Pervasive bullying and its negative consequence on standardized tests of Reading, Science and Mathematics – A comparative analysis of three countries in Sub-Saharan Africa

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Abstract: School bullying is a common yet unfortunate occurrence associated with several hindering outcomes for children's educational and psychological development. Using a nationally representative data sample of 26,467 students from three sub-Saharan African countries of Ghana, Botswana and South African, we investigate the prevalence of bullying and its ramification on students' academic performance. The data reveals that more than 50% of the survey participants were bullied regularly in school. We employ a Propensity Score based matching technique to estimate the effect of bullying of their performance on standardized reading, mathematics and science tests. The results of our estimation reveal statistically significant decreases due to bullying in scores on all three types of standardized evaluations between 3% to 8% for all three countries.

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1. Introduction:

Bullying in and around educational settings is a global phenomenon. Bullying can be physical, verbal, or relational, which refers to children being systematically excluded from social activities by their peers (Olweus, 1993). Most Current estimates by the non-governmental organization Plan International suggests that around 20% of the global student population is affected by bullying (Greene et al., 2013). A few recent studies from countries of Europe, South America and USA have shown that bullying can lead to school avoidance and poor attendance, inability to concentrate, negative attitudes, lack of academic engagement, depression and reduced self-esteem, and even physical health problems (e.g. Ammermueller 2012; Brown & Taylor 2008; Eriksen et. al 2012; Ponzo 2013; Hazel, 2010; Ouellet-Morin et al., 2011). However, for African countries the only previous research on bullying and its negative consequence have been documented for a gender based study of Ghanaian 8th grade mathematics students' (Kibriya et al. 2016). In this research note, we extend on the previous knowledge and generate new evidence of pervasiveness of bullying and its negative consequences through an extensive comparative analysis of standardized Reading, Mathematics and Science tests administered on 4th and 8th/9th grade students in Ghana, Botswana and South Africa using a nationally representative data sample of 26,467 students.

2. Data

We construct a large data set from two international assessments, the Trends in Mathematics and Sciences Study (TIMSS) and the Progress in Reading and Literacy Study (PIRLS), conducted in 2011 by the International Association for the Evaluation of Educational Achievement (IEA). These include assessments of students' reading, math, and science skills and knowledge as well as school environment and demographic measures.

2.1 Participants

The PIRLS and TIMSS use nationally representative samples of students in the fourth and eighth grade in Botswana, Ghana, and South Africa. 3,108 participants are analyzed for reading performance, 7,807 for math, and 15,552 for science. (The same students from each grade are surveyed for math and science performance) Ninth grade students participated in the TIMSS in Botswana and South Africa. In Botswana and South Africa, the pre-PIRLS, an easier and shorter version of the PIRLS, was administered. All students and their associated schools were randomly chosen.

2.2 Measures

Student achievement in reading, math, and science is reported on a scale of 0 to 1000 with typical scores in the range of 300 to 700. Experiences of bullying were measured through the Student Questionnaire. The "Students Bullied at School" scale was constructed from students' responses to the following six items:

a) I was made fun of or called names

b) I was left out of games or activities by other students

c) Someone spread lies about me

d) Something was stolen from me

e) I was hit or hurt by other student(s) (e.g., shoving, hitting, kicking)

f) I was made to do things I didn't want to do by other students

Response options were: "At Least Once a Week," "Once or Twice a Month," "A few times a year," or "Never." From these responses, three categories of bullying frequency were created: "About Weekly", "About Monthly", and "Almost Never." Students bullied "Almost Never" reported never experiencing at least three of the six bullying behaviors and each of the other three behaviors "a few times a year," on average. Students bullied "About Weekly" reported experiencing each of three of the six behaviors "once or twice a month" (bullied 3-6 times a month) and, in addition, each of the other three "a few times a year," on average.

In addition to the Student Questionnaire, the Home Questionnaire (completed by parents or legal guardians), Teacher Questionnaire, School Questionnaire (completed by the school's principal),

and Curriculum Questionnaire provide relevant information about other variables that may influence performance, including school resources, instructional approaches, teacher characteristics, student attitudes, and home support for learning.

3. Data Analysis Method

"Bullied weekly," a binary variable, is used as the key explanatory variable for the analysis presented. To obtain un-confounded estimates, we control for school specific characteristics; students' age, and sex; teachers' age, sex, and experience; parents' income and education, and facilities available to students at home. The propensity score in this experimental setting is the probability of a unit (i.e., a student) being assigned to a treatment (i.e., being bullied weekly), given a set of observed covariates. This approach, proposed by Rosenbaum and Rubin (1983), solves the 'curse of dimensions' by combing all confounders into a single propensity score, and matches observations based on the score. Thus we are able to identify the influence of bullying by comparing the average difference in academic performance between the group of students who are bullied and the matched sample of students who had a similar chance of being bullied, based on their other observed covariates, but are not actually bullied (Abadie and Imbens, 2016; Rosenbaum and Rubin, 1983). We obtain the average treatment effect on the treated (ATT). To formally define the ATT, we define two potential outcomes. Y_{0i} is the academic performance (in this case, test score) for individual i if he or she is not treated (i.e. bullied) and Y_{1i} is the value of the outcome variable for individual i if he or she is treated. The ATT is given by $E[(Y_{1i}-Y_{0i})|T=1]$.

4. Results and Discussion:

Figure 1A shows the average test scores for each country and each discipline. Considering that that the international average is 500 points (source: PIRLS and TIMSS) and the low international benchmark is 400 points (source: PIRLS and TIMSS), we confirm that academic performance in the three countries is not up to international standards. Figure 1B shows the percentage of students who were bullied weekly, disaggregated by sex. The figure shows that bullying is widespread in all three countries, with around 50% of the students reporting regular experiences of bullying compared to only 20% at a global level.

[*Figure 1 here*]

Following, we estimate the possible negative impact of "bullied weekly" on standardized reading, mathematics and science tests. We implement three matching algorithms: nearest neighbor, radius, and kernel (Caliendo & Kopeining, 2008; Imbens, 2015). Table 1 summarizes the results of bullying on 4th graders performance in pre-PIRLs (reading), mathematics and science tests for Botswana and pre-PIRLS (reading) test scores in South Africa with the three matching algorithms. In terms of the direction of effect, both countries show consistent and significant negative effects of bullying for the tested disciplines. The magnitude of this impact is highest for South African students' reading scores with a decrease around 24.51 points on average, while lowest is for mathematics exams in Botswana with 12.37 points decrease on average. Reading and Science scores of Botswanan students' exhibit an average decrease of 13.49 and 13.67 respectively across the three matching methods. The negative impact for 4th grade students is almost equal for all subjects in Botswana implying that the effect is robust and consistent across all disciplines.

[*Table 1 here*]

Table 2 summarizes the results of bullying on 8/9th graders performances on math and science exams for Botswanan, Ghanaian and South African students. The results show statistically significant negative effect of bullying across all three countries and matching algorithms in both of the disciplines. However, unlike 4th grade students, 8th/9th grade bullied students are more sensitive towards science scores than mathematics scores. The average score decrease in science exams are 30.53, 24.06 and 24.06 for Botswana, Ghana and South Africa respectively. Math scores decreased an average of 15.65 and 13.49 for Botswanan and South African students. Botswanan students were the most affected by bullying at school and also had the highest discrepancy levels between mathematics and science scores.

To summarize our results, at an average score of 400 points, the effects of bullying correspond to a 3% to 8% decrease in performance and are consistent across all countries, disciplines and grades. As robust check the same analysis was performed using the "bullied

monthly" variable and showed similar results. The impact of "bullied monthly" is provided in the online appendix.

[*Table 2 here*]

5. Conclusion:

The determinants of in-class performance depend on a myriad of quantitative and qualitative factors. While we remain cautious to claim causality, our efforts at least establish consistent, strong, negative consequences of bullying on academic performance in various disciplines across sub-Saharan Africa with a relatively large dataset. We also provide evidence of an alarming percentage of students being bullied and harassed in selected schools. We recommend stronger and specific programs targeted to the reduction of bullying in African schools and expect such programs would go a long way in increasing student performance to international levels.

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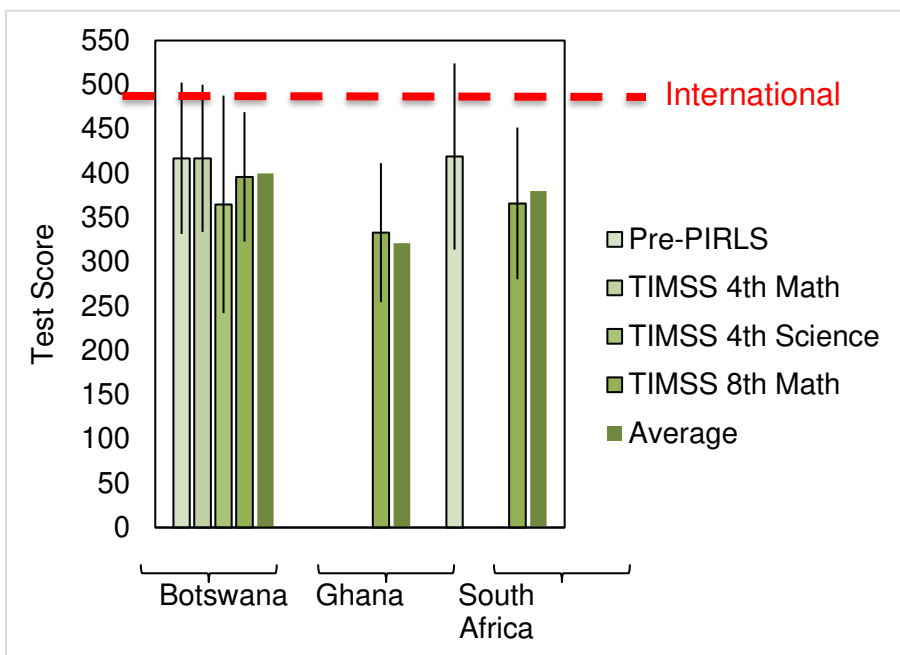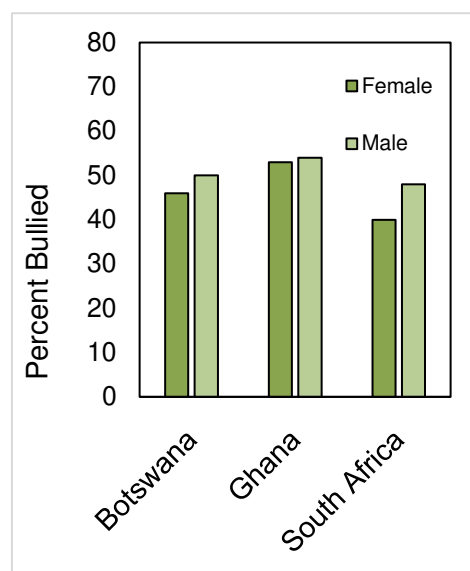
Figure 1A: Average test scores by assessment and country.

Figure 1B: Percentage of students reporting that they have been bullied weekly.

Table 1: Impact on weekly bullying on 4th grade academic performances

Matching methods	4th-grade reading (perPIRLS) scores Botswana	4th-grade math scores Botswana	4th-grade science scores Botswana	4th-grade reading scores (pre-PIRLS) South Africa
Nearest neighbor	-16.22***	-14.09**	-15.04*	-24.52***
	(5.60)	(6.32)	(9.01)	(9.01)
Number of treated	862	844	844	575
Number of controls	951	954	954	720
Radius/caliper	-12.48***	-11.11***	-11.90*	-25.52***
	(4.64)	(3.37)	(6.46)	(6.28)
Number of treated	834	827	827	562
Number of controls	947	948	948	680
Kernel (Epanechnikov)	-11.79***	-11.93***	-14.13***	-23.52***
	(3.90)	(3.46)	(5.04)	(4.34)
Number of treated	862	844	844	575
Number of controls	951	954	954	720

*,**,*** denotes significance levels at 10%, 5% and 1% respectively. Standard errors are in parenthesis

Table 2: Impact on weekly bullying on 8th grade academic performances

Matching methods	9th-grade math scores Botswana	9th-grade science scores Botswana	8th-grade science scores Ghana	9th-grade math scores South Africa	9th-grade science scores South Africa
Nearest neighbor	-18.84***	-32.30***	-22.72***	-12.62***	-23.06***
	(4.35)	(4.50)	(4.07)	(2.84)	(3.83)
Number of treated	1481	1617	2378	2424	2445
Number of controls	1467	1640	2112	3522	3562
Radius/caliper	-14.06***	-29.24***	-24.47***	-16.14***	-24.43***
	(2.928)	(3.295)	(2.815)	(1.647)	(2.214)
Number of treated	1475	1611	2359	2425	2437
Number of controls	1436	1607	2042	3562	3530
Kernel (Epanechnikov)	-14.06***	-30.16***	-25.00***	-17.02***	-24.71***
	(2.649)	(3.285)	(2.762)	(1.458)	(2.020)
Number of treated	1481	1617	2378	2424	2445
Number of controls	1467	1640	2112	3522	3562

*,**,*** denotes significance levels at 10%, 5% and 1% respectively. Standard errors are in parenthesis

Appendix

Table 1: Impact on monthly bullying on 4th grade academic performances

Matching methods	4th-grade reading (perPIRLS) scores Botswana	4th-grade math scores Botswana	4th-grade science scores Botswana	4th-grade reading scores (pre-PIRLS) South Africa
Nearest neighbor	-17.08***	-14.87***	-26.36***	-34.47***
	(8.498)	(8.235)	(10.74)	(11.49)
Number of treated	1275	1218	1218	922
Number of controls	209	203	203	217
Radius/caliper	-15.135***	-20.260***	-32.196***	-39.23***
	(5.97)	(6.42)	(11.50)	(8.67)
Number of treated	1268	1205	1205	861
Number of controls	205	203	203	213
Kernel	-16.34***	-20.42***	-32.89***	-31.14***
(Epanechnikov)	(6.003)	(6.268)	(7.378)	(6.306)
Number of treated	1275	1218	1218	922
Number of controls	209	203	203	217

*,**,*** denotes significance levels at 10%, 5% and 1% respectively. Standard errors are in parenthesis

Table 2: Impact on monthly bullying on 8th /9th grade academic performance

Matching methods	9th-grade math scores Botswana	9th-grade science scores Botswana	8th-grade science scores Ghana	9th-grade math scores South Africa	9th-grade science scores South Africa
Nearest neighbor	-17.89***	-38.01***	-27.69***	-9.15***	-20.89**
	(4.14)	(4.91)	(4.66)	(3.08)	(3.93)
Number of treated	2370	2611	3556	4283	4279
Number of controls	536	593	954	1656	1681
Radius/caliper	-21.58***	-35.48***	-25.96***	-10.44***	-23.19***
	(3.399)	(4.217)	(3.733)	(1.782)	(2.50)
Number of treated	2359	2603	3543	4282	4279
Number of controls	525	582	953	1650	1667
Kernel (Epanechnikov)	-21.40***	-35.327***	-25.89***	-12.06***	-25.05***
	(3.42)	(3.36)	(3.46)	(1.85)	(2.33)
Number of treated	2370	2611	3556	4283	4279
Number of controls	536	593	954	1656	1681

*,**,*** denotes significance levels at 10%, 5% and 1% respectively. Standard errors are in parenthesis