Impacts of Boarding on Primary School Students' Mental Health Outcomes – Instrumental-Variable Evidence from Rural Northwestern China

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Selected Poster prepared for presentation at the 2020 Agricultural & Applied Economics Association Annual Meeting, Kansas City, MO
July 26-28, 2020

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Abstract: This paper estimates the impacts of boarding on primary school students' health outcomes, using data on 7,606 students from rural areas of two northwestern provinces (Qinghai and Ningxia) of China. Exogenous variations in students' home-to-school distance are exploited to address potential endogeneity in their boarding status. Instrumental variable estimates suggest that while boarding has little impact on students' physical health (measured by height-for-age and BMI-for-age z-scores and hemoglobin concentration levels), it has a significantly detrimental effect on their mental health status, amounting to 0.455 standard deviations (SDs) of the distribution of scores on a Mental Health Test (a modified version of the Children's Manifest Anxiety Scale). The effect of boarding is more pronounced for students with relatively advantageous backgrounds. For example, boarding boys scored 0.544 SDs higher on the Mental Health Test (suggesting more anxiety problems) than nonboarding boys, and boarders from relatively wealthier families scored 0.754 SDs higher than wealthier nonboarders.

Key words: Boarding school; Mental health; Physical health; Rural China

JEL codes: I10; I20

1. Introduction

China's population control policies, along with its rapid economic development, have greatly reduced Chinese parents' demand for children. As a consequence, the total fertility rate in rural China has declined by more than 60% since the late 1970s.[1] The number of children under age 17 also dropped rapidly from 410 million in 1982 to 345 million in 2000 (NBSC, 1982, 2000). The shrinking population of school-age children since the early 1990s has led to substantial reductions in school enrollment in rural China (Chen et al. 2015). Small-scale enrollments and the resulting high teacher-to-student ratios have, in turn, caused substantial waste of the already-scarce educational resources in rural China (Ministry of Education, 2010).

In reaction to this problem, the Chinese government launched a national school merger program in 2001 (State Council, 2001; Liu et al., 2010). The key part of this program involved plans to close small primary schools in remote villages, especially non-complete primary schools and teaching points that had only 3 grades, and merge them with larger, complete primary schools (with all 6 grades) (Ministry of Education, 2010). Approximately 300,000 rural schools were then merged to bigger and better-equipped schools during the first decade of the new Millennium (Wang, 2017). While also accommodating nonboarding students, boarding schools have become the major platform of education provision and management in rural China since 2004: by 2015, the numbers of boarding students in rural primary schools had reached 9,550,000, accounting for 14.4% of the total enrollments of rural primary schools (Ministry of Education, 2016).[2] The 19th Congress of China, held in October 2017, further stressed the key role boarding schools ought to play in the development of China's rural education system in the

[1] In 1975, the national total fertility rate was 3.58 (Attané, 2002) and the figure in rural China was 3.80 (Feeney et al. 1989). According to the results of the sixth population census of China (NBSC, 2011), these two figures became 1.18 and 1.44 in 2010, respectively.

[2] After the school merger program, there is usually one "central" primary school within each township in rural China. By law, all school-age children residing in this township are supposed to attend the only one central primary school. Those who live far from the center of the township usually opt to become boarding students, because it is not possible for them to travel between their home and school on a daily basis (− unlike Charter schools in the U.S., rural schools in China seldom provide school bus services for their students). There are also reasons for students who live close to their school to become boarders. For example, their parents may think that living at school is good for developing their social and communication skills or their sense of independence. Some parents may even enroll their children as boarding students just to relieve the pressure of looking after their children.

foreseeable future.[3] Yet to better serve their mission, boarding schools need to first overcome a series of problems plaguing China's rural education system, the most pressing one being poor child health (Yue et al., 2018).

While it is relatively easy to monitor students' physical health status through more frequent and regular checkups, it is much more difficult to detect their mental health problems. Worse yet, if not discovered in time, mental health problems can lead to more serious consequences. A series of devastating suicide incidents stemming from students' mental health issues occurring the early 2000s have since induced the Chinese government to devote considerable efforts to reducing mental health problems at all levels of schooling (Hesketh et al., 2002; Zhang et al., 2013). A question naturally arising in this context is: How does boarding, the new platform for education provision and management in rural China that may last for decades, affect students' mental well-being?

The answer to this question is theoretically ambiguous. On the positive side, the collective living environment supervised by designated student-care staff at school may help ensure boarding students' health and safety (Wang et al., 2017). School rules and teachers' instruction may also help boarders develop more living skills and form healthier living habits (Liu, 2005). For students with disadvantaged backgrounds, living away from their disadvantaged home environment may improve their subjective well-being (Child, 2016; Martin et al., 2014). On the negative side, however, boarding implies a lack of close parental care, without which boarding students' personalized emotional need may not be easily met. Homesickness, schooling-related stress, and lack of constant and continuous support from parents may also incur psychological costs (e.g. Fisher et al., 1986; Cookson, 2009). Since the relative strengths of these boarding-related effects are unclear in theory, how boarding affects students' mental health is ultimately an empirical question.

Unfortunately, existing empirical evidence from China also fails to provide a conclusive answer. While some studies found significantly negative associations between boarding and students' mental health outcomes (e.g. Du et al., 2010; Wang et al., 2016), others found virtually no association between them (Zhou et al., 2018). As recently

[3] Available at: http://www.china.com.cn/cppcc/2017-10/18/content_41752399.htm (accessed October 31, 2018).

pointed out by Wang et al. (2016), the lack of a consensus in existing findings may be due to two methodological drawbacks: relatively small sample size and lack of exogenous variations to identify boarding effects.

To overcome these drawbacks, the present study employs a large dataset on 7,606 students collected from 74 rural primary schools in two northwestern provinces of China (Ningxia and Qinghai) to estimate the causal effect of boarding on students' mental health status, including subdimensions such as study anxiety, social anxiety, and loneliness, etc. (− effects of boarding on students' physical health outcomes, including height, weight and hemoglobin concentration levels, are also examined for comparison and interpretation purposes). To address potential endogeneity in students' boarding status, we exploit exogenous variations in their home-to-school distance to create an instrumental variable (IV) for it. Admittedly, this IV is not free of concerns, a major one being that home-to-school distance may capture the level of prosperity of one's home village relative to his/her school location, thereby confounding the effect of boarding. For instance, students who grew up in well-developed villages may be physically and mentally healthier than those who grew up in remote and less-developed villages, regardless of their boarding status. We address this concern by (1) controlling for school fixed effects, and (2) restricting our analysis to the sample of students with a relatively short home-to-school distance (≤ 3 km). The rationale is that, conditional on the school being attended, identification of boarding effects comes from *within*-school variations in students' home-to-school distance, which are unlikely to capture the influence of home-village prosperity when the focus is placed on students with a short home-to-school distance. Our IV estimates suggest that while boarding has a negligible effect on students' physical health, it has a significantly negative effect on their mental health status.

Our study makes two contributions to the literature. First, to the best of our knowledge, our study is the first to identify causal effects of boarding on students' mental health outcomes in the context of (rural) China. To measure students' mental health status, we administered a mental health test, adapted from the widely-used Children's Manifest Anxiety Scale originally developed by Cecil R. Reynolds (1980), to all sampled students, assessing their mental well-being in eight subdimensions including study

anxiety, social anxiety, loneliness, self-punishment, physical anxiety symptoms, sensitivity, fear and impulsiveness. This test helps to depict a comprehensive profile of students' mental health status in rural northwestern China and assess how boarding affects it. Second, our analysis provides new evidence on the education-health nexus from an often-overlooked angle. The majority of previous studies on this nexus have mainly focused on estimating the impact of the *quantity* of education (e.g. years of schooling or the highest degree earned) on one's health behavior and outcomes (e.g. Arendt, 2005; De Walque, 2007; Groot and van den Brink, 2007; Albouy and Lequien, 2009; Braakmann, 2011; Zhong, 2016; Parinduri, 2017).[4] Our study, in contrast, examines how boarding, as a *particular form* for education provision and management, affects one's (mental) health. This line of inquiry also contributes to the emerging literature on the role boarding schools play in forming students' human capital (Curto and Fryer, 2014; Behaghel et al., 2015; Gregg, 2018).

The remainder of this paper is structured as follows. The next section describes our data. Section 3 develops a framework underlying our empirical analysis. Section 4 reports and discusses our main findings. The final section draws conclusions and suggests several directions for future research.

2. Data

2.1. Survey and data

The data analyzed in this study were collected in October 2009 through a school-based survey conducted in two provinces in northwestern China: Qinghai Province and Ningxia Autonomous Region.[5] As with other western provinces, Qinghai and Ningxia are relatively under-developed compared to other regions in China, mainly due to their disadvantaged natural and transportation conditions. Official statistics indicate that per capita incomes of rural households in Qinghai and Ningxia were, respectively, 35.1% and 21.4% lower than the national average at the time of the survey (NBSC, 2010). Poor child

[4] See also Glewwe and Miguel (2008) for a thorough review on studies on the health-education relationship in developing countries.

[5] In China, an autonomous region is also a province-level administrative unit, usually with a large ethnic minority proportion. For example, 36% of the population in the Ningxia autonomous region are of Hui ethnicity.

health was also prevalent in these two provinces. For example, as high as 51% and 25.4% of primary school students were anemic in Qinghai and Ningxia in 2009 (Luo et al., 2011). Students' mental health status was also worrisome: our survey of more than 7,000 fourth and fifth graders in these two provinces revealed that more than 50% of the sampled students suffered from study anxiety issues (Table 1A).[6] The high proportion of boarding students (> 30%) in rural Qinghai and Nixing renders this area suitable for studying the boarding–mental health relationship.[7]

The study sample was collected based on a multi-stage, random sampling procedure. First, a list of all counties located in each of the two provinces was compiled, with a ranking of counties based on gross value of industrial output (GVIO) per capita in 2008.[8] Based on this ranking, five poorest (Mandarin speaking) counties were chosen from each province. Official records were then used to identify all primary schools from the 10 chosen counties that met the following criteria: (a) being a "complete" primary school, i.e. having all six grades (Grades 1-6); (b) equipped with boarding facilities that meet the requirements set by local education authorities; and (c) with an enrollment of 400 or more students.[9] Finally, two Grade 4 and two Grade 5 classes were selected from each of the chosen schools.[10] A total of 7,606 Grades 4-5 students enrolled in the 74 sampled schools (38 in Qinghai and 36 in Ningxia) were interviewed during the survey.

Information on sampled students' personal, family, and school characteristics was collected through a set of questionnaires. Students filled out a "student" questionnaire on their personal characteristics during class on a survey day. With the assistance from a professional nursing team, physical health indicators on sampled students' height, weight,

[6] Zhang et al. (2013) found in Shaanxi province (which is geographically adjacent to Ningxia and Qinghai) that nearly 40% of fourth graders in eight poor counties suffered from anxiety issues.
[7] A statistical analysis conducted by the Ministry of Education (2010) indicated that in 2009, boarding students accounted for more than 30% of the total number of students enrolled in rural primary schools in western China. This figure is very close to that in our sample (33%).
[8] Rozelle (1996) shows that GVIO per capita is a more reliable measure to reflect the level of development of rural counties in developing countries than GDP per capital.
[9] The threshold of 400 enrolled students was adopted with reference to the average enrollment of primary schools in China, i.e., 386 students in 2009 (Ministry of Education, 2010). To put this number into perspective, note that if a grade has two classes and a class has 32 students, then a complete school with 6 grades would have 384 students.
[10] If a school had more than two classes in a given grade, then two classes from this grade were randomly selected; if a school had no more than two classes in each grade (which accounted for 90% of the cases in our project), all Grade 4 and Grade 5 classes in this school were then selected.

and hemoglobin (Hb) concentration levels were also collected, all measured with standard medical instruments operated by the nursing team (– however, due to budgetary constraints, physical health information was collected only for about half (N = 3,749) of the sampled students). Information on students' family characteristics was provided by their parents through a take-home "household" questionnaire. Finally, information on basic teacher characteristics, such as educational background and teaching experience, as well as that on school facilities, were provided by school principals through a "school" questionnaire.

2.2. Measuring mental health outcomes

The outcome of primary interest in this study, students' mental health status, was measured by their scores on a mental health test (MHT). The MHT adopted in this study is an updated version of the Children's Manifest Anxiety Scale originally developed by Cecil R. Reynolds (Reynolds,1980, 1985; Paget and Reynolds,1984; Reynolds and Richmond, 1994), an internationally standardized test for child mental health that has long been used in both developed and developing countries (Reynolds and Richmond, 2005). Our version of the MHT, adapted to fit the Chinese context, has been shown to have a reliability score of 0.84-0.88 and a retest reliability score of 0.78-0.86 (Zhang et al., 2013), which indicate that the test measures an aspect of mental health that is relatively stable over time.

The MHT consists of 100 "yes or no" questions. Ten questions are used to test the reliability of test-takers' responses; the other 90 are used to assess eight subdimensions of child mental health status, i.e., study anxiety (15 questions), social anxiety (10 questions), loneliness (10 questions), self-punishment (10 questions), sensitivity (10 questions), physical anxiety symptoms (15 questions), fear (10 questions), and impulsiveness (10 questions).[11] Each question is worth one point: the lower the score the better a student's mental health status is. A score greater than 8 points (even if the subdimension has 15 points) is considered clinically high and thus flags a need for treatment.

[11] For example, a question in the study anxiety subdimension is, "Will you be worried about your test score after an exam?", a question in the social anxiety subdimension is, "Do you always feel someone takes notice of you?", and a question in the self-punishment subdimension is, "Do you sometimes regret what you have done?" The full set of MHT questions is provided in Appendix A.

Table 1A, presenting summary statistics of students' MHT scores, reveals two important patterns. First, while the average score of the overall MHT, 40.85 (out of 90), does not seem to suggest any serious mental health problems among sampled students, displaying scores separately on the eight subdimensions reveals some concerns.[12] Most strikingly, over half (51.27%) of all sampled students suffered from study anxiety and more than one sixth (17.68%) exhibited physical-anxiety symptoms. Second, cross-sectional comparisons reveal significant gaps in mental health status between boarders and nonboarders – the latter outperformed (i.e. scored lower than) the former on the MHT in at least three subdimensions (loneliness, self-punishment, and fear). As with the patterns of mental health outcomes, while the physical health status appeared worrisome for both groups, the boarder−nonboarder differences were in general in favor of non-boarders.

[*Tables 1A and 1B about here*]

Note that these patterns are only suggestive of negative boarding effects on student health, because the boarder-nonboarder differences are observed without netting out the influences of potential confounding factors. As shown in Table 2, panel A, there are also statistically significant board-nonboarder differences in personal, family and school characteristics that are in general in favor of nonboarders,[13] which may be driving the observed board-nonboarder differences in health outcomes. Thus, to obtain "cleaner" estimates of boarding impacts, more-rigorous analysis that controls for potential confounding factors is needed. The next section develops an estimation framework for this purpose.

[12] The mean score of 40.85 on the MHT is similar to those found in other large-scale samples collected in China. Zhang et al. (2013) administered the same MHT test as ours to 2,730 fourth graders from Shaanxi Province in 2008. The mean MHT score in their sample was 39.1. More recently, Wang et al. (2015) administered the MHT to a sample of 4,465 rural middle school students, also from Shaanxi, in 2012. The mean MHT score was 38.46 in their sample. To the best of our knowledge, no more-recent large-scale samples were collected in rural China.

[13] Compared to nonboarders, boarders are on average older and more likely to belong in ethnic minority groups than borders. Their parents are older, less-educated, and less likely to be migrant workers. Schools with lower teacher-to-student ratios, less-educated teachers, and with no library tend to have more boarders.

[*Table 2 about here*]

3. Estimation Framework

3.1 Statistical relationship of interest

Consider first a statistical model that links a student's health outcomes and his/her boarding status, as well as other health determinants:

$$H_{ijk} = \beta_{0i} + \beta_{1i} \times Board_{jk} + \mathbf{Z}_{jk}\boldsymbol{\beta}_{2i} + u_{ijk}, \qquad (1)$$

where H_{ijk} is the i^{th} health outcome of student j in school k; $Board_{jk}$ is an indicator of this student's boarding status (=1 if boarding, and 0 otherwise); other exogenous covariates $\mathbf{Z}_{jk}$ include a set of child (e.g., age and gender), family (e.g., parental education and occupation), and school characteristics (e.g., teacher qualifications and conditions of school facilities); the error term u_{ijk} captures the influence of all unobserved factors.

If boarding is exogenously given, Equation (1) can be viewed as a "reduced-form" relationship (as opposed to a health "production" function), in that it does not involve (endogenous) health inputs, which are functions of exogenous determinants involved in $\mathbf{Z}$ (and of u). While in theory boarding may be thought of as an "input" variable, it seems more reasonable to view it as a "policy" variable in our context− and the main task here is to evaluate the impacts of this policy. If Equation (1) is correctly specified, the parameter β_{1i} captures the causal effect of boarding on one's i^{th} health outcome and can be estimated consistently by ordinary least-squares (OLS) regressions.

However, in the context of rural China, one's boarding status is likely to be endogenously determined. There are at least two potential endogeneity problems that may lead to biased OLS estimates of β_{1i}. First, reverse causality may arise if healthier children are more likely to be boarders. Second, there may be unobserved factors (e.g., pre-existing health conditions) that simultaneously affect one's health and boarding status, leading to omitted-variable bias.

A standard solution to these problems is to find a source of exogenous variation in one's boarding status to create instrumental variables for boarding. Adopting a strategy similar to those of Card (1995), Gowrisankaran and Town (1999), Kling (2001), Baiocchi

et al. (2010), Borowiecki (2013), Doyle and Skinner (2016), and Gregg (2018), we use students' home-to-school distance as an IV for their boarding status. To the extent that home-to-school distance strongly predicts one's boarding status (− because long distance implies more travelling costs) but does not directly affect one's health outcomes (which will be checked below), it serves as a plausible IV for boarding. More formally, we estimate Equation (1), together with the following first-stage equation, in a two-stage least squares (2SLS) framework:

$$Board_{jk} = \alpha_0 + \alpha_1 \times \log(Dist_{jk}) + \mathbf{Z}_{jk}\boldsymbol{\alpha}_2 + v_{jk}, \qquad (2)$$

where $Dist_{jk}$ is the distance (in *km*) between student *j*'s home location and his/her school. Given that $Dist_{jk}$, ranging from less than 1 *km* to 50 *km* in our data, is heavily skewed to the right, we take the log of it in the first stage (Equation 2) to improve the model's fit.

3.2 Validity of the IV

Note that while geographic proximity has been widely exploited to construct IVs for endogenous variables that are related to school or program attendance (Card, 1995; Kling, 2001; Baiocchi et al. 2010; Borowiecki, 2013; Doyle and Skinner, 2016; Gregg, 2018), there are three potential concerns over the validity of our distance-based IV in the context of rural China. First, it is possible that a long distance to school induces students to self-select into pure boarding schools. In that case, home-to-school distance will pick up influences of unobserved school characteristics, such as the availability and qualification of medical care staff at school. Yet this is hardly a concern because there are no pure boarding schools in our data – all sampled schools were accommodating both boarding and non-boarding students at the time of survey. This fact allows us to isolate the effects of boarding from unobserved school effects by replacing the set of **Z** variables with a set of school fixed effects (FE) in estimating Equations (1)-(2). Conditional on the school being attended, the impact of home-to-school distance on students' boarding status (captured by α_1) in Equation (2) comes from *within*-school contrasts (rather than *between*-school contrasts) between schoolmates with different home-to-school distances.

The school FE approach also effectively controls for the influences of all variables (e.g., tuition and local food prices) that vary at the school level.

The second concern is that students with long home-to-school distances may come from other school districts, which undermines the comparability between these students and those from local districts.[14] Since our data do not contain information on the school district a student officially belongs to, we address this problem indirectly by restricting the analytic sample to include only students with a relatively short home-to-school distance (i.e. $Dist_{jk} \leq 3$ km – summary statistics for this restricted sample are reported in Table 1B and Table 2, panel B). This sample restriction greatly reduces the concern over cross-district school selection, in that within such a short home-to-school distance, the probability of a student attending a school in another district is minimal.

The third concern is that long distance may reflect the "remoteness" and thus the level of (under)development of a student's home village, which may in turn exert some direct effect on this student's health status. For example, students growing up in well-developed villages may be physically healthier and have more self-esteem than those from remote and less-developed villages. Yet this problem is greatly reduced by the two afore-mentioned strategies (i.e., the conditioning on school fixed effects and the exclusion of students with long home-to-school distances) – students whose homes are located within a mere 3-km radius from their school are presumably not significantly different in health status due to distance-related reasons. To further assess the validity of this presumption, we perform a falsification test, in the spirits of Di Falco et al. (2011), Alem et al. (2015), and Tambo and Wünscher (2017). Specifically, we test if our distance-based IV has a significant predictive power for health outcomes of *non-boarding* students.

4. Results

4.1. Impacts of boarding on overall mental health test scores

[14] Although students are required to attend the primary school closest to their home location (usually located in the township of their home residence) by law, some may attend schools in other locations for special reasons. For example, when some parents (temporally) migrated out of their home village to seek off-farm employment, they might ask their relatives residing in other locations to take of these children and enroll their children as boarding students in schools in those locations.

Table 3 reports main estimation results for the overall MHT scores (which have been standardized to have zero mean and unit standard deviation for ease of interpretation), for both the full sample (panel A) and the restricted sample with home-to-school distance ≤ 3 km (panel B).[15] Note first that the results for the two samples are qualitatively and quantitively comparable. For both samples, while the OLS estimates (columns 1 and 6) suggest that boarding raises students' overall MHT scores only modestly, by 0.07-0.08 SDs (of the distribution of the overall MHT scores), their 2SLS counterparts (columns 2 and 7) suggest a much larger effect. In particular, the IV estimate for the restricted sample (column 7), our preferred estimate, suggests that the impact of boarding on students' overall MHT scores is as large as 0.455 SDs. Because higher MHT scores indicate more serious mental health concerns, the above comparisons suggest that OLS significantly underestimates the detrimental effect of boarding on rural students' mental health status in our study area.[16]

Note that the credibility of these findings hinges on the validity of the IV used in estimation. Thus, we performed two tests to assess the validity of our IV. The first was to test whether our IV is a weak IV – the lack of strong predictive power of the IV for the endogenous variable may bias the IV estimate toward the OLS estimate (Bound et al., 1995; Greene, 2018). The results, reported in columns (3) and (7) of Table 3, indicate that home-to-school distance indeed has a highly significant predictive power for students' boarding status for both samples, even after netting out the impacts of other included explanatory variables, such as age, grade, parental education, as well as school fixed effects. Consistent with this, formal weak-IV tests yield F-statistics that are larger than 60, which are substantially greater than the widely-used threshold of 10 (Staiger and Stock, 1997; Greene, 2018), suggesting little sign of the weak-IV problem.

[*Table 3 about here*]

[15] Results remain very similar when we further standardize the overall MHT scores by students' age. We thank an anonymous reviewer for suggesting such an approach as a robustness check.

[16] For example, results of a standard Hausman-Wu endogeneity test suggest that for the restricted sample, the difference between the OLS estimate of boarding effect in column (5) and its 2SLS counterpart in column (7) is statistically significant at the 0.0061 level.

Another potential concern is that the distance-based IV may have a direct effect on the outcome variable (due to unmeasured confounders), whereby violating the exclusion restriction. Although we have exploited only one source of exogenous variation in students' boarding status to achieve identification, there is a natural set of other IVs to facilitate an overidentification test. As suggested by Nichols (2007), under the assumption that the IV used is uncorrelated with the error term *u* in Equation (1), thus satisfying the exclusion restriction, any functions of this IV are also uncorrelated with *u* and can thus serve as additional IVs. Following this suggestion, we used both $Dist_{jk}$ and log ($Dist_{jk}$) as IVs for boarding and re-estimated our preferred model (in column (7) of Table 3). The new IV estimate of the boarding effect ($\beta_{1MHT} = 0.434$, se = 0.137) is very similar to its counterpart in column (7) of Table 3. Results of the overidentification test (Chi-sq = 0.0437, p-value = 0.8343) also provide no evidence that either IV violates the exclusion restriction. Other functional forms of the home-to-school distance variable (e.g., $Dist_{jk}$ alone and dummies for 0-0.5km, 0.5-1 km, 1-1.5 km, and 1.5-3 km, etc.) were also tried; the IV estimates remained quite similar.[17]

Admittedly, one could argue that the above results of the overidentification test only suggest that different "segments" along the range of home-to-school distance affect one's boarding decision in a similar way, so that the two IVs extracted similar variations in the first stage. It is still possible that the entire variation extracted by these IVs is correlated with the error term *u* in Equation (1), and standard overidentification tests failed to detect this problem. Thus, we performed another, falsification test to assess the validity of our IV. Following Di Falco et al. (2011), Alem et al. (2015), and Tambo and Wünscher (2017), we tested if the IV for program *participation* (i.e., *boarding* in our context) has a significant predictive power for the outcome variable for the *non-participants* (i.e., *nonboarders* in our case), who were presumably not affected by the program. The results show that while the IV fails to pass the test for the full sample (column 5: p-value = 0.005), it does pass the test for the restricted sample at the 5% level (column 10: p-value = 0.126): put differently, conditional on the school being attending

[17] We thank an anonymous reviewer for suggesting this exploration. The estimate obtained using home-to-school distance (*Dist*), without taking log, as the IV for boarding is 0.434 SDs (of the distribution of the overall MHT scores) and that obtained using a set of distance dummies descried in the text is 0.400 SDs, both of which are significant at the 1% level. Detailed regression results are available upon request.

(by controlling for school FEs), the distance between a student's home location and his/her school (≤ 3 km) does not help predict his/her mental health status (beyond the predictive power of the set of personal, family and school characteristics included in the model).[18] In fact, the estimated coefficients on the IV for both samples are very *small*, suggesting that even if home-to-school distance does have some direct effect on the outcome variable (column 5), this effect would not overthrow the finding of a statistically significant and detrimental boarding effect.[19]

Note also that if remoteness is *negatively* correlated with the level of development of one's home location, it would be *negatively* correlated with one's mental well-being (e.g., feeling less self-esteem and more depressed). This negative correlation predicts an *upward* bias (i.e., more positive or less negative) in the IV estimate of the boarding effect on MHT scores. Thus, bias will be detected if one sees a *decline* (i.e., less positive or more negative) in the IV estimate of the boarding effect when the range of home-school distance is narrowed. But this is not what is revealed in Appendix Table 1 in Appendix B. Indeed, the Table shows that as students' home location moves from within 25 km from their school, to 20 km, 15 km, 10 km, 5 km, and 3 km from their school, the estimated impact of boarding increases from 0.34 SDs to 0.44 SDs (of the distribution of students' overall MHT scores).

The estimated coefficients of other explanatory variables are also quite informative. Boys fair better than girls in mental health status. Other things being equal,

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[18] As suggested by an anonymous reviewer, we also checked if differences in observed characteristics are correlated with home-to-school distance for various samples. None of the 15 observed characteristics reported in Table 2 is significantly correlated with home-to-school distance for both the boarders subsample and the nonboarders subsample in the full sample. But age and father's education were found to be significantly correlated with home-to-school distance for nonboarders in the restricted sample. The age-distance correlation is somewhat counterintuitive and is likely due to sampling errors. The correlation between father's education and home-to-school distance is more concerning, but checking the first-stage regression suggests that father's education has little impact on students' boarding status. In any case, we controlled for all 15 observed characteristics in all regressions discussed in the paper to minimize confounding effects. In fact, IV estimates obtained without controlling for these 15 observed characteristics are very similar to those reported in Table 3: $\beta_{1i} = 0.400$ (se = 0.093) for the full sample and $\beta_{1i} = 0.477$ (se = 0.170) for the restricted sample (detailed regression results are available upon request).

[19] Consider, for example, the estimate for the full sample (Table 3, column 5), 0.028 SDs. Since home-to-school distance enters the model in the log scale, this estimate says that doubling a nonboarder's home-to-school distance (i.e., a 100% increase) results in a mere 0.028-SD increase in one's overall MHT score. The impact for the restricted sample (with home-to-school distance ≤ 3 km) is even smaller: moving a student's home from 1.5 km away from his/her school to a location that is 3 km away from this school would only lead to a 0.020-SD increase in his/her overall MHT score, which seems practically insignificant.

boys outperformed girls on the MHT, by 0.15-0.16 SDs lower (Table 3, columns 2 and 7), echoing the significant gender health gap in previously found in rural China (e.g., Anson and Sun, 2002). Somewhat surprisingly, students from wealthier families also have higher MHT scores, probably because their parents engage more in local off-farm activities and spend less time with them.[20] One's mother (but not father) being a migrant worker is positively associated with one's overall MHT score, suggesting that "reduced time with parents" could be a cause of mental health problems (− more on this point below). Finally, schooling appears to have a positive effect on students' mental health status: on average, fifth graders scored substantially lower on the MHT (by 0.28-0.29 SDs, Table 3, columns 2 and 7) than fourth graders, suggesting that one's mental health status may improve as one advances to a higher grade. However, because our data are cross-sectional in nature, this estimate could be simply reflecting cohort effects. To further explore whether the effect of boarding diminishes with grade, we added an interaction term between the "Grade 5" dummy and the "boarding" dummy in the model, and re-estimated the model using the interaction between the "Grade 5" dummy and the IV for boarding as the IV for the "boarding × Grade 5" interaction.[21] The results suggest that while the detrimental effect of boarding is somewhat smaller for fifth graders than fourth graders (e.g. by 0.28 SDs for the restricted sample), the difference is not statistically significant.[22]

4.2. Impacts on subdimensions of mental health

One way to understand how boarding affects students' overall mental health status is to investigate *which of its subdimensions* are the most affected by boarding. Thus, we further estimated the impacts of boarding on the eight subdimensions of the MHT (i.e., study anxiety, social anxiety, loneliness, self-punishment, sensitivity, physical anxiety symptoms, fear and impulsiveness) separately, whose scores were standardized *within subdimension* to have zero mean and unit standard deviation. The main results of

[20] Unfortunately, our data do not contain information on whether parents participated in local off-farm work.
[21] We thank an anonymous reviewer for suggesting this test.
[22] The interaction term is significant at the 10% level when home-to-school distance (*Dist*, without taking log) is used as the IV for boarding. Detailed regression results are available upon request.

this investigation, reported in Table 4, reveal two notable patterns. First, both OLS (panel A) and IV estimates (panels B-C) are positive (although not always statistically significantly so), suggesting that boarding increases the risk of mental health problems in many subdimensions. Second, IV estimates are usually 3-4 times the magnitude of their OLS counterparts, again, suggesting that OLS underestimates the detrimental impacts of boarding on students' mental health. The IV estimates indicate that boarding has a statistically significant and detrimental effect – ranging from 0.341 to 0.534 SDs − on at least five of the eight subdimensions (i.e. study anxiety, social anxiety, self-punishment, physical anxiety symptoms, and fear in Panel C), suggesting that to address boarding-induced mental health problems, multidimensional interventions may be needed.

[*Table 4 about here*]

4.3. Possible working channels

To further explore the potential channels through which boarding affects students' mental health status, we performed a series of additional regressions and tests. The first potential channel is reduced time with parents. As shown in column (7) of Table 3, our preferred specification (reproduced in column 1 of Appendix Table 2), one's mother (but not father) being a migrant worker has a statistically significant and positive effect (0.086 SDs) on his/her MHT scores, suggesting a potential effect of reduced time with parents (mothers). This effect also suggests that the effect of boarding discussed above may be confounded with that of maternal migration.[23] Yet note that the magnitude of the estimated effect of maternal migration is much smaller compared to that of boarding (0.455 SDs). Note also that this coefficient measures the impact for *all* students (boarders and nonboarders combined), which could be misleading because the specifications in Table 3 do not allow the impact of parental (maternal) migration to differ between boarders and nonboarders. If "reduced time with parents" is a major driving channel (and if the estimated effect of boarding is confounded with that or parental migration), one would expect the impact of parental (maternal) migration to be *smaller* for boarders than for nonboarders. To obtain a "cleaner" estimate of the impact of parental migration for

[23] We thank an anonymous reviewer for pointing out this and the next possibility.

nonboarders (to avoid confounding the effects of parental migration and boarding), we added an interaction term between boarding and the "migrant mother" dummy in the model (and used the interaction between the "migrant mother" dummy and home-to-school distance (the IV for boarding) as the IV for the "boarding × migrant mother" interaction). This regression yielded a small and insignificant coefficient on the interaction term (Appendix Table 2, column 2), suggesting that the effect of maternal migration is similar for both boarders and nonboarders. Moreover, while the coefficient on the "migrant mother" dummy is quantitatively similar to that reported in column 7 of Table 3 (and Appendix Table 2, column 1), it becomes statistically insignificant when the interaction term is added. These findings suggest that the specification without the interaction term actually fits the data better. Since the impact of "reduced time with parents" reflected in the coefficient of maternal migration is quite small relative to the estimated effect of boarding, even if our estimated boarding effect does pick up some impact of parental migration, much of it is not explained by the latter.[24]

The second possibility is that boarders may have a higher likelihood of receiving scholarships; thus, they may feel more at-risk of losing opportunities. To test this possibility, we estimated whether boarding significantly affects a students' academic performance. To the extent that scholarships in China are usually merit-based (rather than need-based), a student's academic performance serves as an important indicator of his/her chance of receiving a scholarship. Our data contain information on sample students' scores of a standardized math test.[25] Our estimation results, reported in column (3) of Appendix Table 2, show a negative but statistically insignificant effect of boarding on students' math test scores, suggesting that the effect of boarding is unlikely to work through the scholarship channel.

The third possible channel is nutrition and physical health. If boarding undermines students' nutritional and health status, their worsened nutritional and health

[24] One related concern is that parental migration may be endogenous to boarding, leading to biased estimates of the effect of parental migration. To further address this concern, we estimated the impact of boarding on parental migration. The results, reported in Appendix Table 3 in Appendix B, reveal little impact of boarding on parental migration.

[25] The test questions on the math test were chosen from the Trends in International Mathematics and Science Study (TIMSS) test data bank. All chosen questions were consistent with the curriculum that was being taught in all of the sample schools.

outcomes may trigger frustration about boarding life, whereby generating more mental health problems. To examine this possibility, we estimated the effects of boarding on students' physical health outcomes (which are of interest in their own right). Given data availability, three outcomes reflecting different subdimensions of students' nutrition and physical health status were examined: 1) BMI-for-age z-score (i.e., BMI standardized by gender and age), which reflects important aspects of one's short-term nutritional intakes; 2) height-for-age z-score (i.e., height standardized by gender and age), which reflects one's long-run nutritional status (WHO, 2007; Lundeen et al., 2014); 3) hemoglobin (Hb) concentration, adjusted for latitude,[26] which reflects the adequacy of one's iron intake.

Table 5 reports OLS (columns 1, 4 and 7) and 2SLS results for both the full (columns 2, 5 and 8) and the restricted sample (columns 3, 6 and 9). Except the OLS estimate for BMI-for-age (column 1), which suggests a significantly positive effect of boarding on BMI, no statistically significant impact of boarding is found in the table. Taken together, the results reported in the table do not provide any significant evidence that boarding undermines students' physical health.[27] Another way to see if whether the effect of boarding on students' mental health works through their nutrition and physical health status, is to add the three health indicators (i.e. height-for-age, BMI-for-age and Hb concentration) as additional controls in the IV model.[28] The estimates of boarding effects obtained with these controls, reported in Appendix Table 4 in Appendix B, are quite similar to those obtained without controlling for them; the impacts of physical

[26] The most commonly used method to assess anemia is to measure the level of Hb concentration in blood in grams per liter (g/L) through a test with cut-off values provided to determine whether the individual is anemic. The cut-off value is 115 g/L for children aged 5–11 years, and 120 g/L for children aged 12–14, irrespective of their gender. Since the students involved in our study attend schools at altitudes of above 1000 meters, their raw Hb measurements need to be adjusted for altitude effects. To that end, we applied the formula provided by the U.S. Centers for Disease and Control and Prevention (CDC), which were used in a number of recent studies: Hb (altitude adjusted) = Hb (unadjusted) - $0.32 \times alt \times 0.0033 - 0.22 \times (alt \times 0.0033)^2$, with *alt* denoting altitude above sea level in meters.

[27] Other variables play more important roles in affecting students' physical health; their impacts also mirror the patterns for the overall MHT scores discussed above. Again, boys fair better than girls in all three dimensions of physical health, which might reflect traditional son preference in rural China. Unsurprisingly, students from wealthier families are physically healthier, but somewhat surprisingly, parental education is negatively associated with students' physical health outcomes. Since parents' migration status has been controlled for in the regressions, the negative effect of parental education is likely due to their parents' engagement in local off-farm work. Again, our data do not allow us to explore further in this direction.

[28] We thank an anonymous reviewer for suggesting this specification.

health outcomes are themselves negligible. These results suggest that the effect of boarding does not work through the channel of physical health.

[*Table 5 about here*]

Given data limitations, a final way to probe how boarding affects students' mental health is to see how its effect varies across students with different characteristics that have significant impacts on the overall MHT scores (Table 3), including gender (panels A-B), ethnicity (panels C-D), family wealth (panels E-F), and grade attended (panels G-H). Results reported in Table 6 (especially those for the restricted sample) suggest that while boarding has a harmful effect on mental health (i.e. higher MHT scores) for all the subgroups considered, students with relatively more advantageous backgrounds, e.g., boys (Panel B), ethnic Han students (Panel D), and students from wealthier families (Panel F), suffer more detrimental effects from boarding. This finding suggests that for students with advantaged backgrounds, schools may fail to serve as a perfect substitute for their families and home environment in mental support provision.

5. Discussion and Conclusion

Given the declining population of school-age children in rural China and the recently announced policy initiative to revitalize rural China (State Council, 2018), the role rural boarding schools play in forming rural Chinese children's human capital is becoming increasingly more important. Recently, the State Council of China officially stressed the need to improve the quality and living conditions of rural boarding schools across the country so that they can better serve their mission in helping to develop China's rural education system (State Council, 2018). Our study identifies an area that needs improvement: boarding students' mental health status. Our analysis revealed that while rural schools manage to provide an environment to help maintain students' physical health status, boarding does incur some losses in their mental health domain. Also, boarding is found to have detrimental effects on many subdimensions of students' mental health (i.e. study anxiety, social anxiety, self-punishment, physical anxiety symptoms, and fear). Two policy implications are immediate. First, rural students' mental health

status should be more closely monitored and assessed. Second, multidimensional interventions may be needed to improve their mental health status. Hiring more life teachers and mental health counselors for this task may be an effective solution (Yue et al., 2014). Clearly, more research needs to be done to see what measures are effective.

Before closing, we note a number of limitations of our study. First, because our survey did not collect detailed information on the quality of boarding facilities and students' activities related to their boarding life, we are unable to identify the ultimate channels of the effects of boarding on their mental health status, despite our attempts to rule out some potential channels. Yet given the finding that boarding negatively affects the majority of subdimensions of students' mental health, there may be many ways to improve boarding students' mental health status. Future studies, especially those based on randomized controlled trials, may be fruitful in providing lessons to inform policy in this regard.

Secondly, while our analysis discovered that the detrimental effect of boarding on mental health reduces as students reach a higher grade, our data lack the information to pin down whether this negative effect actually diminishes with the experience of boarding – given the cross-sectional nature of our data, the significant grade effect might be simply reflecting cohort effects. Even if there is a significantly negative grade effect, such an effect does not necessarily imply that the effect of boarding will decline with one's experience of boarding, as an assumption of "no student ever changes status or transfers schools" would be needed.[29] Thus, to provide a better answer to the question of whether negative effects of boarding would diminish over time, tracking students over time may be needed.

Thirdly, given the interpretation of IV estimates as the local average treatment effects (LATE) for the subsample of students who became boarders because of their long home-to-school distance, the effects of boarding identified using our distance-based IV speak only to this subsample, rather than the full sample of rural students in northwestern

[29] We thank an anonymous reviewer for pointing out this and the following limitations.

China.[30] Other IVs or other identification strategies are needed to understand the impacts (LATEs) of boarding for the rest of the sample.

Finally, our study focuses on a relatively underdeveloped area. The lessons learned from the present study may not be generalizable to other areas of China. Yet our finding that boarding incurs more psychological losses for students with relatively advantageous backgrounds suggests that one may find larger harmful effects of boarding in more developed regions. More studies may be conducted in rural areas in more developed provinces to examine this prediction.

Acknowledgments

The authors thank Scott Rozelle, Xiaolong Sun, Zhihao Zheng, participants at the 10th CAER-IFPRI annual conference in Guangzhou, China, and two anonymous reviewers for their helpful comments on earlier versions of this paper. We also thank Haoze Li, Jifei Yu and Chunchen Pei for excellent research assistance. This work was financially supported by the National Natural Science Foundation of China [grant numbers 71603261, 71973134, 71973136]; Humanities and Social Science Fund of the Ministry of Education of China [grant numbers 16YJC880107, 18YJC790010]; The Fundamental Research Funds for the Central Universities [grant numbers 2020TC018, 2020TC020].

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[30] To help estimate the proportion of compliers, we converted the continuous distance-based IV into a dummy variable (=1 if one's home-to-school distance is above the median (1.25 km) and = 0 otherwise) and used this dummy to predict one's boarding status, mimicking the first-stage regression with a binary IV. The results suggest that 19.3% of students in the restricted sample are compliers. Yet since our conversion of the continuous IV into a binary IV sacrifices some variation in home-to-school distance that can be exploited to predict the proportion of compliers, the actual proportion of compliers could be higher than 19.3%.

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Table 1A: Summary Statistics of Health Outcomes, by Boarding Status (Full Sample)

Variables	(1) Mean	(2) SD	(3) Proportion with anxiety problems (%)	(4) Mean	(5) SD	(6) Proportion with anxiety problems (%)	(7) Mean	(8) SD	(9) Proportion with anxiety problems (%)	(10) Difference in means [= (4)-(7)]
	Overall			Boarders			Nonboarders			
Mental health outcomes										
Total MHT score	40.85	(12.26)		41.24	(12.76)		40.66	(12.00)		0.58**
Study anxiety	8.53	(2.63)	51.27	8.53	(2.66)	51.10	8.53	(2.61)	51.35	0.00
Social anxiety	4.50	(2.11)	2.92	4.47	(2.17)	3.35	4.51	(2.08)	2.71	-0.04
Loneliness	3.32	(2.01)	0.78	3.41	(2.05)	1.15	3.28	(1.99)	0.59	0.13***
Self-punishment	5.53	(2.08)	7.85	5.64	(2.13)	8.92	5.48	(2.05)	7.32	0.16***
Sensitivity	5.06	(1.93)	3.58	5.09	(1.95)	4.02	5.04	(1.92)	3.36	0.05
Physical anxiety	5.89	(2.87)	17.68	5.94	(2.93)	18.36	5.87	(2.84)	17.35	0.07
Fear	4.91	(2.44)	7.27	5.10	(2.45)	8.72	4.82	(2.43)	6.55	0.28***
Impulsiveness	3.10	(2.34)	1.51	3.08	(2.34)	1.79	3.12	(2.33)	1.37	-0.04
N	7,606			2,511			5,095			
Physical health outcomes										
Underweight	0.10	(0.30)		0.09	(0.29)		0.11	(0.31)		-0.02
Stunting	0.29	(0.45)		0.31	(0.46)		0.28	(0.45)		0.03**
Anemic	0.34	(0.47)		0.36	(0.48)		0.33	(0.47)		0.03*
N	*N* = 3,737 for "Underweight" and "Stunting" and *N* = 3,749 for "Anemic" outcomes.			*N* = 1,218 for "Underweight" and "Stunting" and *N* =1,230 for "Anemic" outcomes.			2,519			

Source: Author's survey.

Notes: 1. Due to budgetary consideration, the survey collected information on height, weight and Hb concentration for only roughly half of the sampled students.

2. Raw scores of the MHT test are reported in the table. A total of 90 questions were used to assess eight subdimensions of sample students' mental health status, namely, study anxiety (15), social anxiety (10), loneliness (10), self-punishment (10), sensitivity (10), physical anxiety symptoms (15), fear (10), and impulsiveness (10). Each question is worth one point: the lower the score the better a student's mental health status is. A score greater than 8 points (regardless of the total points in a given dimension) is considered clinically high and thus flags a need for treatment.

3. Physical health outcomes (dummy variables) defined as: "Underweight" = 1 if BMI-for-age z-score < -2(SD), and = 0 otherwise; "Stunting" =1 if height-for-age z-score < -2(SD), and = 0 otherwise; "Anemic" = 1 if (altitude-adjusted) Hb level > 115 g/L for children aged 5–11 years, or > 120 g/L for children aged 12–14, irrespective of their gender.

4. *** p<0.01, ** p<0.05, * p<0.1.

Table 1B: Summary Statistics of Health Outcomes, by Boarding Status (Restricted Sample: Home-to-School Distance ≤ 3km)

Variables	(1) Mean	(2) SD	(3) Proportion with anxiety problems (%)	(4) Mean	(5) SD	(6) Proportion with anxiety problems (%)	(7) Mean	(8) SD	(9) Proportion with anxiety problems (%)	(10) Difference in means [= (4)-(7)]
	Overall			Boarders			Nonboarders			
Mental health outcomes										
Total MHT score	40.66	(12.19)		41.05	(12.82)		40.53	(11.97)		0.52
Study anxiety	8.52	(2.62)	50.97	8.51	(2.67)	50.10	8.53	(2.61)	51.27	-0.02
Social anxiety	4.50	(2.11)	3.06	4.49	(2.17)	3.46	4.50	(2.09)	2.92	-0.01
Loneliness	3.28	(2.01)	0.68	3.38	(2.08)	1.07	3.25	(1.99)	0.54	0.13**
Self-punishment	5.50	(2.08)	7.66	5.59	(2.14)	8.66	5.47	(2.06)	7.32	0.12*
Sensitivity	5.05	(1.92)	3.48	5.07	(1.93)	3.66	5.05	(1.92)	3.42	0.02
Physical anxiety	5.86	(2.86)	17.30	5.88	(2.92)	17.65	5.85	(2.84)	17.17	0.03
Fear	4.85	(2.45)	7.19	5.03	(2.46)	8.93	4.79	(2.44)	6.59	0.24***
Impulsiveness	3.08	(2.35)	1.52	3.09	(2.41)	2.33	3.08	(2.32)	1.25	0.01
N	5,915			1,501			4,414			
Physical health outcomes										
Underweight	0.10	(0.31)		0.11	(0.31)		0.11	(0.31)		0
Stunting	0.29	(0.45)		0.31	(0.46)		0.28	(0.45)		0.03*
Anemic	0.34	(0.47)		0.36	(0.48)		0.33	(0.47)		0.03
N	*N* = 2,903 for "underweight" and "stunting outcomes; *N* = 2,908 for "anemic" outcomes.			N = 717 for "underweight" and "stunting" outcomes; N = 724 for "anemic" outcomes.			2,185			

Source: Author's survey.

Notes: 1. Due to budgetary consideration, the survey collected information on height, weight and Hb concentration for only roughly half of the sampled students.

2. Raw scores of the MHT test are reported in the table. A total of 90 questions were used to assess eight subdimensions of sample students' mental health status, namely, study anxiety (15), social anxiety (10), loneliness (10), self-punishment (10), sensitivity (10), physical anxiety symptoms (15), fear (10), and impulsiveness (10). Each question is worth one point: the lower the score the better a student's mental health status is. A score greater than 8 points (regardless of the total points in a given dimension) is considered clinically high and thus flags a need for treatment.

3. Physical health outcomes (dummy variables) defined as: "Underweight" = 1 if BMI-for-age z-score < -2 (SDs), and = 0 otherwise; "Stunting" =1 if height-for-age z-score < -2 (SDs), and = 0 otherwise; "Anemic" = 1 if (altitude-adjusted) Hb level > 115 g/L for children aged 5–11 years, or > 120 g/L for children aged 12–14, irrespective of their gender.

4. *** p<0.01, ** p<0.05, * p<0.1.

Table 2: Summary Statistics of Personal, Family and School characteristics, by Boarding Status

		A. Full sample					*B. Restricted sample (home-school distance ≤ 3 km)*				
		Boarders		Nonboarders		Difference	Boarders		Nonboarders		Difference
Variables	Definition	Mean	(SD)	Mean	(SD)	in means	Mean	(SD)	Mean	(SD)	in means
		(1)	(2)	(3)	(4)	(5) = (1)-(3)	(6)	(7)	(8)	(9)	(10) = (6)-(8)
Personal char.											
Boy	Dummy, = 1 if boys; = 0 if girls	0.52	(0.50)	0.51	(0.50)	0.01	0.52	(0.50)	0.51	(0.50)	0.01
Age	A student's age in months	141.35	(15.32)	136.29	(14.42)	5.06***	141.07	(15.29)	136.00	(14.15)	5.07***
Ethnic Han	Dummy, = 1 if of ethnic Han; = 0 otherwise	0.32	(0.47)	0.37	(0.48)	-0.05***	0.31	(0.46)	0.37	(0.48)	-0.06***
Grade 5	Dummy, = 1 for fifth graders; = 0 for fourth graders	0.60	(0.49)	0.48	(0.50)	0.12***	0.60	(0.49)	0.48	(0.50)	0.12***
Family char.											
Sibship size	Number of siblings	2.45	(1.34)	2.44	(1.27)	0.01	2.34	(1.30)	2.43	(1.26)	-0.09**
Father's age	Father's age in years	38.57	(5.27)	38.13	(5.08)	0.44***	38.27	(5.18)	38.14	(5.11)	0.13
Mother's age	Mother's age in years	36.00	(4.57)	35.59	(4.51)	0.41***	35.77	(4.46)	35.55	(4.52)	0.22*
Father's education	Father's years of schooling	5.95	(3.70)	6.76	(3.79)	-0.81***	6.12	(3.67)	6.83	(3.75)	-0.71***
Mother's education	Mother's years of schooling	3.24	(3.66)	3.95	(4.06)	-0.71***	3.26	(3.70)	3.98	(4.06)	-0.72***
Migrant father	Dummy, = 1 if father is a migrant worker	0.33	(0.47)	0.37	(0.48)	-0.04***	0.33	(0.47)	0.37	(0.48)	-0.04***
Migrant mother	Dummy, = 1 if mother is a migrant worker	0.04	(0.20)	0.04	(0.20)	0.00	0.05	(0.21)	0.04	(0.20)	0.01
Distance to school	Home to school distance (km)	4.40	(5.84)	2.51	(5.79)	1.89***	1.57	(0.80)	1.07	(0.73)	0.50***
Wealth index	The log of the value of household assets (yuan) obtained from the ownership of 20 durable goods.	8.84	(1.38)	8.82	(1.57)	0.02	8.88	(1.35)	8.81	(1.59)	0.07
School char.											
Teacher-student ratio	Number of teachers per student	6/100	(0.05)	7/100	(0.06)	-0.01*	6/100	(0.05)	7/100	(0.07)	-0.01*
Teacher's education	Teacher's years of schooling	14.92	(0.94)	15.00	(0.87)	-0.08***	14.94	(0.92)	15.01	(0.88)	-0.07***
Teacher experience	Teacher's years of teaching experience	13.02	(10.30)	13.03	(9.47)	-0.01	12.34	(10.13)	12.93	(9.40)	-0.59**
Library	Dummy, = 1 if the school has a library	0.36	(0.48)	0.41	(0.49)	-0.05***	0.34	(0.47)	0.42	(0.49)	-0.08***
Computer lab	Dummy, = 1 if the school has a computer lab	0.62	(0.49)	0.51	(0.50)	0.11***	0.60	(0.49)	0.50	(0.50)	0.10***
N		2,511		5,095			1,501		4,414		

Source: Author's survey.

Notes: Standard deviations in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Estimated Impacts of Boarding on Students' Overall Mental Health Test Scores (Standardized)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sample	*A. Full sample*					*B. Restricted sample (Distance to school ≤ 3 km)*				
Outcome	MHT	MHT	Boarding	MHT	MHT	MHT	MHT	Boarding	MHT	MHT
Estimator	OLS	2SLS	OLS; 1st-stage	OLS; reduced-Form	OLS; falsification test (Non-boarders)	OLS	2SLS	OLS; 1st-stage	OLS; reduced-form	OLS; falsification test (Non-boarders)
Dist. to sch. in log			0.084***	0.032***	0.028***			0.066***	0.030***	0.020
			(0.007)	(0.007)	(0.010)			(0.008)	(0.011)	(0.013)
Boarding	0.078***	0.388***				0.069*	0.455**			
	(0.029)	(0.095)				(0.035)	(0.177)			
Boy	-0.160***	-0.156***	-0.008	-0.161***	-0.136***	-0.149***	-0.146***	-0.008	-0.151***	-0.130***
	(0.028)	(0.027)	(0.009)	(0.028)	(0.033)	(0.028)	(0.027)	(0.010)	(0.028)	(0.033)
Age	0.004***	0.003***	0.002***	0.004***	0.003**	0.003***	0.002**	0.002***	0.004***	0.002
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Ethnic Han	0.015	0.014	0.001	0.019	0.018	0.001	0.000	-0.004	0.004	0.017
	(0.043)	(0.044)	(0.035)	(0.044)	(0.054)	(0.052)	(0.051)	(0.032)	(0.052)	(0.061)
Grade 5	-0.274***	-0.291***	0.058**	-0.271***	-0.289***	-0.263***	-0.281***	0.049*	-0.262***	-0.285***
	(0.051)	(0.051)	(0.025)	(0.052)	(0.053)	(0.053)	(0.051)	(0.028)	(0.054)	(0.054)
Sibship size	0.012	0.012	-0.002	0.011	0.009	0.012	0.014	-0.006	0.011	0.010
	(0.011)	(0.011)	(0.005)	(0.011)	(0.013)	(0.012)	(0.012)	(0.005)	(0.012)	(0.015)
Father's education	-0.003	-0.002	-0.004**	-0.003	-0.008*	-0.006*	-0.005	-0.002	-0.007*	-0.008*
	(0.003)	(0.003)	(0.001)	(0.003)	(0.004)	(0.003)	(0.004)	(0.002)	(0.003)	(0.004)
Mother's education	-0.005*	-0.004	-0.003*	-0.005*	-0.004	-0.003	-0.002	-0.002	-0.003	-0.003
	(0.003)	(0.003)	(0.001)	(0.003)	(0.003)	(0.004)	(0.004)	(0.001)	(0.004)	(0.004)
Father's age	0.002	0.002	0.003	0.003	0.007	0.003	0.003	-0.000	0.003	0.008*
	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)
Mother's age	0.002	0.001	-0.001	0.001	-0.004	0.001	0.001	0.001	0.001	-0.005
	(0.004)	(0.004)	(0.002)	(0.004)	(0.005)	(0.005)	(0.005)	(0.002)	(0.005)	(0.005)
Migrant father	0.014	0.019	-0.015	-0.023	0.021	0.012	0.014	-0.005	-0.031	0.011
	(0.024)	(0.025)	(0.013)	(0.026)	(0.033)	(0.027)	(0.026)	(0.013)	(0.027)	(0.033)
Migrant mother	0.085**	0.087***	-0.005	0.008	0.075*	0.087**	0.086**	0.007	-0.017	0.085**
	(0.033)	(0.033)	(0.014)	(0.055)	(0.040)	(0.034)	(0.034)	(0.016)	(0.063)	(0.040)
Wealth index	0.017**	0.016**	0.003	0.018***	0.019***	0.007	0.005	0.006	0.008	0.016*

	(0.007)	(0.007)	(0.004)	(0.007)	(0.007)	(0.007)	(0.007)	(0.004)	(0.007)	(0.008)
Constant	-0.325**	-0.331**	0.111	-0.241	0.067	-0.130	-0.166	0.144*	-0.046	0.150
	(0.149)	(0.148)	(0.075)	(0.151)	(0.201)	(0.156)	(0.161)	(0.085)	(0.156)	(0.218)
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7,606	7,606	7,606	7,606	5,095	5,915	5,915	5,915	5,915	4,414
R^2	0.093	0.076	0.269	0.093	0.095	0.099	0.077	0.253	0.098	0.099

Source: Author's survey.

Notes: 1. A total of 90 questions were asked on the MHT to assess the eight subdimensions of sample students' mental health status: study anxiety (15), social anxiety (10), loneliness (10), self-punishment (10), sensitivity (10), physical anxiety symptoms (15), fear (10), and impulsiveness (10). The overall mental health test scores are standardized to have zero mean and unit standard deviation (SD), so the coefficients are measured in SD units.

2. "Boy" is a dummy, =1 for boys and =0 for girls; "Age" is measured in months; "Grade 5" is a dummy, = 1 for fifth graders and =0 for fourth graders; "Ethnic Han" is a dummy, =1 for Han ethnicity and 0 = ethnic minority groups; "Sibship size" is the number of siblings; "Father's education" and "mother's education" are, respectively, father's and mother' years of formal schooling; "Father's age" and "mother's age" are their ages in years; "Migrant father" and "migrant mother" are dummies indicating father's and mother's migration status, =1 father/mother is a migrant worker and =0 otherwise; "Wealth index" is defined as the log of the value of household assets (yuan) obtained from a factor analysis applied to the ownership of 20 durable goods.

3. Robust standard errors in parentheses, adjusted for clustering at the school level.

4. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Estimated Impacts of Boarding on Sub-dimensional Scores of the Mental Health Test (Standardized within Subdimensions)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Study anxiety	Social anxiety	Loneliness	Self-punishment	Sensitivity	Physical anxiety	Fear	Impulsive-ness
	A. OLS estimates							
Boarding	0.017	0.013	0.039	0.124***	0.057*	0.051	0.109***	0.002
	(0.029)	(0.030)	(0.033)	(0.027)	(0.029)	(0.031)	(0.027)	(0.032)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7,606	7,606	7,606	7,606	7,606	7,606	7,606	7,606
R^2	0.062	0.059	0.108	0.044	0.042	0.085	0.088	0.084
	B. IV estimates (full sample)							
Boarding	0.257***	0.174*	0.291***	0.325***	0.073	0.333***	0.353***	0.190**
	(0.090)	(0.096)	(0.091)	(0.106)	(0.105)	(0.093)	(0.107)	(0.087)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7,606	7,606	7,606	7,606	7,606	7,606	7,606	7,606
R^2	0.052	0.054	0.096	0.037	0.042	0.071	0.078	0.078
	C. IV estimates (restricted sample: home-to-school distance ≤ 3 km)							
Boarding	0.402**	0.372**	0.184	0.341*	0.110	0.407**	0.534***	-0.031
	(0.173)	(0.188)	(0.185)	(0.177)	(0.181)	(0.183)	(0.182)	(0.171)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5,915	5,915	5,915	5,915	5,915	5,915	5,915	5,915
R^2	0.042	0.041	0.114	0.038	0.044	0.075	0.064	0.089

Source: Author's survey.

Notes: 1. A total of 90 questions were used on the MHT to assess eight subdimensions of students' mental health (anxiety) status: study anxiety (15), social anxiety (10), loneliness (10), self-punishment (10), sensitivity (10), physical anxiety symptoms (15), fear (10), and impulsiveness (10). Each question is worth one point: the lower the score the better a student's mental health status is. A score greater than 8 points (regardless of the total points in a given subdimension) is considered clinically high and thus flags a need for treatment. All sub-dimensional MHT scores are standardized within their respective subdimensions to have zero mean and unit standard deviation.

2. All regressions control for the full set of covariates, including child gender (a dummy for boys), age (months), grade attended (a dummy for fifth graders), ethnicity (a dummy for Han ethnicity), number of siblings, father's and mother's education (years), father's and mother's age (years), whether father/mother is a migrant worker (dummies), a family wealth index, as well as a set of 74 school fixed effects.

3. Robust standard errors in parentheses, adjusted for intra-school clustering.

4. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Estimated Impacts of Boarding on Students' Physical Health Outcomes

Outcome variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	BMI-for-age z-score			Height-for-age z-score			Hb concentration level		
	OLS	2SLS	2SLS	OLS	2SLS	2SLS	OLS	2SLS	2SLS
Sample	Full	Full	Restricted	Full	Full	Restricted	Full	Full	Restricted
Boarding	0.170***	0.108	-0.060	0.029	0.234	0.293	-0.312	0.422	0.093
	(0.038)	(0.150)	(0.245)	(0.045)	(0.145)	(0.246)	(0.476)	(2.738)	(2.780)
Boy	0.103***	0.103***	0.110***	0.172***	0.172***	0.204***	1.007**	1.117**	1.204***
	(0.037)	(0.036)	(0.038)	(0.027)	(0.027)	(0.029)	(0.432)	(0.457)	(0.448)
Age	-0.016***	-0.016***	-0.016***	-0.036***	-0.036***	-0.037***	0.055***	0.047**	0.047**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.016)	(0.022)	(0.021)
Ethnic Han	-0.054	-0.052	-0.082	0.009	0.005	-0.025	0.499	0.143	-0.044
	(0.058)	(0.056)	(0.062)	(0.060)	(0.058)	(0.079)	(0.728)	(0.944)	(0.929)
Grade 5	0.154***	0.158***	0.155***	0.408***	0.395***	0.406***	0.732	0.675	0.727
	(0.033)	(0.036)	(0.042)	(0.037)	(0.039)	(0.043)	(0.557)	(0.588)	(0.590)
Sibship size	-0.030**	-0.031**	-0.032**	-0.023	-0.021	0.004	-0.201	-0.208	-0.219
	(0.012)	(0.012)	(0.016)	(0.014)	(0.013)	(0.015)	(0.179)	(0.228)	(0.223)
Father's age	-0.001	-0.001	-0.000	0.009**	0.008*	0.008	0.082	0.032	0.030
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.060)	(0.066)	(0.067)
Mother's age	0.005	0.005	0.006	0.013***	0.013***	0.014***	-0.001	0.049	0.045
	(0.005)	(0.005)	(0.006)	(0.004)	(0.004)	(0.005)	(0.055)	(0.057)	(0.059)
Father's education	-0.006	-0.007	-0.008	-0.016***	-0.014***	-0.011*	0.041	0.068	0.072
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.062)	(0.073)	(0.072)
Mother's education	0.005	0.004	0.002	-0.005	-0.005	-0.010**	-0.103**	-0.071	-0.074
	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)	(0.045)	(0.053)	(0.052)
Migrant father	-0.076***	-0.076***	-0.056*	-0.051	-0.050	-0.052	-0.080	-0.240	-0.248
	(0.029)	(0.028)	(0.032)	(0.036)	(0.035)	(0.038)	(0.386)	(0.516)	(0.534)
Migrant mother	0.123	0.123	0.125	0.056	0.057	0.045	-2.394**	-2.017*	-2.125**
	(0.077)	(0.075)	(0.084)	(0.091)	(0.089)	(0.097)	(0.965)	(1.049)	(1.053)
Wealth index	0.026**	0.026**	0.026**	0.028***	0.029***	0.024**	0.132	0.141	0.114
	(0.011)	(0.010)	(0.012)	(0.010)	(0.010)	(0.010)	(0.131)	(0.138)	(0.147)
Constant	1.196***	1.204***	1.250***	2.235***	2.209***	2.173***	102.080***	101.822***	102.366***
	(0.224)	(0.220)	(0.268)	(0.267)	(0.256)	(0.278)	(3.005)	(3.326)	(3.283)
School FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3,737	3,737	2,902	3,737	3,737	2,902	3,749	3,749	2,908
R^2	0.153	0.152	0.159	0.286	0.280	0.286	0.351	0.360	0.361

Source: Author's survey.
Notes: 1. Due to budgetary consideration, the survey collected information on height, weight and Hb concentration for only roughly half of the sample students.
2. The "restricted" sample includes only observations with home-to-school distance ≤ 3 km.
3. "Boy" is a dummy, =1 for boys and =0 for girls; "Age" is measured in months; "Grade 5" is a dummy, =1 for fifth graders and =0 for fourth graders; "Ethnic Han" is a dummy, =1 for Han ethnicity and 0 = ethnic minority groups; "Sibship size" is the number of siblings; "Father's education" and "mother's education" are, respectively, father's and mother' years of formal schooling; "Father's age" and "mother's age" are their ages in years; "Migrant father" and "migrant mother" are dummies indicating father's and mother's migration status, =1 father/mother is a migrant worker and =0 otherwise; "Wealth index" is defined as the log of the value of household assets (yuan) obtained from a factor analysis applied to the ownership of 20 durable goods.
4. Robust standard errors in parentheses, adjusted for clustering at the school level.
5. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 6: Estimated Impacts of Boarding on Students' Overall Mental Health Test Scores (Standardized), Various Subsamples

	(1)	(2)	(3)	(4)	(5)	(6)
Estimator	OLS	2SLS	2SLS	OLS	2SLS	2SLS
Sample	Full	Full	Restricted	Full	Full	Restricted
	A. Girls			*B. Boys*		
Boarding	0.101***	0.381***	0.313	0.050	0.369***	0.544**
	(0.034)	(0.137)	(0.236)	(0.047)	(0.122)	(0.254)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
N	3,709	3,709	2,868	3,897	3,897	3,047
R^2	0.097	0.083	0.090	0.108	0.091	0.084
	C. Ethnic minority			*D. Ethnic Han*		
Boarding	0.069**	0.327**	0.352	0.100*	0.551***	0.646**
	(0.032)	(0.128)	(0.224)	(0.055)	(0.111)	(0.302)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
N	4,896	4,896	3,809	2,710	2,710	2,106
R^2	0.091	0.078	0.090	0.108	0.079	0.071
	E. Household asset < median			*F. Household asset ≥ median*		
Boarding	0.065	0.221*	0.117	0.085**	0.552***	0.754***
	(0.041)	(0.130)	(0.196)	(0.042)	(0.136)	(0.248)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
N	3,645	3,645	2,795	3,961	3,961	3,120
R^2	0.099	0.095	0.110	0.106	0.068	0.041
	G. Grade 4			*H. Grade 5*		
Boarding	0.054	0.599***	0.748**	0.121***	0.369***	0.299
	(0.044)	(0.179)	(0.329)	(0.031)	(0.134)	(0.241)
Covariates	yes	yes	yes	yes	yes	yes
N	3,659	3,659	2,894	3,947	3,947	3,021
R^2	0.109	0.061	0.047	0.135	0.124	0.145

Source: Author's survey.

Notes: 1. The "restricted" sample includes only observations with home-to-school distance ≤ 3 km.

2. The outcome variable in all regressions is students' overall mental health test scores, standardized to have zero mean and unit standard deviation.

3. All regressions control for the full set of covariates, including child gender (a dummy for boys), age (months), grade attended (a dummy for fifth graders), ethnicity (a dummy for Han ethnicity), number of siblings, father's and mother's education (years), father's and mother's age (years), whether father/mother is a migrant worker (dummies), a family wealth index, as well as a set of 74 school fixed effects.

4. Robust standard errors in parentheses, adjusted for intra-school clustering.

5. *** p<0.01, ** p<0.05, * p<0.1.