha coefficients were computed to examine the internal consistency and reliability of the scales. Bivariate associations between the constructs of interest were assessed by Pearson product-moment correlations.

The main analyses were conducted using path analysis. Path analysis is a sequence of several regressions and possible correlations whose determination is based on the adopted hypotheses, allowing for: (1) the simultaneous estimation of a series of partial regression coefficients (when controlling all variables included in the path model), and (2) estimations of not only of direct, but also indirect effects.

Based on the literature review, it was assumed that (1) mathematics anxiety, test anxiety and general anxiety directly affect mathematics achievement; (2) general anxiety determines mathematics anxiety and test anxiety. It is therefore also assumed that general anxiety will be affected not only directly, but also indirectly by mathematics and test anxiety (see Figure 1).

Figure 1. ***Path model for mediation analysis.***



Note: **lines with a single arrow – regression paths; lines with two arrows – correlation paths.**

3.6. Software and estimation methods

All analyses were conducted with the Mplus 8.2 package using the maximum likelihood (ML) estimation (Muthén & Muthén, 2017). The bootstrapping procedure recommended by Preacher and Hayes (Preacher & Hayes, 2008) was applied for testing the significance of the indirect effects. Unlike traditional tests, such as the Sobel test (Sobel, 1982), bootstrapping does not require the assumption that the sampling distribution of the indirect effect is normal, which is especially difficult to meet with small research samples. We used 10,000 bootstrap resamples to calculate the bias-corrected 95% confidence interval (CI). If the interval does not include zero, the effect is statistically significant at $p < 0.05$. We used only cases with no items missing in the selected variables.

RESULTS

Means, standard deviations, and Pearson correlations with confidence intervals for the instruments administered to study participants are presented in Table 1. General, mathematics, test anxiety and mathematics achievement were all significantly correlated in the expected direction.

Table 1 ***Means, standard deviations, and correlations with confidence intervals***

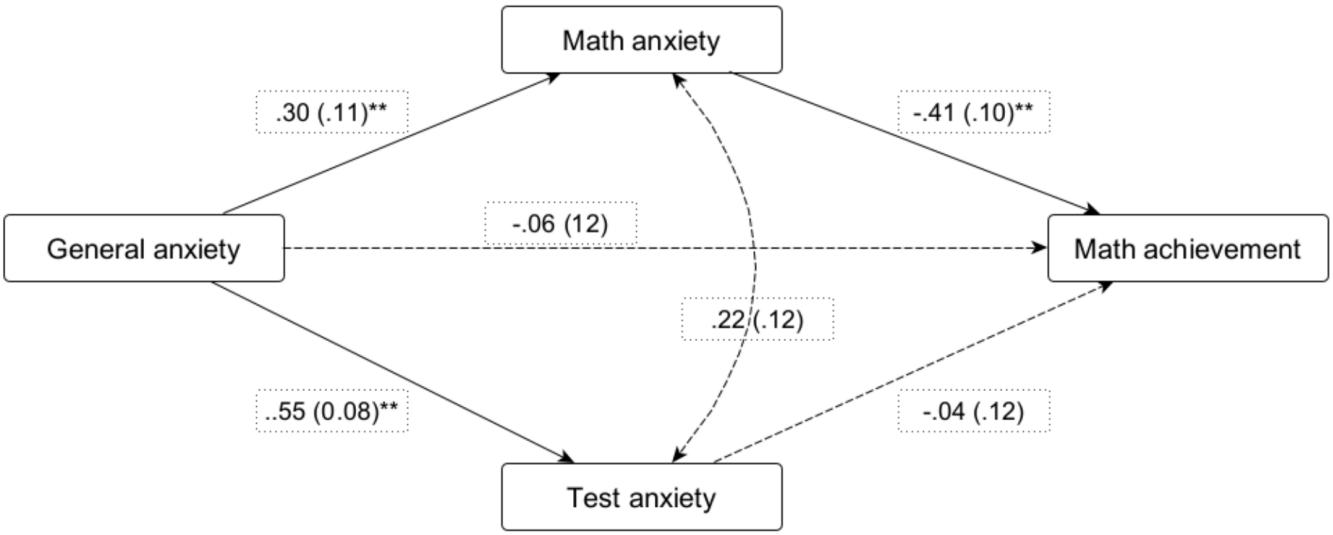
Variable	*M*	*SD*	1	2	3
1. Math Achievement	85.84	17.95			
2. General anxiety	11.04	6.69	-.22*		
			[-.42, -.00]		
3. Math anxiety	18.07	5.61	-.45**	.35**	
			[-.60, -.25]	[.15, .53]	
4. Test anxiety	11.99	4.18	-.22*	.55**	.37**
			[-.42, -.00]	[.38, .68]	[.16, .54]

Note. **M and SD represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates p < .05. ** indicates p < .01.**

Standardized regression parameters from the tested path model are shown in Table 2 and Figure 2. Mathematics achievement depends directly only on mathematical anxiety, the relationship is relatively strong ($\beta = -0.41$, SE = 0.10, $p < 0.01$), explaining as much as 20% of the variance in mathematics achievement. Importantly, mathematics achievement is not affected directly either by test anxiety or general anxiety, as the effects are not statistically significant. To determine whether or not the calculated p value was caused by the small number of participants, a post-hoc power analysis was performed based on the Monte Carlo simulation (Muthén & Muthén, 2002). With a (large) sample size of 1000 and the results of the study as population values with 100,000 replications, the simulation indicated that the power for regression coefficients for math achievement on general anxiety was 0.36 and for math achievement on test anxiety was 0.20. Following Cohen (1988), the statistical power estimates (i.e., 0.8 and above) mean that under these conditions, there was a only 36% and (respectively) 20% chance that these coefficients would be proven to be statistically significant. This result reaffirms that the p value of the regression coefficients obtained in our analysis does not emerge from the small sample. However, replicating the results on a larger sample is needed to confirm the conclusions we have reached.

General anxiety is significantly associated either with mathematical anxiety ($\beta = 0.30$, SE = 0.11, $p < 0.01$) or test anxiety ($\beta = 0.55$, SE = 0.08, $p < 0.01$).

Figure 2. ***Path model for mediation analysis.***



Note: **General anxiety – General Anxiety Disorder-7 (GAD-7); Math anxiety – Abbreviated Math Anxiety Scale (AMAS); Test Anxiety – Test Anxiety Inventory (TAI); Math achievement – Math Matura Exam (high stake exam); lines with a single arrow – regression paths; lines with two arrows – correlation paths; solid lines – standardized regression coefficients significant at the .05 level; dashed lines – standardized regression coefficients not significant at the .05 level; results in brackets represent the standard error. * p < .05; ** p < .01**

The results presented here do not mean, however, that mathematics achievement is entirely independent of general anxiety. We found one essential indirect effect in the case of general anxiety (see Table 2). Higher levels of general anxiety decrease levels of mathematical achievement by increasing mathematics anxiety (βIND = -0.15, 95% CI -0.31 and -0.04). The mediating effect via test anxiety is not significant (βIND = -0.02, 95% CI -0.15 and 0.01).

Table 2 ***Standardized regression parameters from the path model of the effects of general anxiety, math anxiety and test anxiety on math achievement***

	Direct Effect			Indirect Effect	
	Math anxiety	Test anxiety	Math achievement	Math achievement on General anxiety	
	β (SE)	β (SE)	β (SE)	Path via	β_{IND} (95% CI)
General anxiety	.35 (.11)**	.55 (.08)**	-.06 (.12)		
Math anxiety	–	–	-.41 (.10)**	Math anxiety	-.15 (-.31 – -0.04)
Test anxiety	–	–	-.04 (.12)	Test anxiety	-.02 (-.15 – .01)
R-square	.124	.302	.204	–	–

Note: **β – estimation of standardized coefficient; SE – standard error; CI = confidence interval; General anxiety – General Anxiety Disorder-7 (GAD-7); Math anxiety – Abbreviated Math Anxiety Scale (AMAS); Test Anxiety – Test Anxiety Inventory (TAI); Math achievement – Math Matura Exam (high stake exam) *p < .05, **<.01 (two-tailed tests).**

DISCUSSION

The purpose of this study was to investigate the mechanisms through which general anxiety affected math achievement (secondary school completion math exam) among Polish youth (aged 18+ years) during the COVID-19 pandemic at the end of secondary school. Neither general nor test anxiety is related to math achievement when math anxiety is included in the analysis. Our results suggest that math achievement for this group directly depends only on math anxiety, whereas general anxiety affects mathematics achievement only indirectly through mathematics anxiety. In other words, the results show that general anxiety is a risk factor that may contribute to the development of a more specific form of anxiety – math anxiety, and therefore may be indirectly related to mathematical performance. These results confirmed what Szczygieł found, but this research was only on young children (primary school) (Szczygieł, 2002b). Another difference between our analysis and Szczygieł's is that we used well-known and validated measurement tools. The third difference in our approach was checking the relationship between math achievement and math anxiety among students taking a high-stakes examination.

The absence of associations between test anxiety and math achievement (after controlling for general and math anxiety) is interesting given that previous research has indicated that test anxiety is moderately correlated with math anxiety (Hembree, 1990; Kazelskis et al., 2000; Samuel & Warner, 2021), and remains a significant predictor of math performance when controlling for math anxiety (Szczygieł, 2020a, 2020b). This lack of relationship may be due to methodological issues (our small study sample), which resulted in the lack of interactions with gender in the analyses. Taking gender into account can be important because some studies show that after controlling for test anxiety, the negative relationship between girls' math anxiety and math performance remained, but the negative relationship between boys' math anxiety and math performance became only marginal (Devine et al., 2012). Thus, although our results indicate that test anxiety appears not to be related to math achievement, we cannot be sure that this applies to both boys and girls without controlling for gender. More research in this area is needed.

The findings from this study provide valuable insights and practical implications for educators, teachers and policymakers working with students preparing for high-stakes exams. The results of our study suggest that improving students' math skills should primarily be served by interventions that directly focus on math anxiety rather than generalized or test anxiety. Schools could implement broader mental health programs providing teachers with access to professional development workshops on recognizing and alleviating math anxiety. This is in line with previous studies reporting that acting directly to improve students' experiences and performance in math – as intensive one-to-one math tutoring with individualized attention (Supekar et al., 2015; for a review of this type of intervention: Ramirez et al., 2018) – may be more likely to improve their performance (Carey et al., 2017) than simply trying to reduce levels of general anxiety (Bicer et al., 2020). Finally, we should work towards an examination system that reduces students' stress and schools should adjust the testing atmosphere to be more supportive e.g., by introducing a short relaxation period before an exam.

STRENGTHS, LIMITATIONS, AND FUTURE RESEARCH

Establishing a panel of youth and monitoring them before an exam and after announcing its results are innovative aspects of this study. This particular generation is unique, as even though there is a plan to repeat this study with a new cohort in the future, their situation is different given the exceptional way their education was organized due to external circumstances. Therefore, it will not be possible to compare these results to those of other young cohorts.

The findings from this research must be interpreted in the context of several methodological limitations. First, even though the participants were members of a larger panel survey, the data we used has to be treated as cross-sectional (as it is not possible to follow the trends of this specific group or to repeat this situation in the future for them because such an event is possible only once). This precludes any definite inferences about the direction of the relationships between the variables. Next, it should be considered that the sample was a targeted one, comprised of Polish students from only one city in Poland (with usually better scores from such exams than the rest of Poland), and therefore the findings cannot be generalized to include students from other places in Poland, as well as in other countries and contexts. We can only assume that if math anxiety was an issue in taking a high-stakes math exam for such a better-prepared group of youth, the effect of math anxiety for average pupils or those with lower achievements in school may be even greater. Furthermore, our analyses did not include potentially relevant variables, such as mathematical self-esteem or measurements of prior mathematical skills, which are planned to be added in the next waves of the panel for successive cohorts of youth in the country, and more specifically, in the selected city.

CONCLUSIONS

We believe that our research can provide new light on better understanding the mechanisms by which general anxiety, math anxiety and test anxiety contribute to math achievement among youth, especially in times of such unpredictable situations

such as the pandemic and its consequence of remote education. Most notably, our results can also be important for pedagogy and teachers, including those who are responsible for supporting and helping pupils to prepare for math exams, in terms of introducing measures which will also reduce general anxiety and test anxiety. The measures that will be effective open up fields for an additional evaluation of how to be successful in minimizing a fear of mathematics. As such, reducing the fear of taking math exams can have a positive impact on exam results and thus be accepted to a desired higher education program.

RESEARCH TEAM

The team involved in the Jagiellonian Panel at the Jagiellonian University (in 2021) consisted of: Jolanta Perek-Białas (Co-ordinator), Małgorzata Kossowska, Katarzyna Szczerbińska, Paweł Grygiel, Marta Smagacz-Poziemska, Barbara Worek, Maksym Dębski, Łukasz Fiedeń, Grzegorz Humenny, Regina Skiba, Paulina Skórska, Michał Wolszczak, Weronika Król, Marcin Baumann, Anna Horodyska, Aleksandra Gościcka, Jan Stąporek. Currently, the core group of the Jagiellonian Panel consists of Jolanta Perek-Białas, Paweł Grygiel, Paulina Skórska and Ewa Krzaklewska with support of Małgorzata Kossowska.

FUNDING

This research was supported by a grant from the Strategic Program Excellence Initiative at the Jagiellonian University (in 2021) and followed by a grant from the Priority Research Area (Future Society: Behavior in Crisis Lab—Flagship Project) under the Strategic Programme Excellence Initiative at Jagiellonian University (Poland) https://phils.uj.edu.pl/en_GB/inicjatywa-doskonalosci.

DATA

The data supporting the findings of this study are available from the research team (contact the Corresponding Author) but restrictions apply to their availability, which were used under license for the current study. For this reason, they are not yet publicly available. However, the data will be made available upon reasonable request by e-mail to the authors and after the permission of the research team is obtained.

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