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Bennour, Khaled

École Supérieure de la Statistique et de l'Analyse de l'Information
Tunisie

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**Multilevel modeling of the effect of bullying on absenteeism
and performance in Saudi schools**

Dr. Khaled Bennour¹

École Supérieure de la Statistique et de l'Analyse de l'Information
Tunisie

¹ E-mail: kbennour03@gmail.com

<https://orcid.org/0000-0001-6394-2677>

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Abstract

This study explores the role of bullying in Saudi schools to explain absenteeism, gender-gap and between-school variation in mathematics achievement. Using the 2015 Trends in the International Mathematics and Science Study (TIMSS) dataset, the mathematics achievement scores and questionnaire responses of 4337 fourth-graders from 189 single-sex schools are analyzed. A multilevel linear modeling is employed; the results indicate that the level of student bullying and the average bullying score for that student's school have a limited but significant impact on the risk of the student missing school. We highlight the potential role of bullying in explaining girls' advantage in mathematics. The bullying level in a school is largely more predictive of the school mathematics achievement than measures of home background of students. All these findings demonstrate the need to tackle the bullying phenomenon in Saudi Arabia, particularly in the most afflicted all-boys schools, to reduce variation in performance between schools, decrease significantly the gender difference with regard to mathematics, and improve the overall attainment of Saudi schools and students.

Keywords: bullying, absenteeism, gender-gap, educational achievement, TIMSS

1. Introduction

TIMSS 2015 results show that Saudi Arabia ranks among the lowest-performing countries at the fourth grade with an average mathematics attainment score of 383, significantly behind the average of the 47 TIMSS participating countries with 510 score points. It is then imperative to explore factors that are associated with negative educational outcomes.

Bullying at school is a global phenomenon (United Nations Educational, Scientific and Cultural Organization, 2017). However, prevalence rates vary quite substantially across countries, suggesting that some countries should commit to addressing all the forms of bullying experienced by students (Yang and Salmivalli, 2013). Saudi schools are no exception; in the past two years, the Saudi press and social media have discussed in detail the death of three students in 2019 and 2020, as a result of bullying.

The different TIMSS surveys show that bullying remains a major problem in Saudi Arabia, as well as in all Gul countries. Based on TIMSS 2015, the rates of bullying in Saudi Arabia was very high compared with the TIMSS average, and with many other countries. More than one in four students in Saudi Arabia (26.2 percent) said that they experienced bullying “about weekly”, which was slightly less than double that of the TIMSS average (14.9 percent). The percentage of students reporting recurrent bullying was statistically significantly lower in 40 of the 47 countries, and higher in only one country.

In TIMSS 2015 there is no difference between boys and girls in mathematics achievement in more than half the countries. The largest gender-gap in mathematics was observed in Saudi Arabia and favoring girls. Saudi Arabia exhibited a high rank (39 percent) for the variance between students in mathematics achievement that was accounted for by school-level differences. A cross-country analysis indicates that, in most countries, school accounted for a portion of the variance in fourth-graders’ mathematics achievement, ranging from between 10 percent in Finland and Japan, to around 4 percent in Chile, Bulgaria, and Turkey. The absenteeism rate is also among the highest in terms of other TIMSS participants. The percentage of students who were absent at least once every two weeks was 35.3 percent in Saudi Arabia but 14.7 percent across TIMSS participants. This study explores the relationship between mathematics performance, absenteeism, gender-gap, and bullying, and in particular answering the following questions:

- 1- What effect, if any, do student and school levels of bullying have on school attendance?
- 2- What is the role of bullying in explaining the gender-gap in mathematics attainment?
- 3- What is the role of the level of bullying in a school, measured by the students’ average on the bullying scale, in explaining the variance in mathematics attainment observed between schools?

2. Literature Review

Growing attention to bullying in schools has highlighted various unfavorable consequences for victims of peer harassment, including school avoidance. A number of studies analyzed the relationship between bullying victimization and avoidance behaviors. Glew et al. (2005) examined bullying involvement and school problems for 27 U.S. elementary schools. They did not find that children involved in bullying were associated with lower attendance. Wolke et al. (2001) interviewed children from 31 primary schools and found no association between victimization

experiences and school absenteeism. In contrast, Juvonen et al. (2000) investigated a sample of middle school students and reported that students who experienced harassment incidents tend to have psychological problems which partly account for their poor school attendance. This study explored the relationship between absenteeism and bullying in Saudi schools.

A large literature has documented gender inequalities in education and a large number of factors for explaining these inequalities have been studied (Buchmann et al., 2008; Anaya et al., 2021). Several researchers relied on evidence related to socio-cultural environments (Rodríguez-Planas and Nollenberger, 2016; Stoet and Geary, 2018). Baker and Jones (1993) found that, for a sample of developed and developing nations, the magnitude of the sex differences in the performance of eighth-grade mathematics significantly correlated, across nations, with several indicators of gender stratification of opportunity. Guiso et al. (2008) used the Gender Gap Index (GGI), a measure of economic and political opportunities, education, and well-being for women. They concluded that the mathematics gender gap varies across nations with low gender-equality countries tend to have larger mathematics gender gap in favor of boys. In more gender-equal countries, the male advantage in mathematics disappears. Likewise, Nollenberger et al. (2016) argued that cultural beliefs of second-generation immigrants are influenced by the gender equality in the country of ancestry. Using a sample of U.S. second-generation immigrants, they found that culture of ancestry matters. More precisely, mathematics achievement of girls, as compared to boys, is higher for students whose parents were born in countries that approach equal opportunities for males and females. All these researches suggest that, in less gender-equal societies, a large gender gap happens and favors boys. However, the results TIMSS 2015 provide evidence of a substantial gender difference in mathematics in favor of girls in most Gulf countries. Saudi Arabia is among seven countries with the lowest gender parity in Global Gender Gap Report 2017 and exhibited the largest gap favoring girls. This gender gap cannot be explained by gender equality and then warrants investigation.

A large literature has suggested that social and behavioral skills play a central role in gender stratification. The higher incidence of behavioral problems among boys has also been recognized as a potential driver of a gap in college attendance and school performance, favoring girls (Goldin et al. 2006). Research by Rosenbaum (2001), Farkas et al. (1990), and Downey and Vogt Yuan (2005) provide evidence that female adolescent students have better social and behavioral skills at older ages than boys, and that gender differences in social and behavior skills may be an important

component of gender differences in academic performance. In this paper, we explore the role of bullying in explaining mathematics gender gap in Saudi Arabia. We hypothesize that the effect of behavioral and social skills dominates the cultural effect. More precisely, the high levels of bullying in all-boys schools, as signals of behavior problems, may explain the large difference in Saudi Arabia in mean female and male performance that favors girls.

Bullying involvement has been found to have a negative impact on children's educational outcomes, particularly academic performance (Nakamoto and Schwartz, 2010). Also, the relationship between school-level socioeconomic background and school level achievement is established in the literature (Sirin, 2005). However, little work has examined the contribution of the bullying at the school-level toward the prediction of mean school achievement over and above that made by the socioeconomic composition of the school. In this study we ask whether the differences in school bullying level explain much of the differences in achievement between Saudi schools that is normally attributed to the average level of the home background variables in the school. This complex interrelationship between composition, climate and achievement among Saudi schools is one of the focus of this research.

3. Method

3.1 Data

The data is derived from a large-scale quantitative study called TIMSS. TIMSS is an international assessment of the mathematics and science knowledge of students at the 4th and 8th grades. 57 participating countries/regions, including all GCC countries, and 7 benchmarking countries participated in TIMSS 2015. Saudi Arabia participated in TIMSS 2003, 2007, 2011 and 2015. 91 all-girls primary schools and 98 all-boys primary schools participated in TIMSS 2015, and 4337 fourth grade students were tested. The average age of primary 4 students tested is 10 years old.

3.2 Measures

3.2.1 Mathematics achievement

Students' achievement in mathematics is presented as *five plausible values*. Plausible values are multiple imputations of the unobservable latent achievement for each student.

3.2.2 Bullying

Student Bullying scale is created based on students' responses to how often they experienced eight bullying behaviors. A higher bullying score is more favorable; in other words, a higher value on the scale indicates that less bullying was experienced. For regression models we decide to reverse the pattern.

3.2.3 Absenteeism

TIMSS 2015 assess the absenteeism of students by asking students about the frequency they are absent from school. The four response categories were: "never or almost never", "once every two months", "once a month", "once every two weeks", "once a week". We create a variable, entitled *Absence*, equal to 1 if a student is absent at least once per week, and 0 otherwise.

3.2.4 Control variables

A number of individual-level variables are included as control variables.

Gender has the value of boy or girl.

Home resources for learning scale is constructed based on students' and parents' responses with regard to the availability of five home resources for learning.

Early Literacy and Numeracy scale is created based on the frequency parents engaging in sixteen activities prior to the student beginning primary school.

4. Results

4.1 Descriptive statistics

Descriptive statistics of the study sample are presented in Table 1. The TIMSS 2015 data reveals that Saudi fourth graders performed at a lower level in mathematics compared with most other countries. Also, the largest gender-gap is observed in Saudi Arabia. As the average bullying scale is 10 internationally, the low average of the bullying scale in Saudi Arabia, equal to 9.5, indicates a relatively high level of bullying. This confirms the high prevalence of bullying, as Saudi Arabia ranked 10th among the 47 TIMSS participants. Boys are much more likely than girls to experience bullying. For Saudi boys, on average, 35.6 percent of students are bullied frequently; that number is cut in half, to 17.1 percent, when it comes to girls. Similarly, when examining the bullying scale, boys have significantly higher scores than girls, with a difference of nearly 10 percent. Across TIMSS participants, the boy-girl difference is reduced by a third. The absenteeism rate is also

among the highest in terms of other TIMSS participants. The percentage of students who were absent at least once every two weeks was 35.3 percent in Saudi Arabia but 14.7 percent across TIMSS participants.

Table 1: *Descriptive statistics*

Type of bullying	Saudi Arabia	TIMSS International average
Mathematics achievement-boys	363	505
Mathematics achievement-girls	405	505
Bullying scale	9.5	10.0
Bullying scale-boys	9.1	9.8
Bullying scale-girls	10.0	10.2
Exposure to frequent bullying (weekly)	26.2%	14.9%
Exposure to frequent bullying-boys	35.6%	17.1%
Exposure to frequent bullying-girls	17.1%	12.1%
Chronic absenteeism	35.3%	14.7%

4.2 Multilevel Analysis

Given the hierarchical nature of the data, with students nested in schools, a multilevel analysis is applied. As there is a differentiated effect of the home resources for learning scale and the early literature and numeracy scale, the bullying scale at the student-level is entered as group-mean centered, while the school-level averages is entered as grand-mean centered. The choice of the group-mean over the grand-mean is particularly crucial as we are examining the moderating influence that the level of bullying within the school exerts on the association between the bullying level experienced by the students and their absenteeism (Hofmann and Gavin, 1998; Raudenbush, 1989a, 1989b).

4.2.1 Bullying and Absenteeism

To explore how the level of bullying, as measured by the bullying scale, impact the absenteeism of students, a multilevel logistic regression is run, using SAS's command GLIMMIX. The student's bullying scale and the school average of students' bullying scale are the independent variables, and the student absenteeism is the dependent variable. The results of this analysis show

that the level of bullying, at both the student and the school level, are significant variables to explain students' absenteeism. Students scoring high on the bullying scale, and in schools in which the students' average bullying as measured by the bullying scale is high, i.e. when the frequency of bullying is high, are much more likely to engage in chronic absenteeism. An increase in bullying, by increasing the bullying scale score by one-unit, other things equal, induces an increase in the odds of chronic absenteeism by a factor of 10 percent (see column 1 of Table 2). This conclusion is strengthened by the fact that the overall pattern of results from this analysis is unchanged after adjusting for home resources for learning and early literacy and numeracy scales, at both student and school levels (see column 2 of Table 2). Finally, when modelling the interaction of bullying at the student and the school levels, we find that student's level of exposure to bullying has a differential influence on absenteeism, depending on the level of bullying in the school. More precisely, a higher level of bullying in the school exacerbates the effect of the student bullying level on the risk of chronic absenteeism (see column 3 of Table 2).

Table 2: *Odds of being absent*

	Model 1	Model 2	Model 3
Intercept	-0.696***	-0.755***	-0.753***
Students' bullying scale	0.110***	0.101***	0.095***
Students' average of bullying scale	0.230***	0.230***	0.231***
Interaction term			0.037*
Students' home resources for learning		0.004	0.005
Students' early numeracy and literacy		-0.051*	-0.052*
Students' average of home resources for learning		-0.101	-0.102
Students' average of early numeracy and literacy		-0.088	-0.089
Male		0.080	0.077

*p < 0.05 **p < 0.01, ***p < 0.001. Missing data excluded.

4.2.2 Bullying and the Mathematics Gender-gap

In Table 3, we first estimate a null-model that shows how much of the variation in students' mathematics scores is due to their nesting in schools. Model 2 explores the association between gender's student and attainment after controlling for the influences of home backgrounds, measured by the home resources for learning scale and the two early learning scales, at both the

student and the school level. We observe that boys overall have significantly lower mathematics scores than girls ($b=-39.5$). In model 3, the bullying scale variables, at both the student level and the school level, are included as main effects. We obtain a reduction in gender-gap difference of 60 percent, and a decrease of the percentage of variance explained by the school-level predictors by 19 percent. In model 4, we include a cross-level interaction and a level 2 interaction to question whether the influences of the level of bullying, at the student and the school levels, on the student performance depend on a student's gender. The cross-level interaction represents the difference in the effect of the level of bullying at the student level between boys and girls. We see that a higher student level of bullying affects boys' mathematics scores ($b=[-2.4-3.3]-5.7$) more negatively than that of girls ($b=-2.4$). Also, a higher level of bullying in a school is more detrimental for boys' mathematics scores than for girls' mathematics scores since boys' mathematics score decreases ($b=[-10.2-14.5]-24.7$) more than girls' scores ($b=-10.2$).

Table 3: *Multilevel model to explain gender difference*

	Model 1 Null	Model 2	Model 3	Model 4
Intercept	385.7***	409.0***	398.0***	402.5***
Boy		-39.5***	-15.8*	-18.2**
Students within Schools				
Bullying Scale			-4.0***	-2.4*
Home Resources for Learning		5.5***	5.2***	5.2***
Early Numeracy/Literacy Scale		6.6***	6.2***	6.2***
Between Schools				
School Average of Bullying Scale			-19.4***	-10.2**
School Average of Home Resources for Learning		5.6	10.0*	8.3
School Average of Early Literacy/Numeracy Tasks		-4.4	2.0	3.2
<i>Interactions</i>				
Student Bullying × Boy				-3.3*

School Bullying × Boy				-14.5**
<i>Variance Statistics</i>				
Between Schools	3365.6	2799.2	2257.8	2199.7
Within Schools	5230.3	4998.1	4897.0	4885.2

*p < 0.05 **p < 0.01, ***p < 0.001. Missing data excluded.

4.2.3 Bullying and School Variation in Performance

In this section, we examine the role of bullying in explaining between-school variations in performance. For this we use the average of students' home resources for learning scale and the average of students' early literature and numeracy scales as control variables. In the model including only control variables (model 2 of Table 4), the contribution of these home factors to explaining between-school differences in achievement, is virtually non-existent in Saudi Arabia. They account for only 1 percent of the school-to-school differences in mathematics but for more than 50 percent in the TIMSS average. Saudi Arabia has no significant predictors of student achievement in this school background model. The model 3 with only the school average of students' bullying scale covariate reveals that the bullying scale at the school level explains 23 percent of the school-to-school differences in Saudi Arabia, but explains only 7 percent for the TIMSS average.

Table 4: *Multilevel model estimating bullying effect at the school level*

School Variables	Model 1 Null	Model 2	Model 3	Model 4
Intercept	385.7***	385.8***	385.8***	385.5***
Students' average of home resources for learning		9.3		13.0**
Students' average of early numeracy and literacy		-1.4		4.2
Students' average of bullying scale			-22.3***	-24.1***
School level variance	3365.6	3314.5	2603.2	2463.1
Student level variance	5230.3	5230.4	5230.4	5230.7

*p < 0.05 **p < 0.01, ***p < 0.001. Missing data excluded.

Analysis in Table 4 indicates that, after controlling for home background, including the schools' bullying variable, there is a decrease in the variance component from 3314.5 (estimated in model

2) to 2463.1, which means that the levels of bullying in schools explain 26 percent of the between school variation in students' mathematics performance (the international average is 7 percent). The decrease in the mathematics performance of a particular school that is associated with an increase of one-unit in terms of the school average for the students' bullying scale, is substantial in Saudi Arabia as compared to most TIMSS participants. More precisely, on average, the performance of a school decreases by 24.1 score points when bullying increases, that is when the average of students' bullying scale increases by one unit (the international average is a decrease of 8 score points). Finally, when the data is analyzed separately for boys and girls, by considering all-boys schools and then all-girls schools, we find that, in both cases, there is no significant effect with regard to the two home background variables measured at the school level. The bullying measure at the school level has a negative and significant effect on attainment, although the magnitude is rather small in girl schools. More precisely, the coefficient of the bullying scale is half as high in all-girls schools as it is in all-boys schools.

5. Discussion

In the present study, we explore whether bullying in Saudi schools is connected to chronic absenteeism. We show that bullying has a modest but a significant negative effect on absenteeism. This finding is consistent with the results of Hutzell and Payne (2012). In their study of 11,161 students between the ages of 12 and 18, bullying victimization has been found to affect avoidance behaviors in school. In contrast, in their survey of 31 primary schools, Wolke et al. (2001) found that levels of absenteeism to be similar between victims and non-victims.

While the gender gap in mathematics attainment in Saudi Arabia has received increasing attention in recent years, it has gone largely unexplained in the empirical research literature. The large gender gap in performance in Saudi Arabia, favoring girls, contradicts the argument that gender inequality could be a major factor that negatively influences mathematics performance of girls. By showing the leading role of bullying in explaining the gender gap, we provide evidence that, in Saudi Arabia, social and behavioral factors may help explain gender differences in mathematics.

A large literature emphasized TIMSS 2015 revealed that there is a considerable variation in mathematics attainment between schools in Saudi Arabia. Surprisingly, this difference was not due to differences in the home background between schools, as the school average of home

resources for learning and early numeracy and literacy scales account for only one percent of school-to-school differences.

The majority of research that explored the link between bullying and academic achievement did not analyze the contribution of bullying to explain school-level variance in attainment. Our results suggest that, in Saudi schools, a high percent of the total variance between schools in mean mathematics achievement is accounted for by the school level of bullying. Coefficient of the bullying scale is half as high in all-girls schools as it is in all-boys schools.

6. Conclusion

Based on all our findings, we believe that greater emphasis needs to be put on preventing and tackling bullying, particularly for boys. Successful responses to bullying will significantly reduce student absenteeism and the gender-gap in mathematics attainment, help reduce the differences in performance between Saudi schools, and improve the performance of the lowest-achieving students.

Saudi Arabia has recently initiated a program clearly aimed at promoting co-educational schools by authorizing mixed-gender classes in 15 private schools and the first three primary grades. The results of this paper raise the interesting question of whether decreasing the fraction of single-sex schools will increase achievement by reducing bullying. Studies exploring the effect of the sex composition of schools on achievement found mixed results (Gándara and Silva, 2016).

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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