MATH/SCHOOL ANXIETY AND SPORT PARTICIPATION. A CORRELATIONAL STUDY FROM THE ABMOVE! PROJECT

ANSIA IN MATEMATICA/ANSIA SCOLASTICA E PARTECIPAZIONE ALLO SPORT. UNO STUDIO CORRELAZIONALE ALL'INTERNO DEL PROGETTO ABMOVE!

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ABSTRACT
Participation in sports activities yields substantial benefits for individual well-being, potentially mitigating anxiety symptoms. This study is part of the PNRR 2022 project ABMOVE! funded by the European Union – Next Generation EU and examines the relationship between participation in sports activities and perceived anxiety levels in a large-scale sample of Italian students. This preliminary analysis offers insights into anxiety profiles and sports engagement, generating implications for educational practice.

La partecipazione ad attività sportive apporta notevoli benefici al benessere individuale, attenuando potenzialmente i sintomi dell'ansia. Questo studio fa parte del progetto PNRR 2022 ABMOVE!, finanziato dall'Unione Europea - Next Generation EU, e analizza la relazione tra la partecipazione ad attività sportive e i livelli di ansia percepiti in un ampio campione di bambini/e italiani/e. Questa analisi preliminare offre spunti di riflessione sui profili di ansia e sull'impegno sportivo, generando implicazioni per la pratica educativa.

KEYWORDS
Math Anxiety; School Anxiety; Sport Participation.
Ansia in matematica; Ansia scolastica; Partecipazione sportiva.

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Introduction

Physical activity is associated with various health benefits, including maintaining a healthy weight, enhancing cognitive function, and improving cardiorespiratory fitness. Studies across the literature have examined and confirmed the relationship between physical activity and mental health or mental disorders (Biddle & Asare, 2011) indicating that it can lead to better mental health outcomes or help prevent the onset of mental disorders in a wide range of individual, especially in adolescents (Chi & Wang, 2022) and young adults.
Although further rigorous studies are needed to confirm the effects of physical activity on the mental health of primary school children (Rodriguez-Ayllon et al., 2019), an interesting study on early childhood (Bellafiore & Palma, 2010) suggests that playful motor activity has a huge impact on the motor and cognitive development of children from a very early age.

Doing physical activity from nursery school onwards affects not only musculoskeletal development but also all those cognitive and emotional functions that are the basis of children's psycho-physical well-being.
Recognizing the importance of movement and sports practice in the psycho-physical development of children, the contribution presented here is part of the PNRR 2022 project ABMOVE! "Inclusive Didactics for Enhancing Math Learning and Reducing Math Anxiety: Efficacy of Active Breaks in the Classroom", funded by the European Union – Next Generation EU (CUP: F53D23010970001).

1. School and Math anxiety

Performance anxiety is a widely studied psychological phenomenon that can manifest itself in a variety of everyday life circumstances, particularly when individuals are being assessed. In school settings, this form of anxiety is one of the most common manifestations and can significantly influence students' academic performance and well-being, as well as their emotional and social development. Although the scientific literature has mainly focused on secondary school and university students, there is a growing awareness of the importance of examining this phenomenon also among primary school students. During their school years, children start developing the core skills needed for thinking and managing emotions, skills that are vital for their long-term success. Early experiences of

performance anxiety can have lasting effects, influencing not only their immediate performance, but also shaping their self-confidence and attitude toward future academic tasks and challenges (Di Vita & Di Martino, 2024). Additionally, this anxiety can be heightened by the pressure of high-stakes standardized testing (Nichols & Berliner, 2007), which many children see as pivotal to their academic and career paths.
More precisely, "math anxiety" (MA) may be defined as "a feeling of tension, apprehension, or fear that interferes with math performance" (Ashcraft, 2002, p.181).

MA is a multidimensional construct that can manifest in various ways (Caviola et al., 2019):

- emotionally, through negative feelings such as worry, fear, apprehension, and frustration;
- physically, through symptoms such as increased heart rate, breathing difficulties, and "butterflies" in the stomach;
- behaviorally, through avoidance and disengagement from the subject.

The nature of the subject itself must also be considered. For example, errors in mathematics are often seen as absolute and objective indicators of failure, reinforcing the notion that mistakes are inherently negative. This perception is incorrect and can harm the relationship with mathematics, influencing even teachers, who often aim to maximize correct answers while minimizing errors. Although this approach might seem logical and justified, it can negatively impact classroom activities; teachers may tend to avoid exercises likely to cause difficulties and errors among students. This fosters the belief that only the correct final product matters to the teacher, overshadowing the importance of the problem-solving process, which is, in fact, the true educational moment. School should be the ideal place for students to face challenges and overcome obstacles. However, particularly in mathematics, the distorted view of errors leads to the demonization of mistakes and fosters a fear of failing, along with various negative emotions (Baccaglini-Frank et al., 2018).

MA can also affect collective situations, where the fear of making mistakes can intensify and trigger anxious reactions (Ashcraft, 2002; Toso et al., 2023). Moreover, MA is not confined to academic settings but can also be experienced in everyday situations involving numbers (Ashcraft, 2002; Ashcraft & Moore, 2009).

MA can therefore cause distress and negative thoughts, leading individuals to exhibit lower interest and motivation and to avoid math-related situations. This avoidance behavior further exacerbates the problem: reduced exposure to mathematics over time leads to decreased competence and increased vulnerability to anxious experiences (Cuder et al., 2020). Mathematical competence is often perceived as a symbol of intelligence, which can cause individuals struggling with math to experience broader self-esteem issues in academic contexts (Ashcraft, 2002).

The long-term negative impact of MA should not be underestimated, as it severely limits future professional choices. Believing they lack the necessary abilities, individuals may avoid academic and career paths involving mathematics or STEM fields (Science, Technology, Engineering, and Mathematics), thus narrowing their future career opportunities (Ashcraft, 2002; Ashcraft & Moore, 2009).

The international Programme for International Student Assessment (PISA) survey has explored math anxiety, particularly since 2012, revealing that in OECD countries, 30% of students reported feeling helpless or nervous when faced with mathematical problems; in Italy, this figure rises to 43%. This correlates with lower performance in mathematical competence assessments (OECD, 2013). In the most recent survey from 2022, data confirmed the impact of math anxiety across all participating countries. Interestingly, some Asian countries, despite achieving significantly higher test scores than others, still reported high levels of MA. This supports the view that math anxiety is a multidimensional construct influenced by various personal and contextual factors, rather than explainable by a single cause (OECD, 2023).

Math anxiety differs from test anxiety (TA), which "refers to the presence of worries, physiological responses (e.g., sweating, trembling, increased heart rate), behavioral responses (e.g., avoidance), and social consequences related to the fear of failure and being evaluated during tests and exams" (De Francesco et al., 2020, p.558). While MA specifically concerns mathematics, TA involves anxiety in any evaluation situation, regardless of the subject. Both are specific forms of generalized anxiety disorder (GAD), which manifests across multiple life contexts (De Francesco et al., 2020). It is therefore reasonable to expect relationships between these constructs; individuals with high MA often also exhibit high levels of other types of anxiety (Ashcraft, 2002; Toso et al., 2023). These correlations may vary with age. For instance, younger children seem to show

a stronger relationship between math anxiety and generalized anxiety, whereas in older children, the types of anxiety appear to be more distinct (Carey et al., 2016).

Rubinstein et al. (2018) developed a bio-psycho-social model to describe the risk factors involved in math anxiety. This model posits that MA results from the interaction of individual and environmental factors:

- individual factors include neurocognitive and genetic predispositions;
- environmental factors encompass the social context, from family to school, and broader cultural influences.

Throughout an individual's life, the interplay between these factors can foster the development of math anxiety or, alternatively, contribute to a positive emotional experience related to mathematics (Cuder et al., 2020).

Furthermore, the age of onset and development of math anxiety remains unclear, partly because most research has focused on adolescents, with more recent studies starting to explore the phenomenon in younger children (Sorvo et al., 2017). Age certainly plays a role, as demonstrated by Hill et al. (2016), who confirmed that math anxiety levels tend to increase with age.

Ashcraft and Moore (2009) noted that children in the first two or three years of primary school generally do not report significant math anxiety. However, by the fourth and fifth grades, some students begin to show apprehension. With younger children, it may be more appropriate to speak of "numerical apprehension", better reflecting the educational stage where complex mathematical procedures are not yet fully present. Identifying these early negative feelings is crucial, as they could serve as precursors to later math anxiety (Petronzi et al., 2019).

2. The relationship between sport participation and anxiety

Physical activity and sport participation have been consistently associated with improved mental health outcomes across multiple domains. A substantial body of evidence has established that regular physical activity contributes to reduced symptoms of anxiety and depression in children and adolescents (Biddle & Asare, 2011; Rodriguez-Ayllon et al., 2019). These benefits appear to operate through multiple physiological and psychological mechanisms, including improved

neurotransmitter function, enhanced self-efficacy, and increased opportunities for positive social interaction (Lubans et al., 2016).

With regard to school-related anxiety specifically, research has demonstrated that physical activity interventions can positively influence various aspects of academic functioning. Álvarez-Bueno et al. (2017) conducted a systematic review and meta-analysis examining the effects of physical activity on children's cognition and metacognition, finding that structured physical activity programs were associated with improved executive functioning and reduced test anxiety. Similarly, Singh et al. (2019) documented positive effects of physical activity interventions on cognitive and academic performance in children and adolescents, highlighting potential pathways through which physical activity might mitigate school-related stress.

An interesting study involving a group of children with ADHD revealed that those who engaged in three or more sports exhibited significantly fewer symptoms of anxiety or depression compared to those who participated in fewer than three sports. These findings suggest that active involvement in sports may be linked to a reduction in the expression of anxiety or depression symptoms in children with ADHD (Kiluk, Weden & Culotta, 2009).

The relationship between sport participation and performance anxiety in academic contexts appears to be mediated by several factors, including improved concentration, enhanced working memory capacity, and reduced physiological arousal in stressful situations (Leahy et al., 2020). In a study examining the effects of physical activity breaks on mathematics engagement, Owen et al. (2018) found that short bouts of physical activity during school hours were associated with increased attention and reduced anxiety during subsequent mathematics instruction. These findings suggest that regular physical activity may provide both immediate and cumulative benefits for managing anxiety in academic performance situations.

However, despite the growing body of research on physical activity and general mental health, there remains a notable gap in the literature specifically examining the relationship between sport participation and mathematics anxiety. While Ashcraft and Krause (2007) have extensively documented the negative impact of mathematics anxiety on working memory and performance, few studies have directly investigated whether sport participation might serve as a protective factor

against this specific form of academic anxiety. The research that does exist tends to focus on general academic performance rather than anxiety specifically. For instance, Rasberry et al. (2011) conducted a systematic review that identified positive associations between physical activity and mathematics performance, but did not specifically address mathematics anxiety as an outcome variable.

Some promising evidence comes from Schmidt et al. (2017), who investigated relationships between motor abilities, executive functions, and academic achievement, finding that physical coordination skills were positively associated with mathematics performance through the mediating role of executive functions. This suggests potential cognitive pathways through which sport participation might indirectly influence mathematics anxiety, though direct evidence remains limited.

The limited empirical attention directed toward the relationship between sport participation and mathematics anxiety represents a significant gap in the literature, particularly given the prevalence and detrimental effects of mathematics anxiety documented across diverse educational contexts (Ashcraft & Krause, 2007). This gap highlights the need for targeted investigations examining how different forms of sport participation might influence mathematics anxiety across developmental stages, and whether specific types of physical activity might be particularly beneficial for reducing anxiety in mathematics learning and testing situations.

3. Methodology

3.1 Research aims and hypotheses

This study aims to investigate the relationship between participation in sport activities and school-related anxiety—particularly math anxiety and general performance anxiety—in primary school students, with the broader goal of providing a comprehensive understanding of how sport engagement may influence children's emotional responses in academic contexts.
Accordingly, we hypothesize that:

- Students who regularly engage in sport activities will report significantly lower levels of both math anxiety and school anxiety compared to those who do not participate in sports.
- There are significant differences in anxiety levels across grade levels, with anxiety expected to increase progressively from second to fifth grade.

- The duration of sport participation is negatively associated with anxiety levels, such that longer engagement in sports corresponds to lower reported anxiety.

3.2 Sample

The sample size of the ABMOVE! Project includes a group of 4150 students from 37 schools of three Italian Regions: Apulia, Sicily and Piedmont. Of the total participants, 3317 students (age M=8.3, SD=1.16) completed the three questionnaires. For each participant socio-demographic information was collected: gender, region of origin, and school order. The sample's demographic characteristics are shown below (Tab.1).

		Counts	% of Total
Region	Apulia	1600	48.2 %
	Piedmont	*476*	*14.4 %*
	Sicily	*1241*	*37.4 %*
Gender	Female	1537	48.9 %
	Male	1605	51.1 %
Grade level	2^{nd}	759	22.9 %
	3^{rd}	930	28.0 %
	4^{th}	891	26.9 %
	5^{th}	737	22.2 %
Students with disability	No	3051	94.5 %
	Yes	178	5.5 %
Students with SEN (with personalized didactic plan)	No	3120	97.1 %
	Yes	92	2.9 %

Table 1. Sample demographics distributed by region, gender, grade level, disability, and SEN status.

3.3 Instruments

3.3.1 Questionnaire of Math Anxiety

The AMAS questionnaire (Abbreviated Math Anxiety Scale; Hopko, 2003; Caviola et al., 2017) investigates the level of fear and negative feelings towards mathematics. It is a self-report questionnaire composed of 9 items. Specifically, it is divided into two subscales: mathematics learning anxiety (the anxiety that can be experienced when learning new content) and evaluation anxiety (the anxiety related to

moments of evaluation and verification of mathematical skills). The student is asked to identify with the situations described and indicate the level of fear and concern about the specific situations. The response possibilities are distributed on a 5-point Likert scale (from “Very little” to “A lot”). In calculating the score, 1 point is obtained if the answer given is “Very little”, 2 points if it is “A little”, 3 if it is “Moderate”, 4 if it is “Quite a lot” and 5 if it is “A lot”.

The scale showed satisfactory reliability, with a Cronbach’s alpha of 0.750 and a McDonald’s omega of 0.752 (Taber, 2018).

3.3.2 Questionnaire of School Anxiety

The Worry Emotionality-Junior (WE-J) is a specifically adapted measure designed to evaluate performance anxiety in primary school students aged 8-10 years who are attending grades 3-5 (Di Vita & Di Martino, 2024). This instrument represents an adaptation of the Worry Emotionality (WE) test previously developed to assess performance anxiety in secondary school and university students (Di Nuovo, 2013).

The WE-J is theoretically grounded in the Cognitive Attention Model and focuses on two fundamental dimensions of performance anxiety: worry (cognitive component) and emotionality (affective-physiological component). The questionnaire consists of 16 items that capture children's thoughts, feelings, and physical reactions when confronted with evaluative situations at school, such as written assignments or oral examinations.

Respondents rate each item on a 5-point Likert scale ranging from "Never" to "Always," indicating the frequency with which they experience various anxiety symptoms in performance situations. The instrument yields two subscale scores: the Emotionality score reflects physiological activation and emotional responses, while the Worry score assesses cognitive preoccupations related to performance.

The psychometric properties of the WE-J demonstrate strong internal consistency, with a Cronbach's alpha coefficient of 0.893 and McDonald's omega coefficient of 0.893 for the total scale (Taber, 2018).

3.3.3 Questionnaire of Sport Activity

Student involvement in sports was evaluated using the Italian adaptation of the Physical Activity Questionnaire for Older Children (PAQ-C-It) (Gobbi et al., 2016). This questionnaire is a retrospective 7-day self-report measure comprising nine questions that assess participation in athletic activities, exercise during school

hours, and recreational physical pursuits, including those undertaken on weekends. Participants respond using a five-point scale (with values from 1 to 5), where higher ratings correspond to increased physical activity engagement. The original questionnaire was supplemented with additional informative items specifically designed to collect data on sports participation. For the purposes of the present analysis, only the items that allowed for determining whether participants engaged in sports (yes/no) and the duration of their engagement (expressed in months) were utilized.

3.4 Procedure

Data were collected and coded during the baseline assessment phase. Questionnaire administration took place between December 2024 and January 2025, using a paper-and-pencil format. Participation was anonymous, and all procedures were approved by the ethics committees of the participating universities.

The analytical procedure followed a structured approach aimed at exploring the relationship between sport participation and anxiety levels among primary school students.

Descriptive statistics were first calculated for all variables, including mean, standard deviation, Mdn, and 95% confidence intervals. These analyses were conducted separately for math anxiety, school performance anxiety (emotionality and worry subscales), and sport participation.

To examine differences in anxiety levels between students who participated in sport activities and those who did not, both independent samples t-tests and non-parametric Mann–Whitney U tests were applied.

Differences in anxiety across grade levels (from second to fifth grade) were assessed using the Kruskal–Wallis H test. Where significant differences were found, pairwise post-hoc comparisons were conducted using the Dwass–Steel–Critchlow–Fligner test.

Correlational analyses were performed to investigate the relationship between the duration of sport participation (measured in months) and levels of anxiety. Both Pearson's and Spearman's correlation coefficients were calculated to capture linear and monotonic associations.

All statistical analyses were conducted using the open-source software JAMOVI (version 2.3) (The jamovi project, 2022).

4. Data Analysis and Results

4.1 Mathematical Anxiety Assessment

Analysis of the Abbreviated Math Anxiety Scale (AMAS) revealed a mean total score of 19.1 (SD = 6.46) across all participants.

Examination of item-level descriptives (Tab. 2) showed varying patterns of anxiety across different mathematical situations. Students reported highest anxiety levels for items related to math testing anxiety, particularly "Having an oral test on math without knowing in advance" (Item 8: M = 3.58, SD = 1.42) and "Thinking about the upcoming written math test" (Item 2: M = 3.00, SD = 1.29). Comparatively lower anxiety was reported for learning situations such as "Having to use diagrams and multiplication tables" (Item 1: M = 1.83, SD = 1.00) and "Carefully listening to the math lesson" (Item 6: M = 1.77, SD = 1.03).

				95% Confidence Interval			
	N	Mean	SE	Lower	Upper	Mdn	SD
QA1	2793	1.55	0.0189	1.51	1.59	1.00	0.999
QA2	2950	2.49	0.0232	2.45	2.54	2.00	1.262
QA3	2937	1.96	0.0222	1.91	2.00	1.00	1.205
QA4	2941	2.42	0.0248	2.38	2.47	2.00	1.343
QA5	2929	2.52	0.0262	2.47	2.57	2.00	1.417
QA6	2929	1.45	0.0174	1.41	1.48	1.00	0.944
QA7	2917	1.79	0.0226	1.74	1.83	1.00	1.221
QA8	2930	3.04	0.0283	2.99	3.10	3.00	1.533
QA9	2942	1.94	0.0232	1.90	1.99	1.00	1.261

Table 2 item-level descriptives of the AMAS

Examination of grade-level differences (Fig. 1) showed a progressive increase in mathematical anxiety from second grade (M = 17.7, SE = 0.331, 95% CI [17.1, 18.4]) to third grade (M = 19.0, SE = 0.228, 95% CI [18.5, 19.4]), fourth grade (M = 19.6, SE = 0.230, 95% CI [19.1, 20.0]), and fifth grade (M = 19.8, SE = 0.251, 95% CI [19.3,

20.3]). Minimum scores were consistent across grades (9.00), while maximum scores ranged from 40.0 to 45.0, indicating considerable variability in anxiety levels within each cohort.

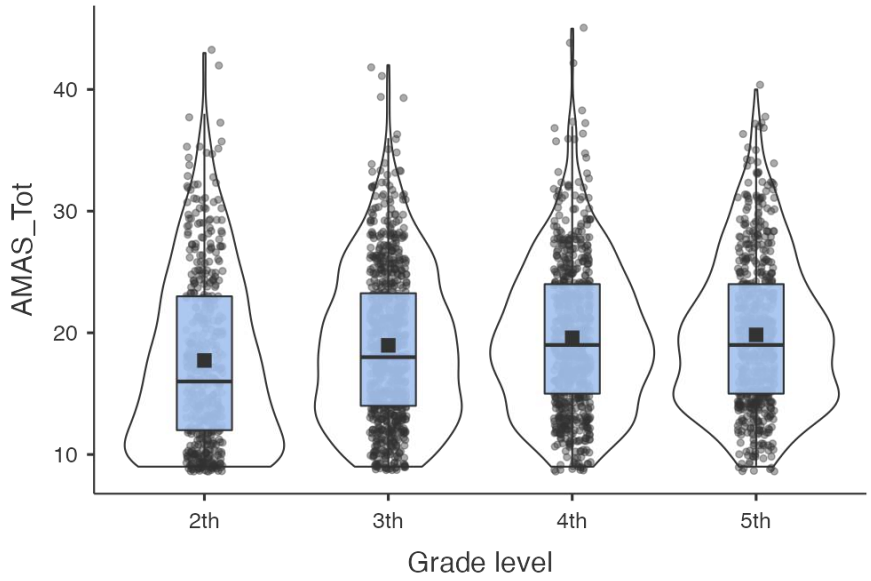

Figure 1 Grade Level differences in Math Anxiety

The Kruskal-Wallis test indicated statistically significant differences in math anxiety across grade levels ($\chi^2 = 43.6$, df = 3, $p < .001$, $\varepsilon^2 = 0.0170$). Pairwise comparisons using the Dwass-Steel-Critchlow-Fligner test demonstrated that second-grade students reported significantly lower anxiety levels compared to third-grade ($W = 5.697$, $p < .001$), fourth-grade ($W = 7.967$, $p < .001$), and fifth-grade students ($W = 8.438$, $p < .001$). However, no significant differences were observed between third, fourth, and fifth grades, suggesting that math anxiety stabilizes after an initial increase from second to third grade.

4.2 School Performance Anxiety Patterns

The Worry Emotionality-Junior (WE-J) assessment yielded overall mean scores of 18.4 (SD = 6.59) for the Emotionality subscale, 20.2 (SD = 7.21) for the Worry subscale, and a total mean score of 38.5 (SD = 12.87).

Detailed item-level analysis (Tab. 3) revealed varying patterns of anxiety manifestations across different assessment scenarios. The highest anxiety scores were observed for items reflecting worry about evaluation, particularly "Having

fear that I will be asked questions I cannot answer" (WEJ14: M = 2.82, SD = 1.35, 95% CI [2.77, 2.87]), "Thinking I cannot do things as well as I would like" (WEJ7: M = 2.68, SD = 1.33, 95% CI [2.63, 2.73]), and "Thinking about what would happen if I did poorly" (WEJ10: M = 2.67, SD = 1.39, 95% CI [2.62, 2.72]).

Cognitive components of anxiety were evident in items such as "Worrying because I don't feel prepared enough" (WEJ2: M = 2.64, SD = 1.17, 95% CI [2.59, 2.68]) and "Feeling my heart beating fast" (WEJ1: M = 2.61, SD = 1.23, 95% CI [2.57, 2.66]). Lower scores were reported for physical symptoms such as "Feeling my muscles becoming heavy" (WEJ11: M = 1.68, SD = 1.18, 95% CI [1.64, 1.72]) and "Having stomach pain due to worry" (WEJ3: M = 1.95, SD = 1.27, 95% CI [1.90, 2.00]). The Mdn scores ranged from 1.00 to 3.00 across items, with all items showing the full range of response options (1.00-5.00).

				95% Confidence Interval		
	N	Mean	SE	Lower	Upper	SD
WEJ1	2928	2.61	0.0227	2.57	2.66	1.23
WEJ2	2914	2.64	0.0217	2.59	2.68	1.17
WEJ3	2901	1.95	0.0235	1.90	2.00	1.27
WEJ4	2902	2.35	0.0227	2.31	2.40	1.22
WEJ5	2915	2.50	0.0224	2.46	2.55	1.21
WEJ6	2891	2.47	0.0250	2.42	2.52	1.34
WEJ7	2892	2.68	0.0247	2.63	2.73	1.33
WEJ8	2904	2.23	0.0243	2.18	2.27	1.31
WEJ9	2894	2.47	0.0231	2.42	2.51	1.24
WEJ10	2887	2.67	0.0258	2.62	2.72	1.39
WEJ11	2895	1.68	0.0219	1.64	1.72	1.18
WEJ12	2893	2.55	0.0270	2.50	2.60	1.45
WEJ13	2900	2.52	0.0251	2.47	2.57	1.35
WEJ14	2886	2.82	0.0251	2.77	2.87	1.35
WEJ15	2928	2.50	0.0259	2.44	2.55	1.40
WEJ16	2930	2.12	0.0258	2.07	2.17	1.40

Table 3. item-level analysis of the WE-J scale

Analysis of subscale scores (Fig. 2) by grade level revealed a consistent developmental trajectory in school-related anxiety.

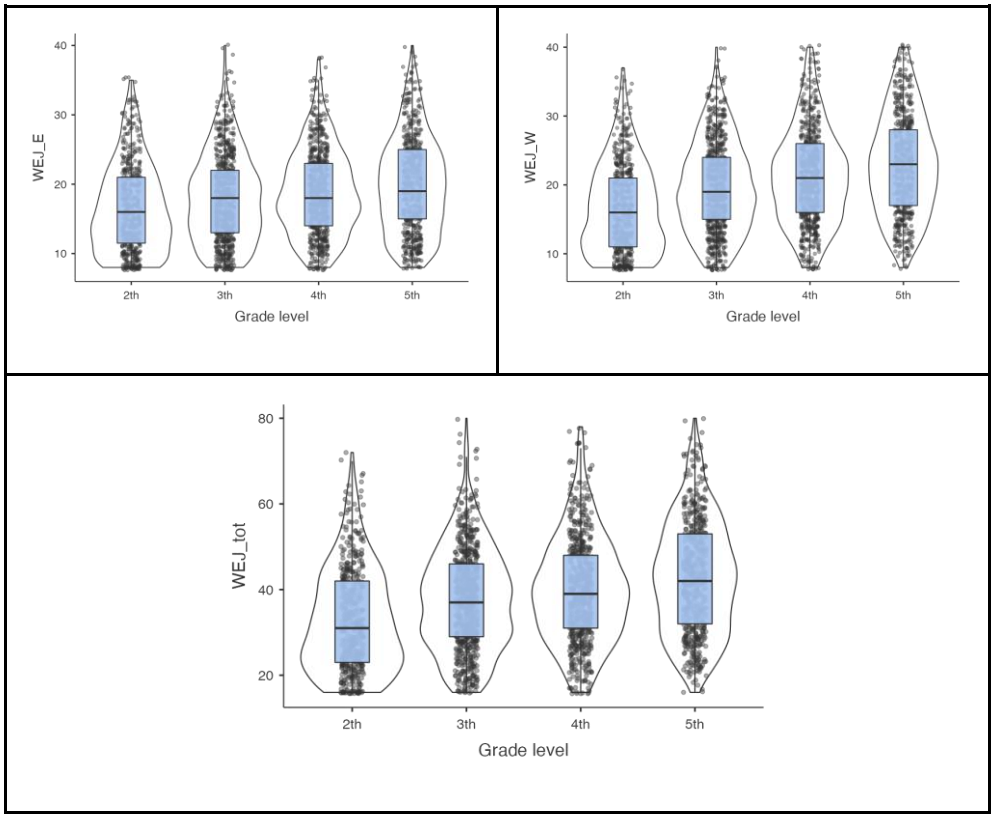

Figure 2. Grade Level differences in Performance Anxiety in the Emotionality, Worry and Total scores

The Kruskal-Wallis test identified significant differences across grade levels for Emotionality ($\chi^2 = 73.4$, df = 3, $p < .001$, $\varepsilon^2 = 0.0291$), Worry ($\chi^2 = 215.9$, df = 3, $p < .001$, $\varepsilon^2 = 0.0857$), and total scores ($\chi^2 = 153.4$, df = 3, $p < .001$, $\varepsilon^2 = 0.0673$).

For the Emotionality subscale, second-grade students (M = 16.6, SD = 6.39) reported significantly lower anxiety than third-grade (M = 18.1, SD = 6.43), fourth-grade (M = 18.8, SD = 6.23), and fifth-grade students (M = 19.9, SD = 6.97). The difference between third and fifth grades was also significant (W = 6.48, $p < .001$).

The Worry subscale revealed a consistent, progressive increase across all grade levels, with second-grade students reporting the lowest scores (M = 16.8, SD = 6.52), followed by third-grade (M = 19.7, SD = 6.67), fourth-grade (M = 21.2, SD =

6.96), and fifth-grade students (M = 23.0, SD = 7.37). All pairwise comparisons were statistically significant ($p < .001$).
Total WE-J scores followed a similar pattern of progressive increase from second grade (M = 33.0, SD = 12.08) to fifth grade (M = 42.8, SD = 13.28), with all pairwise comparisons showing statistical significance except between third and fourth grades ($p = 0.007$).

4.3 Sports Participation Patterns

Analysis of sports participation revealed that a substantial majority of students (80.0%) engaged in sports activities, while 20.0% did not participate in any sports (Tab. 4). Examination of participation rates across grade levels showed a remarkably consistent pattern, with only minor variations in engagement ranging from 78.7% in second grade to 81.2% in fourth grade. This stability in participation rates suggests that sports involvement remains relatively constant throughout the primary education years examined in this study.

Grade Level	**Yes**	**%**	**No**	**%**	**Total**
2nd	529	78.7%	143	21.3%	672
3rd	674	79.9%	170	20.1%	844
4th	630	81.2%	146	18.8%	776
5th	519	80.2%	128	19.8%	647
Total	2352	80.0%	587	20.0%	2939

Table 4. Sport Participation across school grades

4.4 Sport Participation and Anxiety Differences

Independent samples t-tests and non-parametric Mann-Whitney U tests revealed significant differences in anxiety levels between students who participated in sports and those who did not (Fig. 3).

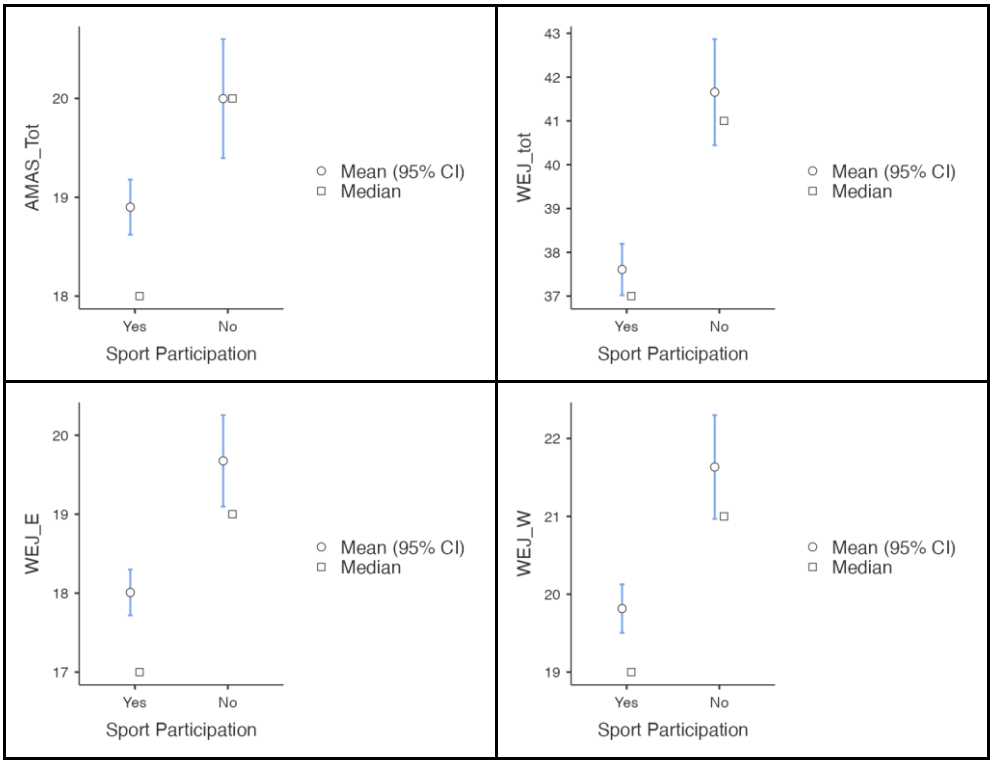

Figure 3. Differences in anxiety levels between sport and no sport participation students in AMAS and WE_J

For mathematical anxiety (AMAS_Tot), sports participants reported significantly lower scores (M = 18.9, SD = 6.38, Mdn = 18.0) compared to non-participants (M = 20.0, SD = 6.76, Mdn = 20.0) (t = -3.36, df = 2497, p < .001; Mann-Whitney U = 442730, p = 0.001).

School anxiety comparisons yielded similar results. On the Emotionality subscale (WEJ_E), sports participants scored significantly lower (M = 18.0, SD = 6.56, Mdn = 17.0) than non-participants (M = 19.7, SD = 6.51, Mdn = 19.0) (t = -5.03, df = 2455, p < .001; Mann-Whitney U = 406819, p < .001). For the Worry subscale (WEJ_W), participants again showed lower anxiety levels (M = 19.8, SD = 7.09, Mdn = 19.0) than non-participants (M = 21.6, SD = 7.36, Mdn = 21.0) (t = -4.97, df = 2459, p < .001; Mann-Whitney U = 401053, p < .001).

The total school anxiety scores (WEJ_tot) demonstrated the largest difference, with sports participants reporting substantially lower anxiety (M = 37.6, SD = 12.70, Mdn = 37.0) compared to non-participants (M = 41.7, SD = 12.77, Mdn = 41.0) (t = -5.92, df = 2224, p < .001; Mann-Whitney U = 313496, p < .001).

4.5 Correlational analysis between Sports Practice duration and Anxiety measures

Correlation analyses examined the relationship between months of sports practice and various anxiety measures. Both Pearson's and Spearman's correlation coefficients were calculated to provide a comprehensive assessment of these relationships.

For mathematical anxiety (AMAS_Tot), results showed small but significant negative correlations using both Pearson's ($r = -0.053$, $p = 0.015$) and Spearman's methods ($\rho = -0.063$, $p = 0.004$).

Similarly, modest negative correlations were observed between sports practice duration and the Emotionality component of school anxiety (WEJ_E) using both Pearson's ($r = -0.044$, $p = 0.047$) and Spearman's methods ($\rho = -0.064$, $p = 0.004$). For the Worry component (WEJ_W), while Pearson's correlation was not significant ($r = -0.037$, $p = 0.097$), Spearman's correlation revealed a small negative relationship ($\rho = -0.055$, $p = 0.014$).

Total school anxiety (WEJ_tot) showed small negative correlations with sports participation duration using both Pearson's ($r = -0.050$, $p = 0.030$) and Spearman's coefficients ($\rho = -0.071$, $p = 0.002$).

These results suggest a potential connection between duration of sports practice and anxiety levels across both mathematical and general school performance contexts, though the modest correlation coefficients indicate that this relationship explains only a small portion of the variance in anxiety scores. Further longitudinal research and experimental designs would be necessary to establish any causal relationship between sports participation duration and reduced anxiety levels.

5. Discussion

The findings with AMAS reveal moderate overall math anxiety levels, with testing situations eliciting the highest anxiety, particularly oral exams without prior notice. In contrast, learning-related tasks elicited lower anxiety responses. Notably, math anxiety increased significantly from second to third grade. This suggests a developmental shift in students' emotional responses to math as academic demands intensify. However, the plateau from third to fifth grade may reflect adaptation or ceiling effects in anxiety perception. The substantial variability in individual scores highlights diverse coping mechanisms and experiences. These

results are in line with the literature (Hill et al; 2016) and remark that Math anxiety is “present at this age and primary students may not possess the coping strategies or cognitive maturity to deal effectively with their maths-related worries” (p.51). Additionally, research by Krinzinger et al. (2010) explored the relationship between calculation ability, self-reported evaluation of mathematics, and math anxiety in primary school children from the end of first grade to the middle of third grade. In line with their findings, our study revealed a significant increase in math anxiety over time, underlining the importance of addressing math anxiety early in primary education.

Although mathematics anxiety is a more specific construct than performance anxiety, it is studied separately with different measurement tools (Mammarella et al., 2018) when we evaluated performance anxiety in our sample of primary school students we observed a similar pattern across grade levels. For the Emotionality subscale, a clear progression was observed from second grade to fifth grade. This pattern indicates a gradual increase in the physiological and emotional manifestations of anxiety across primary school years, with the most notable increase occurring between second and third grades. The Worry subscale displayed an even more pronounced developmental trend, with second-grade students reporting the lowest scores, followed by substantially higher scores in third grade, fourth grade, and fifth grade. This suggests that cognitive aspects of anxiety, including worry about performance and negative self-evaluation, become increasingly prominent as students progress through primary education.

Summarizing, both math and school anxiety scores progressively increased from second to fifth grade. This developmental trajectory is consistent with existing literature and highlights the importance of early preventive interventions.

As regard the correlation between sport participation and anxiety levels, in line with the literature (Vella et al., 2014), sport practice (like volleyball, football, dance, etc...) is associated with lower levels of anxiety: in particular students who engaged in sport activities reported significantly lower scores, compared with student that do not practice sport, in both math anxiety and school performance anxiety (emotional and cognitive components), suggesting a potential protective role of sport engagement.

As regards the differences between sport participants and non-participants statistical comparisons revealed that students that do not practice sport consistently showed higher anxiety scores across all measures, indicating that the absence of sport activity may be linked to increased vulnerability to school-related stress. These findings are in line with several other studies, which although they have not specifically investigated anxiety levels, have found that sports

participation in children is associated with better mental and emotional health, (Hoffman et al., 2022).

Finally, duration of sport participation correlates negatively with anxiety. Although the correlations were modest, longer engagement in sports was significantly associated with reduced anxiety levels. This suggests that anxiety developmental trends in grade level can be moderate through sport participation thanks to its cumulative benefit over time.

6. Conclusions

The findings from this investigation have several important implications for educational practice. They emphasize the relevance of integrating structured physical activity into school curricula as a strategic preventive approach against both mathematics anxiety and general school anxiety. Educational policies that allocate adequate time for physical education and organized sports may yield benefits that extend beyond physical development, potentially mitigating anxiety symptoms that impede mathematical performance and overall academic well-being. The significant differences observed between sports participants and non-participants suggest that targeted interventions might be particularly beneficial for students who do not engage in extracurricular sports activities.

Nevertheless, certain methodological limitations must be acknowledged. The cross-sectional design does not permit causal inferences regarding the relationship between sport participation and mathematics or school anxiety. Pre-existing characteristics or unmeasured variables might account for the observed correlations. Additionally, the reliance on self-report measures may introduce biases related to social desirability or comprehension, particularly among younger respondents.

Future research should prioritize longitudinal designs to examine the causal mechanisms underlying the relationship between sport participation and anxiety trajectories in mathematics and general academic performance. Experimental studies with randomized control trials of sport-based interventions would provide more definitive evidence regarding the efficacy of physical activity as a preventive strategy against math anxiety specifically. Investigations incorporating diverse methodological approaches would contribute to a more comprehensive understanding of how sport participation and different sports influence children's mathematical confidence and emotional well-being across different developmental stages.

Considered together, these findings underscore the value of integrating sports and physical education into the educational experience of children as a strategic tool to reduce mathematics anxiety and promote emotional well-being. The present study, conducted within the ABMOVE! project framework, offers meaningful insights that can inform educational interventions specifically designed to address math anxiety through physical activity, potentially creating more positive learning environments where children approach mathematics with confidence rather than apprehension.

Author contributions

This article is the result of a collaborative effort, with all authors contributing substantially to its conception, development, and finalization. Specific responsibilities were as follows: Clarissa Sorrentino was responsible for Paragraphs: 3.1, 3.4, 4.5 and 5; Valeria Di Martino was responsible for Paragraphs: 3.3.2, 4.1, 4.2, 4.3, and Conclusions; Rosa Bellacicco was responsible for the Paragraphs 1, 3.2 and 3.3.1; Marianna Bellafiore was responsible for Introduction and Paragraphs 3.3.3 and 4.4.

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