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Income inequality is associated with heightened test anxiety and lower academic achievement: A cross-national study in 51 countries

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ABSTRACT

Background: Research on predictors of test anxiety has focused primarily on the role of psychological factors and the proximal environment. However, the role of the broader socio-ecological context, specifically, national income inequality, is seldom explored.
Aims: The present study aimed to test whether national income inequality is associated with greater test anxiety and whether test anxiety is associated with lower academic achievement.
Data: We analyzed data from the 2015 Program for International Student Assessment (PISA), drawing on responses from 389,215 students nested in 51 countries.
Methods: Multi-level structural equation modeling was used.
Results: Results indicated that students in more unequal countries experienced greater test anxiety and had lower levels of achievement. Test anxiety, in turn, was associated with lower academic achievement in reading, math, and science. However, test anxiety did not mediate the effects of income inequality on achievement nor did income inequality moderate the relationship between test anxiety and achievement.
Conclusion: Taken together, the results of this study demonstrate the importance of taking socio-ecological factors such as income inequality into account when examining anxiety and achievement in academic settings.

1. Introduction

Test anxiety reflects the extent to which students find examinations threatening (von der Embse et al., 2018). It is associated with a wide range of maladaptive outcomes including increased risk for poor grades, mental health problems, and difficulties in learning (Segool et al., 2013; Putwain, Gallard, et al., 2021, Putwain, Stockinger, et al., 2021; von der Embse et al., 2018). An international report indicated that 59% of students often worry about taking tests, 66% are anxious about getting poor grades, and 55% are very anxious about a test even if they are well prepared (OECD, 2015).

Research on test anxiety has a long history (Sarason & Mandler, 1952). Much of the research on predictors of test anxiety has focused on internal psychological factors. For example, a meta-analysis by Hembree (1988) focused on factors such as fear of negative evaluation, poor study skills, low self-concept, and an inclination to assign blame to others. A more recent meta-analysis by von der Embse et al. (2018) highlighted the role of other internal psychological factors such as self-concept, motivation, goals, and personality as predictors of test anxiety.

Increasingly, albeit still to a lesser degree, research has examined the role of environmental factors in predicting text anxiety. Some studies have linked test anxiety to perceived threats in the environment. For example, Segool et al. (2013) found that students had higher test anxiety when they had to take high-stakes tests compared to low-stakes tests. Furthermore, when students perceive the learning task as important but have low levels of self-efficacy, they are more likely to experience test anxiety compared to when they perceived the task as less important (Nie et al., 2011).

Other studies have documented the role played by other environmental factors such as families and peers. For example, Peleg-Popko (2002) found that students had lower levels of test anxiety when they had positive family relationships. Other researchers found that positive relationships with teachers (Hoferichter et al., 2014) and peers (Lei et al., 2021) were associated with lower test anxiety.

Despite increasing attention to environmental factors, the extant literature has focused mostly on the proximal environment. Recent

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trends in socio-ecological psychology, however, have underscored the importance of examining the broader social ecology, including the economic environment (Oishi, 2014). The present study advances the test anxiety literature by examining the role of a critical socio-ecological variable, national *income inequality* (which we refer to as income inequality for shorthand), as a predictor of test anxiety. More generally, the aim of this study was to examine the associations among income inequality, test anxiety, and achievement in a large cross-national sample of adolescent students.

1.1. Income inequality and test anxiety

Income inequality pertains to disparities in income between the rich and the poor and is recognized as one of the world's most serious social problems (Pickett & Wilkinson, 2015). It has been found to be associated with less sustainable economic growth, lower civic engagement, more health problems, and lower psychological well-being (Oishi, 2014; Pickett & Wilkinson, 2015).[1] Studies have found that the effects of inequality remain robust after controlling for income levels, suggesting that its effects are distinct from absolute income. In the educational context, inequality has most often been explored in relation to achievement outcomes, and past studies have shown a negative association between the two (Chiu, 2015; Condron, 2011). However, less attention has been paid to affective outcomes such as test anxiety.

Although we are not aware of any previous empirical study that has linked income inequality to test anxiety, income inequality "may serve as a contextual stressor" (Jiang & Probst, 2017, p. 673) and make test anxiety more prevalent. Indeed, studies have shown that income inequality is perceived as threatening and stressful (Pickett & Wilkinson, 2007).

Indirect empirical evidence for the potential linkage between income inequality and test anxiety can also be found in two interrelated yet distinct strands of literature. The first strand is from epidemiological research. Epidemiological studies have shown that people living in areas with higher levels of income inequality have worse mental health outcomes, including higher levels of depression and anxiety. This pattern has been found both within and across countries, and applies to both those of lower and higher socioeconomic status (SES) (Du et al., 2019a, 2019b; Messias et al., 2011; Pickett & Wilkinson, 2015; Wilkinson & Pickett, 2010, 2019; however, see also Ngamaba et al., 2018; Sommet et al., 2022). Research has also shown that students who have high test anxiety are more likely to suffer from mental health and socio-emotional problems (Cassady et al., 2019; Owens et al., 2012).

The second strand of work comes from sociological literature which focuses on income inequality and status anxiety (Layte & Whelan, 2014). In highly unequal societies, individuals can gain more material and social resources by doing better than their peers (Layte, 2012). Inequality also makes one's position in the social hierarchy more important and salient (Kraus et al., 2013). Thus, people become stressed and anxious about their relative social position and fearful of being left behind by their peers (Kraus et al., 2013). Although test anxiety is distinct from status anxiety, these different forms of anxiety nevertheless share a common conceptual dimension (Hill et al., 2016). Furthermore, different forms of anxiety have typically been found to be positively correlated to each other and share a common underlying core (Norton & Paulus, 2017; Sharp et al., 2015). For example, Lowe et al. (2011) found a correlation of $r = .70$ between test anxiety and general anxiety, while Xie et al. (2019) found a positive correlation of $r = 0.64$. Hence, previous findings on the role of income inequality in status anxiety might also be potentially applicable to test anxiety.

Given the importance of academic achievement for upward mobility, performing well in school might be highly important in unequal societies, making students even more anxious. Research has shown that students become more anxious when reminded of the importance of examinations and the dire consequences of doing poorly (Putwain & Best, 2011). In unequal societies, students might be judged more harshly for poorer performance. They are also more likely to have lower social mobility in the future (Jerrim & Macmillan, 2015). This lower mobility applies to everyone, including those from higher and lower-SES backgrounds (Andrews & Leigh, 2009; Kuo & Kawachi, 2023). Given the importance of education for upward mobility, school success is critical, and this might increase students' test anxiety.

Students in highly unequal societies might also develop a fear of being left behind by their peers if they do not do well enough. This is because unequal societies make status differences more salient (Layte, 2012). Indeed, studies have shown that higher inequality lowers sense of belonging, fosters greater competitiveness, and makes students more sensitive to interpersonal comparisons (King et al., 2022; Sommet et al., 2018, 2022). Given these findings, we posited the following hypothesis.

Hypothesis 1. Income inequality is positively associated with test anxiety.

1.2. Test anxiety and achievement

Test anxiety has deleterious consequences for student achievement and cognitive performance (Maloney et al., 2014). Numerous studies have shown that greater test anxiety is related to lower school achievement (von der Embse et al., 2018). Longitudinal studies have also indicated that test anxiety negatively predicts performance, even after controlling for prior cognitive ability or prior academic attainment (Pekrun, 1992; Putwain et al., 2013, 2016).

Meta-analytic investigations also converged on the same findings. For example, Hembree (1988) found that test anxiety was negatively correlated with performance on standardized achievement tests ($r = -0.29$). A subsequent meta-analysis by Seipp (1991) found that test anxiety was negatively correlated with academic performance ($r = -0.23$). A meta-analytic study conducted by von der Embse et al. (2018) synthesized findings from 238 studies and found that the negative association between test anxiety and achievement held across primary school, middle school, secondary school, and college (*rs* ranging from −0.16 to −0.27). Two recent meta-analyses further confirmed these findings, with the researchers finding a negative correlation between test anxiety and academic achievement (*rs* ranging from −0.20 to −0.23) (Caviola et al., 2022; Robson et al., 2023).

Cognitive interference theories posit that anxiety in evaluative contexts places a heavy burden on the cognitive system (e.g., working memory) which interferes with key thinking processes (Caviola et al., 2022; Maloney et al., 2014). Test anxiety disrupts the performance of students because worrying uses up valuable cognitive resources. Hence, less working memory is available for the task at hand (Owens et al., 2008; 2012a; 2012b). Aside from having a detrimental effect on achievement, test anxiety also predicts a host of other maladaptive outcomes, including lower expectancies of success, motivation, and well-being (Fréchette-Simard et al., 2022; Putwain & Symes, 2020; von der Embse et al., 2018). These considerations lead to the second hypothesis.

Hypothesis 2. Test anxiety is negatively associated with achievement.

Although most of the existing studies on test anxiety and achievement have looked at linear relationships, there is also a smaller body of work arguing that the relationship might be curvilinear; perhaps moderate levels of anxiety might have a positive motivating function. For example, Eysenck and colleagues (2007) theorized that anxiety may not

[1] This is the prevailing view in the literature. However, it should be noted that there is emerging scholarship suggesting a more nuanced view of the relationship between income inequality and psychological functioning (e.g., that the overall influence of inequality is actually negligible in some instances because it can evoke positive as well as negative processes; see Ngamaba et al., 2018; Sommet et al., 2019).

lead to impaired performance if it facilitates the use of positive strategies such as enhanced effort and cognitive processing. Indeed, a recent study by Cassady and Finch (2020) documented a curvilinear relationship between test anxiety and other important learning-related outcomes. Hence, we also tested the possibility of a curvilinear association as part of the supplementary analyses.

1.3. Income inequality and academic achievement

Income inequality might also be directly associated with achievement. One of the earliest studies on this topic was conducted by Pickett and Wilkinson (2007) who found that higher income inequality was associated with lower math achievement. A more recent study by Condron (2011) revealed that income inequality was negatively associated with achievement, despite controlling for country affluence. Both studies, however, were confined to using the country as the unit of analysis.

Studies that used multi-level approaches also found the same pattern. For example, Chiu (2015) found that income inequality negatively predicted academic achievement. In another study, researchers found that primary school students' reading achievement was negatively associated with income inequality (Chiu & Chow, 2015).

The weight of the empirical evidence seems to favor the position that income inequality is detrimental to achievement. In highly unequal societies, students from disadvantaged backgrounds may find themselves disengaged from schoolwork because they perceive that economic success is out of reach. Students born into higher-income families have greater opportunities for success not available to those from more disadvantaged families (Browman et al., 2019). Individuals who become aware of the state of inequality become less hopeful that they can improve their circumstances. When this happens, students might decrease their engagement in academic tasks which might lead to lower levels of achievement (Browman et al., 2019). This leads us to the following hypothesis.

Hypothesis 3. Income inequality is negatively associated with achievement.

Aside from the direct effects of income inequality on achievement, it is possible that income inequality's detrimental effects on achievement will be partially mediated by test anxiety. In previous research on inequality and achievement outcomes, the most common mechanisms that were investigated pertained to economic resources. For example, it has been shown that unequal countries more often have schools with scarce learning resources (Chiu, 2015). Furthermore, learning resources in unequal societies are more often devoted to students in more affluent schools (Chiu, 2015). In the present research we focused on test anxiety as a mediator of the effects of income inequality on achievement.

Hypothesis 4. The effect of income inequality on achievement is mediated by test anxiety.

1.4. Income inequality as a moderator

We also examined whether national income inequality, a country-specific feature, could have an impact on the relationship between test anxiety and academic achievement for an individual. This would represent a cross-level interaction wherein a higher-order variable (i.e., national income inequality) changes the nature of the association among lower-level variables (i.e., test anxiety and achievement for an individual). Although we are not aware of any empirical research examining whether income inequality functions as a cross-level moderator of the influence of test anxiety on achievement outcomes, past studies have shown that income inequality could moderate the relationships among individual-level psychological constructs (e.g., Jiang & Probst, 2017).

It is possible that in more unequal contexts test anxiety's deleterious effects on achievement become even more harmful because the educational stakes are higher. Income inequality makes disparities between the "haves" and "have nots" greater. Societies with high income inequality have fewer good job opportunities for students after they graduate, schools are less well-resourced, and students face stiffer competition for fewer good opportunities. This might be especially true for students from more disadvantaged backgrounds, who might suffer more from lesser social mobility (Bartram, 2022; Kerney & Levine, 2016). In unequal societies, individuals who have high levels of test anxiety not only contend with the threat of losing good opportunities in school but also in later life, thereby exacerbating the high stakes nature of schooling. This leads us to the following hypothesis.

Hypothesis 5. Income inequality strengthens the negative association between test anxiety and achievement.

1.5. Accounting for alternative explanations

Though several past studies support the argument that income inequality is generally harmful to learning-related outcomes, there is also a smaller body of work showing that income inequality's effects disappear when other more critical factors such as country affluence or socioeconomic status are accounted for. For example, a study by Condron (2011) examined how income inequality was associated with achievement outcomes. When income inequality was the only country-level predictor, it was associated with achievement, but once country affluence was added into the model the effect of income inequality disappeared. Another study by Zagorski et al. (2014) found that income inequality was negatively related to well-being. However, once country affluence was included in the model, income inequality became non-significant.

Other studies have argued that individual-level factors such as socioeconomic status take precedence over country-level factors such as national income inequality. For example, a study by Sommet et al. (2018) explored how income inequality was associated with happiness. They found that income inequality was only harmful to happiness among economically disadvantaged individuals but not among the more economically advantaged populations. Although these studies did not directly examine test anxiety and academic achievement, they indicate that there exists a certain ambiguity in the role of income inequality and the possibility that inequality's effects might be more fragile than might be expected from the existing literature (e.g., Ngamaba et al., 2018). Hence, to provide more robust evidence of the role played by inequality, we controlled for the effects of country affluence, socioeconomic status, and gender.

1.6. The present study

The present research aims to test the links between national income inequality and students' test anxiety and achievement. In sum, five main hypotheses were tested.

- *H1: Income inequality is positively associated with test anxiety.*
- *H2: Test anxiety is negatively associated with achievement.*
- *H3: Income inequality is negatively associated with achievement.*
- *H4: The effect of income inequality on achievement is mediated by test anxiety.*
- *H5: Income inequality strengthens the negative association between test anxiety and achievement.*

To test these hypotheses, we analyzed data from the OECD Program for International Student Assessment (PISA). We choose to work with PISA 2015 because it is the latest and only PISA study that assesses test anxiety in school.

2. Method

2.1. Data and measures

Our study used OECD PISA 2015 data (OECD, 2016) which included responses from 389,215 15-year-old adolescent students (Mean age = 15.80, SD = 0.29) from 51 countries,[2] each occupying 0.4%–8.2% of the total sample. The gender ratio was nearly equal: males = 193,818 (49.8%), females = 195,317 (50.2%). These countries are shown in Table 2.

Income inequality. The Gini index provided by the Standardized World Income Inequality Database (Solt, 2016) was used to represent national income inequality. The Gini index ranges from 0 (*all people have equal income*) to 100 (*one person has all of the income and others have none*) (Solt, 2016). The Gini values of the 51 countries for the year 2014 were used; Mean = 33.60 (SD = 6.48).

Test anxiety. Test anxiety was measured using the *index of school-work anxiety* provided in the 2015 PISA data set (OECD, 2017). This index comprises 5 items and measures students' cognitive and emotional reactions to test taking using a 4-point scale from 1 (*strongly disagree*) to 4 (*strongly agree*). This scale was adapted and developed by OECD partly based on previously published questionnaires measuring test anxiety (e.g., Cassady & Johnson, 2002; Spielberger, 1980). A sample item is, "I often worry that it will be difficult for me taking a test." Cronbach's alpha for the anxiety scale was 0.82. We used the Rasch calibrated test anxiety score supplied by OECD which has a mean of 0 and a standard deviation of 1 (OECD, 2017).

Achievement. The PISA dataset contained achievement scores in three subjects: reading, math, and science. OECD used the Rasch modeling approach to estimate the PISA achievement scores (OECD, 2017). A Rasch model specifies that the probability with which an examinee answers an item correctly depends on the difference between the ability of the examinee and the difficulty of the item (Bond & Fox, 2015). The particular Rasch model that OECD developed can be applied to multiple populations by assuming one population for each participating country (OECD, 2017). The mean for reading was 484.79 (*SD* = 99.61), the mean for mathematics was 479.89 (*SD* = 99.07), and the mean for science was 485.08 (*SD* = 99.82). The reliability of Rasch-calibrated scores for reading, math, and science across groups ranged from 0.80 to 0.85 (OECD, 2017).

Covariates. At the student level, gender (female = 0 and male = 1) and SES were included as covariates. PISA uses the variable economic and social cultural status to represent SES. The economic and social cultural status variable contained information about students' family background such as the number of books at home and their parents' education and occupation among others (OECD, 2016b). SES was a standardized score and had a mean of −0.20 (*SD* = 1.07). At the country level, country affluence was indexed by the Gross Domestic Product (GDP) per capita, which was log transformed (World Bank, 2018).

2.2. Data analysis

A multi-level approach was required given that students were nested within countries. The data were analyzed using multi-level structural equation modeling (SEM) in M*plus* 8.2 (Muthén & Muthén, 1998–2018). The multi-level SEM approach has considerable advantages over conventional multi-level modeling procedures (e.g., hierarchical linear modeling), as it allows the simultaneous estimation of complex models with multiple mediators and/or outcome variables and both direct and indirect effects (Preacher et al., 2016).

The present study tested a multi-level model, wherein income inequality was measured at the country level (Level 3), while test anxiety and achievement were measured at the student level (Level 1). We also accounted for the school-level effects (Level 2) but did not measure specific school-level variables, as our hypotheses were focused on variables at the country and student levels.

The primary analyses proceeded in three steps moving from simpler models to more complex models. In Model 1, we tested an unconditional model to determine the appropriateness of using multi-level analyses. In Model 2, we tested a multi-level SEM model that tested the linkages among the focal variables. In Model 3, we added covariates to account for alternative explanations and tested H1, H2, H3, and H4.

Model 4 added a random slope component to Model 3 and enabled us to test H5. H5 involves a cross-level interaction which we tested using multi-level SEM with random slopes. Multi-level SEM with random slopes has two key assumptions: a dependent variable (e.g., reading, mathematics, or science achievement) can be predicted by independent variables at two levels (test anxiety at the student level; national income inequality and country affluence at the country level). The effect of the independent variable at the lower level depends on the value of the independent variable(s) at the higher level. In the current study, we tested whether a contextual characteristic (i.e., national income inequality at Level 3) moderates the strength of a lower-level relationship (i.e., the relationship between test anxiety and achievement at Level 1). Psychometricians have argued that multi-level models involving cross-level interactions should include the random slope component, as failure to do so may lead to t-ratios that are too high, confidence intervals that are too narrow, and standard errors and *p* values that are too low (Heisig & Schaeffer, 2019). Hence, from a psychometric perspective, using multi-level SEM with random slopes is the optimal approach for testing cross-level interactions. The variables that were included at both levels of analysis were group-mean centered.

Supplementary data analyses. We also conducted supplementary analyses designed to further test the nature of the relationship between test anxiety and academic achievement. Though not part of our main hypotheses, we also tested the possibility of a curvilinear relationship.

3. Results

3.1. Preliminary analyses

At the country level, income inequality was positively correlated with test anxiety but negatively correlated with achievement in reading, science, and math (Table 1). The scatterplots show how income inequality is associated with test anxiety (Fig. 1) and achievement in reading, math, and science (Fig. 2).

At the student level, test anxiety was negatively associated with achievement in reading, math, and science. The overall correlations for the whole sample are shown in Table 1 and the correlations within each country can be found in Table 2.

3.2. Primary results

The results of the primary analyses are described below (see Fig. 3).

3.2.1. Model 1: unconditional model

We first tested whether multi-level modeling was necessary by calculating ICC (the contribution of between-group variance to the total variance) for all outcome variables. The ICC of each outcome variable was larger than zero: 0.13 for reading achievement, 0.20 for math achievement, and 0.16 for science achievement. Researchers have suggested that multi-level modeling is justified when ICC values are close to or exceed 0.10 (Heck & Thomas, 2015, 2020; 2020).

3.2.2. Model 2: linkages among inequality, anxiety, and achievement

Next, we tested a multi-level SEM model that focused on testing the linkages among income inequality, test anxiety, and academic

[2] We use the term country for shorthand but note that some of the contexts included in the PISA dataset are more appropriately classified as cities, jurisdictions, or regions (e.g., Hong Kong).

Table 1
Correlations among the variables at the country and student levels.

	Income Inequality	Country Affluence	Test Anxiety	Reading Achievement	Math Achievement	Science Achievement
Income Inequality	–	−.581**	.612**	−.529**	−.592**	−.519**
Country Affluence	–	–	−.291*	.684**	.631**	.636**
Test anxiety	–	–	–	−.332*	−.353**	−.304*
Reading achievement	–	–	−.094**	–	.925**	.966**
Math achievement	–	–	−.165**	.808**	–	.960**
Science achievement	–	–	−.151**	.882**	.893**	–
SES	–	–	−.114**	.389**	.404**	.399**
Gender	–	–	−.208**	−.110**	.059**	.037**

Note: *p < .05; **p < .01. Correlations above the diagonal are at the country-level; those below the diagonal are at the student-level.

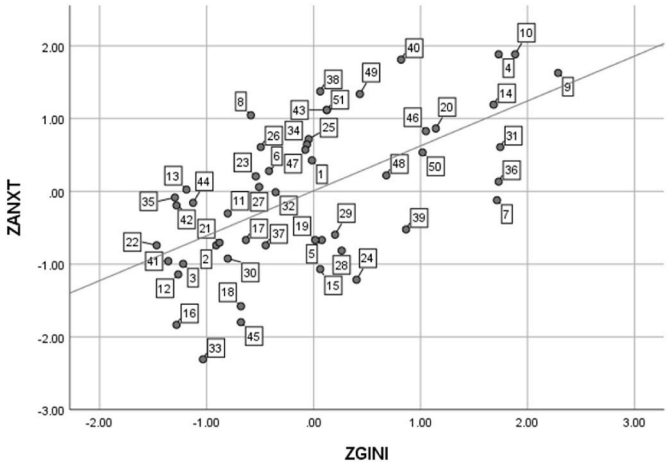


Fig. 1. Relationship between income inequality and test anxiety at the country-level. **Note**. ZGINI = income inequality standardized; ZTanx = test anxiety standardized. Numbers represent countries.

achievement. We considered variance at the student level (level 1), school level (level 2), and country level (level 3) though our focal variables were only located at the student (i.e., test anxiety and academic achievement) and country-levels (i.e., national income inequality). Income inequality positively predicted test anxiety ($\beta = 0.10$, $p < .001$). Test anxiety negatively predicted achievement in reading ($\beta = -0.08$, $p < .001$), math ($\beta = -0.16$, $p < .001$), and science ($\beta = -0.16$, $p < .001$). Furthermore, income inequality negatively predicted achievement in reading ($\beta = -0.09$, $p < .001$), math ($\beta = -0.10$, $p < .001$), and science ($\beta = -0.09$, $p < .001$). The diagram is presented in the Supplementary Files (Fig. S1).

3.2.3. Model 3: inclusion of covariates

To conduct a more rigorous test of our hypotheses and account for alternative explanations, we added covariates such as gender, socioeconomic status, and country affluence to Model 2 above. Results showed that income inequality positively predicted test anxiety ($\beta = 0.67$, $p < .001$), supporting H1. Test anxiety negatively predicted achievement in reading ($\beta = -0.08$, $p < .001$), math ($\beta = -0.10$, $p < .001$), and science ($\beta = -0.10$, $p < .001$), supporting H2. Furthermore, inequality negatively predicted achievement in math ($\beta = -0.32$, $p < .001$), but its effects on reading ($\beta = -0.15$, $p = .25$) and science ($\beta = -0.20$, $p = .13$), were not statistically significant. This meant that in more unequal societies, test anxiety was higher, and higher test anxiety was associated with lower achievement. Students in more unequal societies had lower math, but not reading and science scores. Thus, H3 was only partly supported.

H4 was a mediational hypothesis, indicating that the effects of income inequality on academic achievement would be mediated by test anxiety. The indirect effects were non-significant for all three domains of reading (indirect effect = −0.04, $p = .55$, 90% CI = [−0.18, 0.10]), math (indirect effect: 0.01, $p = .86$, 90% CI = [−0.16, 0.13]), and science (indirect effect: = −0.01, $p = .86$, 90% CI = [−0.17, 0.14]), thereby failing to support H4.

In terms of the covariates, SES negatively predicted test anxiety ($\beta = -0.04$, $p < .001$) but positively predicted achievement in reading ($\beta = 0.08$, $p < .001$), math ($\beta = 0.08$, $p < .001$), and science ($\beta = 0.08$, $p < .001$). This meant that students from more advantaged backgrounds had lower test anxiety but higher levels of achievement. Males had lower test anxiety ($\beta = -0.39$, $p < .001$) and reading achievement ($\beta = -0.26$, $p < .001$), but higher math ($\beta = 0.07$, $p < .001$) and science ($\beta = 0.03$, $p < .001$) achievement.

At the country level, country affluence was not a significant predictor of test anxiety ($\beta = 0.10$, $p = .39$), but was a positive predictor of achievement in reading ($\beta = 0.58$, $p < .001$), math ($\beta = 0.44$, $p < .001$), and science ($\beta = 0.51$, $p < .001$). This meant that richer countries had students with higher levels of achievement in reading, math, and science.

3.2.4. Model 4: income inequality as a moderator

To test whether inequality moderates the association between test anxiety and achievement (H5), we added a random slope component to Model 3 above. The random slope component freed the parameter estimate between test anxiety and achievement to vary across countries. Income inequality and country affluence were designated as predictors of the random slope component. A significant effect of inequality on the random slope could be taken as evidence of a cross-level interaction.

Results indicated that, after controlling for the effect of country affluence, income inequality did not moderate the association between test anxiety and achievement, failing to support H5. Inequality was not a significant predictor of the test anxiety to reading achievement slope ($b = 0.03$, $p = .74$), the test anxiety to math achievement slope ($b = 0.04$, $p = .64$), nor the test anxiety to science achievement slope ($b = 0.22$, $p = .27$).[3] These results indicated that the association between test anxiety and achievement did not vary as a function of income inequality.

3.3. Supplementary analyses

Our supplementary analyses involved testing the curvilinear relationship between test anxiety and academic achievement through the addition of a quadratic term. Results of the supplementary analyses showed that there was a small curvilinear effect such that at relatively low levels, test anxiety was associated with slightly higher levels of reading, math, and science achievement. More details can be found in the Supplementary Materials.

4. Discussion

The aim of this study was to examine how income inequality is associated with test anxiety and achievement in adolescents, and

[3] Only unstandardized estimates are provided when testing random slopes in *Mplus*.

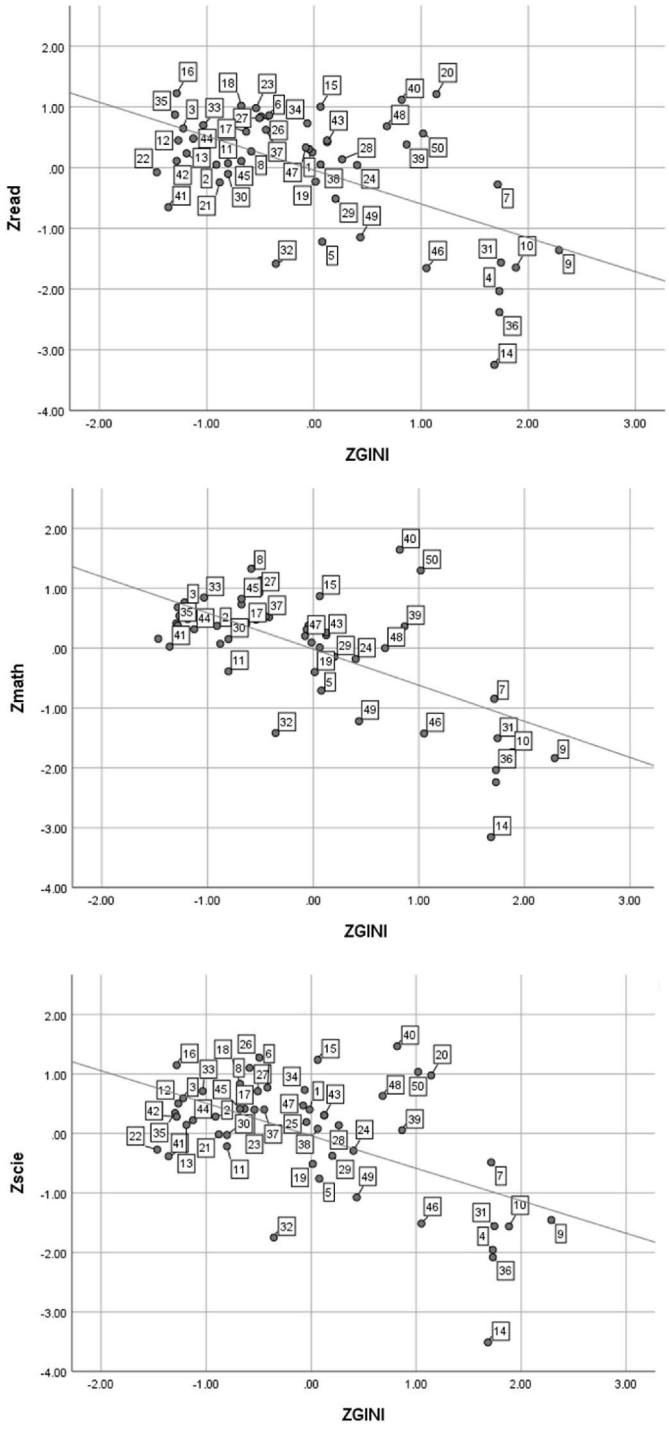


Fig. 2. Relationship between income inequality and achievement in reading, math, and science. **Note**. ZGINI = income inequality standardized; Zread = reading achievement standardized; Zmath = math achievement standardized; Zscie = science achievement standardized. Numbers represent countries. Please refer to Table 2 for the country codes.

whether inequality moderates the relationship between income inequality and achievement. Our study yielded three key findings: First, income inequality was associated with greater test anxiety, supporting H1. Second, test anxiety was associated with lower achievement, supporting H2. Furthermore, income inequality negatively predicted achievement in math but not in reading and science, providing only partial support to H3. However, the effect of income inequality on academic achievement was not mediated by test anxiety (H4), and income inequality did not moderate the association between test anxiety and achievement (H5). Hence, H4 and H5 were not supported. We turn to the specific findings below.

Our first hypothesis — that income inequality is positively associated with test anxiety —was supported. Our findings are novel and make an important contribution to the test anxiety literature. Although research on test anxiety has a long history, much of this work has focused on the effects of test anxiety and the psychological factors that predict it. More recently, the role of the environment has been highlighted, including the testing environment, parents, teachers, and peers (von der Embse et al., 2018). Relatively little work has been done on socio-ecological predictors of test anxiety. Our study extends the existing literature by highlighting the role of the broader socio-ecological environment, specifically national income inequality, in predicting test anxiety.

Students are embedded within larger economic structures and income inequality may shape their school experiences even before they participate in the labor market. In unequal societies, it is possible that the stakes associated with educational success may be much higher and there might be a larger number of students competing for a few privileged spots, where most of the rewards are concentrated. Hence, students might experience higher levels of test anxiety in unequal societies, as performing poorly might mean having fewer job opportunities and lower social status. However, we acknowledge that income inequality as a macro-environmental factor is relatively more distal. There are likely different intermediary mechanisms that could link distal inequality to anxiety and achievement. Hence, future studies may need to test the potential mediating mechanisms.

Our research also makes an important contribution to the income inequality literature by extending it to the adolescent population. Past studies on income inequality and anxiety have primarily focused on adult populations. Furthermore, these past studies examined other forms of anxiety such as status anxiety. Our study demonstrated that income inequality is also a relevant predictor of test anxiety among adolescent students. This finding indicates that income inequality not only affects adults who are participating in the labor market, but also adolescents who are still in school (Elgar et al., 2017).

Our second hypothesis was that test anxiety is negatively associated with reading, math, and science achievement. This hypothesis was also supported. The negative association between test anxiety and achievement held after we included SES and gender as covariates. This finding is in line with previous studies that have shown that anxiety interferes with cognitive functioning leading to lower levels of performance (Eysenck & Calvo, 1992; Eysenck et al., 2007; Gass & Curiel, 2011; Ng & Lee, 2015; Schillinger et al., 2021). However, it is important to note that the PISA test is relatively low stakes and that higher levels of test anxiety occur when the examinations are perceived as important and high stakes (Putwain & Best, 2011). Studies that explore test anxiety in the context of high-stakes examinations (e.g., college entrance exams) might yield more ecologically valid findings.

Our supplementary analyses further indicated a small curvilinear effect, such that at relatively low levels test anxiety was associated with slightly higher achievement. This finding seems to corroborate past studies noting the need to explore non-linear relationships in terms of test anxiety, beyond just linear associations (Cassady & Finch, 2020). However, we note that these curvilinear effects are relatively small in magnitude and overall the relationship between test anxiety and achievement was negative.

Our third hypothesis was that income inequality is associated with lower achievement. This hypothesis was only partially supported. In Model 2, where income inequality was the only country-level variable, income inequality negatively predicted reading, math, and science achievement. However, when country affluence was added as a covariate to Model 3, income inequality was only a negative predictor of math achievement. The effects on reading and science achievement, albeit in the predicted negative direction, became non-significant. Hence, the relation between income inequality and math achievement appears to be

Table 2
Income inequality, test anxiety, and achievement.

				Correlation between anxiety and achievement		
Country	Income Inequality	Log GDP Per Capita	Test Anxiety	Reading	Mathematics	Science
1. Australia	33.5	4.80	0.21	−.061**	−.129**	−.120**
2. Austria	27.7	4.71	−0.11	−.184**	−.241**	−.246**
3. Belgium	25.7	4.68	−0.18	−.072**	−.136**	−.121**
4. Brazil	44.8	4.08	0.61	.027**	−.089**	−.049**
5. Bulgaria	34.1	3.90	−0.09	0	−0.017	−.041**
6. Canada	30.9	4.71	0.17	−.075**	−.184**	−.164**
7. Chile	44.7	4.17	0.06	−.172**	−.219**	−.232**
8. Chinese Taipei	29.8	4.36	0.38	−.025*	−.035**	−.027*
9. Colombia	48.4	3.91	0.54	.022*	−.046**	−.062**
10. Costa Rica	45.8	4.04	0.61	−.085**	−.079**	−.115**
11. Croatia	28.4	4.14	0.01	−0.013	−.088**	−.082**
12. Czech Republic	25.4	4.30	−0.22	−.049**	−.109**	−.131**
13. Denmark	25.9	4.80	0.10	−.126**	−.220**	−.186**
14. Dominican Republic	44.5	3.82	0.42	0.019	0.001	−0.006
15. Estonia	34.0	4.31	−0.20	−.139**	−.195**	−.205**
16. Finland	25.3	4.70	−0.41	−.146**	−.239**	−.241**
17. France	29.5	4.63	−0.09	−.064**	−.097**	−.099**
18. Germany	29.2	4.68	−0.34	−.167**	−.207**	−.214**
19. Greece	33.7	4.33	−0.09	−.067**	−.130**	−.134**
20. Hong Kong	41.0	4.61	0.33	−.046**	−.093**	−.074**
21. Hungary	27.9	4.16	−0.10	−.072**	−.119**	−.124**
22. Iceland	24.1	4.74	−0.11	−.129**	−.274**	−.260**
23. Ireland	30.1	4.74	0.15	−.128**	−.198**	−.188**
24. Israel	36.2	4.58	−0.24	−.033**	−.117**	−.091**
25. Italy	33.3	4.55	0.29	−.061**	−.116**	−.150**
26. Japan	30.4	4.59	0.26	.036**	−0.003	0.024
27. Korea	30.3	4.47	0.11	.075**	0.02	.037**
28. Latvia	35.3	4.20	−0.13	−.112**	−.176**	−.159**
29. Lithuania	34.9	4.22	−0.07	0.002	−.095**	−.075**
30. Luxembourg	28.4	5.09	−0.16	−.149**	−.211**	−.211**
31. Mexico	44.9	4.04	0.26	−.097**	−.181**	−.160**
32. Montenegro	31.3	3.87	0.09	−.045**	−.096**	−.088**
33. Netherlands	26.9	4.72	−0.54	0.002	−.034*	−0.026
34. New Zealand	33.2	4.65	0.27	−.084**	−.210**	−.191**
35. Norway	25.2	4.99	0.07	−.038**	−.131**	−.160**
36. Peru	44.8	3.82	0.13	−.060**	−.087**	−.081**
37. Poland	30.7	4.15	−0.11	−.082**	−.179**	−.160**
38. Portugal	34.0	4.34	0.47	−.059**	−.096**	−.117**
39. Russian Federation	39.2	4.15	−0.05	−.088**	−.116**	−.144**
40. Singapore	38.9	4.76	0.59	−.119**	−.157**	−.154**
41. Slovak Republic	24.8	4.27	−0.17	−0.013	−.092**	−.086**
42. Slovenia	25.3	4.38	0.04	−0.007	−.141**	−.108**
43. Spain	34.4	4.47	0.40	−.091**	−.178**	−.153**
44. Sweden	26.3	4.78	0.05	−.095**	−.192**	−.170**
45. Switzerland	29.2	4.95	−0.40	−.091**	−.161**	−.163**
46. Turkey	40.4	4.08	0.32	−0.002	−.066**	−.065**
47. United Kingdom	33.1	4.68	0.25	−.097**	−.167**	−.137**
48. United States	38.0	4.74	0.15	−.087**	−.203**	−.157**
49. Uruguay	36.4	4.23	0.46	−.125**	−.181**	−.184**
50. B-S-J-G (China)	40.2	3.88	0.24	−.100**	−.122**	−.131**
51. Spain (Regions)	34.4	4.47	0.40	−.061**	−.145**	−.131**
Average correlation				−.094**	−.165**	−.151**

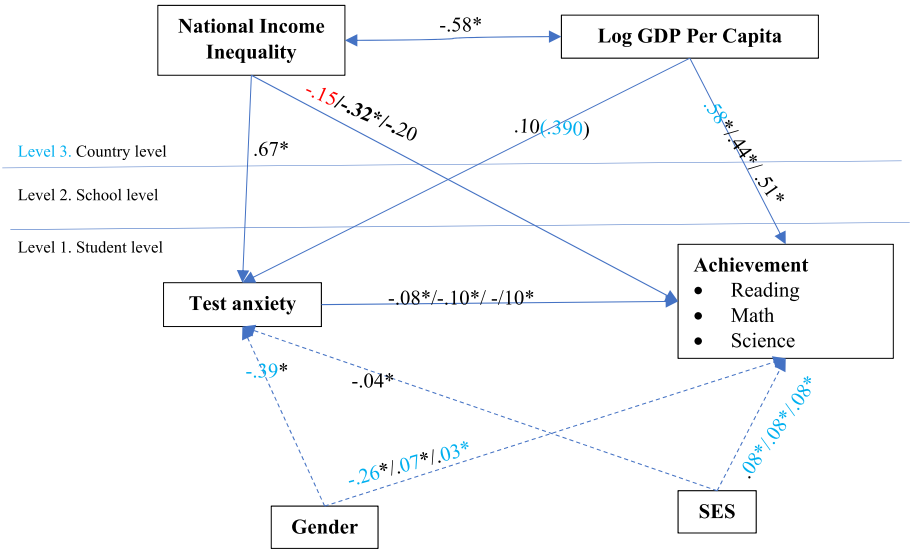
Note. ***$p < .001$, **$p < .01$, *$p < .05$.

particularly robust; evidence for the role of income inequality on reading and science achievement is much less robust.

We found a strong positive association between income inequality and country affluence ($r = -0.58$), which corresponded to findings from past studies (King et al., 2022; Zagorski et al., 2014). In general, poorer countries have higher levels of income inequality (Solt, 2016). It is possible that the effects of income inequality were masked given the overlap between country affluence and income inequality. Future studies that examine a wider range of countries are needed, given that we only included 51 countries in the current study. These countries do not represent the full range of inequality across the globe, and our statistical analyses might have suffered from a restricted range.

It is also possible that income inequality might have stronger deleterious effects on performance in some subjects than others. A study by Pickett and Wilkinson (2007) found that there was a negative correlation between income inequality and math scores, but not with reading and science scores. Perhaps math, given its cumulative nature, is more sensitive to inequality's effects. The math curriculum is more tightly interlinked across different developmental stages, and failure to master key mathematical concepts presented earlier in one's school career (e.g., multiplication), might make it harder to understand more advanced concepts presented later (e.g., algebra). However, for language and science, the link between concepts presented earlier and those presented later may not be so tight.

Our fourth hypothesis was that test anxiety partially mediates the negative association between income inequality and achievement. The results of the mediation analyses were not significant, suggesting that other mechanisms might be able to better account for the negative association between income inequality and achievement than test anxiety. Past studies have shown that economic mechanisms might explain how income inequality is associated with lower achievement (Chiu, 2015; Chiu & Khoo, 2005). In highly unequal societies, there are fewer



CFI = 1.000, TLI = 1.000, RMSEA =.000, SRMR= .000(Level 1), .001(level3).

*$p < .001$.

Fig. 3. 2-1-1 model depicting the role of income inequality on test anxiety and achievement.

learning resources for everyone and there is a lack of proper school infrastructure. Perhaps these economic mechanisms might be more relevant in explaining why income inequality is associated with lower achievement compared to test anxiety. Furthermore, the relationship between test anxiety and academic achievement was much smaller at the country-level than at the student-level, which could also explain the non-significant mediation.

We found that income inequality's effects on achievement were not mediated by test anxiety. However, it is also possible that a different test of this hypothesis might yield supportive data; for example, the use of a more local (e.g., neighborhood) indicator of income inequality may provide a more powerful test that yields significant results. For example, individuals are more sensitive to local income inequality, such as the inequality in their local neighborhood or their district, rather than inequality of their country (Newman et al., 2018).

Our fifth hypothesis was that income inequality moderates the effect of anxiety on achievement. This hypothesis was not supported. We found that inequality did not account for variation in how anxiety was associated with achievement across different societies. It seems that the intrapsychic experience of test anxiety is such a powerful influence on achievement that it exerts its deleterious effects over and above the influence of the macro-environment. Existing test anxiety research supports the contention that anxiety harms learning and disrupts cognitive processes across many different socio-cultural contexts (Caviola et al., 2022; von der Embse et al., 2018).

We also comment on the effect sizes in our study. In terms of the country-level correlations, the relationship between income inequality and test anxiety was $r = .60$, while the correlation between income inequality and achievement ranged from $r = -0.52$ to -0.59. These correlations closely match other ecological correlations in the existing literature between country factors and educational outcomes. For example, He and colleagues (2017) found that the relationship between country affluence and PISA achievement ranged from .48 to .50, while Pickett and Wilkinson (2007) found that the country-level correlation between income inequality and academic achievement was $r = -0.41$.

In terms of the student-level variables, the association between test anxiety and achievement ranged from $r = -0.09$ to 0.19. Updated guidelines in effect size research consider 0.10, 0.20, and 0.30 as relatively small, typical, and large (Gignac & Szodorai, 2016). Hence, the effect sizes of test anxiety in this study could be considered as ranging from small to typical. These effect sizes also match the typical effect sizes found for other emotional and motivational factors in terms of predicting academic achievement (e.g., Camacho-Morles et al., 2021).

When interpreting these effect sizes, it is worth noting two key points. First, our measure of test anxiety was domain-general, and it is possible that larger effect sizes would be obtained if we had domain-specific measures of test anxiety (e.g., mathematics test anxiety). Second, the achievement data in this study was operationalized as students' scores in the PISA tests. However, the PISA test is relatively low stakes. Hence, future studies that examine test anxiety data during high-stakes situations (e.g., students taking college entrance exams or taking their final exams) might likely yield larger effect sizes (e.g., Segool et al., 2013).

We note the strong yet distinct effects of country affluence from income inequality. Country affluence was a more robust predictor of academic achievement compared to income inequality, with effect sizes nearly twice as large as that associated with income inequality. However, only income inequality significantly predicted test anxiety and country affluence was not a significant predictor. This shows that these country-level variables might be associated with distinct sets of outcomes. These findings converge with the existing literature showing that researchers need to attend to the roles of both affluence and inequality, as both are important aspects of the social ecology (King, 2022; Oishi, 2014).

4.1. Practical implications

One of the practical implications of our research is the importance of psycho-educational programs to reduce test anxiety. These programs might even be more necessary in highly unequal societies where test anxiety is likely to be more prevalent. Given the high number of students who have been shown to have test anxiety across the globe, test anxiety interventions could potentially benefit large numbers of students.

4.2. Limitations, and directions for future research

In addition to its strengths, our study has limitations as well. First, PISA, as with most other large-scale international assessments, is cross-sectional in nature. Longitudinal data are needed to afford stronger conclusions about temporal precedence.

Second, our study was confined to 15-year-old students and the PISA test was low stakes. The impact of test anxiety on achievement outcomes might vary across age groups and across test situations. It is possible that test anxiety might have more deleterious consequences for older students such as senior secondary students who are taking their university admissions exams and higher education students whose grades will have direct implications for their future employment opportunities. Hence, we encourage future studies to include a wider range of age groups and different types of tests.

Third, we only examined the linkages among income inequality, test anxiety, and academic achievement. However, there are other mediating variables that might be important to account for. Income inequality is a relatively distal environmental factor and its influence on key outcomes might be shaped by more proximal processes. For example, past inequality studies have focused on the role of both psychosocial variables (e.g., impaired social relationships) and material resources (e.g., less investment in educational resources) in mediating the effects of income inequality on key outcomes (e.g., Du et al., 2022; King et al., 2022; Oishi, 2014). These variables might also be relevant in understanding how national income inequality is associated with test anxiety and achievement.

Fourth, our measure of test anxiety was domain general. It might be useful in future research to also examine domain-specific measures of test anxiety and map out how they would be associated with academic achievement across different domains. Using domain-specific measures might be associated with stronger effect sizes.

Fifth, countries that participate in PISA are relatively wealthier; extremely poor countries do not participate in PISA. However, the poorest countries often have the highest levels of income inequality. Hence, the countries included in this study do not cover the full range of national differences in country affluence and income inequality. This may lead to a restricted range that could reduce the power of our statistical analyses; it additionally limits the generalizability of our results.

Last, we focused on national income inequality but there are other types of inequality such as wealth inequality, inequality among peers, or subjective inequality. Future studies that include different types of inequality are needed to explore how these types of inequality might impact test anxiety and academic achievement.

4.3. Conclusion

Income inequality is becoming an increasingly prevalent feature of contemporary society. The current study demonstrated that students experience heightened test anxiety and lower academic achievement in more unequal societies. This is the first study to empirically link experiences of test anxiety with income inequality. We believe that our understanding of test anxiety can be enriched by broadening our theoretical purview beyond an exclusive focus on psychological factors and the proximal environment. Taking the broader socio-ecological context into account promises to yield a fuller understanding of the factors that underpin students' affective experiences and achievement in academic settings.

Data availability statement

The data that support the findings of this study are openly available in OECD PISA 2015 dataset at: https://www.oecd.org/pisa/data/2015database/

Consent to publication

All authors consent to publish this article in *Learning and Instruction*.

CRediT author statement

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.learninstruc.2023.101825.

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