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The main goal of this paper is to document the nature of boarding schools and empirically analyse the difference in nutrition intake and malnutrition status between boarding and non-boarding students in western rural China. By using two data sets on boarding schools and boarding students in Shaanxi Province, a representative province in western rural China, this paper finds that dormitory and student canteen facilities in boarding schools are under-equipped and services are of poor quality, far below that needed for student development. Poor services in boarding schools and inadequate nutrition intake may be an important cause of low student height-for-age *Z*-scores (HAZ), as students eating at school have a much lower HAZ on average than that of non-boarding students. Furthermore, girls and students with more siblings have relatively lower HAZ, while the higher the number of parents a student has and the more educated they are exerts a positive influence on child nutritional status. Finally, our analysis implies that the effective way to decrease the inequality of health, malnutrition and human capital between urban and rural areas in the long run is to improve the facilities and services of boarding schools in rural China.

Keywords: malnutrition; boarding school; western rural China

Similar to other developing countries in the world (Behrman, Harold, & Hoddinott, 2004), there are still millions of children that suffer from malnutrition in poor areas of rural China, despite the fact that the nation has been the most successful country in the world in terms of poverty reduction in recent decades (Huang & Rozelle, 2008). Rural incomes have risen significantly and hundreds of millions of people have escaped poverty since 1978 (World Bank, 2001).[1] This effort, in fact, has led to a decline of child malnutrition. According to the national surveys on nutrition and health in 1992 and 2002, the decline of child malnutrition in China has been dramatic (Svedberg, 2007).[2] The number of children who are underweight and stunted has fallen by almost half. However, the progress does not mean that malnutrition has been eliminated. There are still large segments of children in rural areas that are suffering from low quality diets and micronutrient deficiencies (Svedberg, 2007). China's own statistics demonstrate that large numbers of children are still underweight and stunted (Ma, 2007).

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What is the strategy that nations can use to try to solve this lingering problem? In most developing countries, as in China (in the past), nutrition problems often are best tackled at home.[3] Most children live at home with parents and eat most of their meals at home. As a result, much of the effort for solving malnutrition must be targeted at getting families to improve the nutritional status of their children.

However, today in China, the home may not be the best place to begin dealing with the problem of malnutrition. In some parts of China, especially in some of its poorest areas, many school-aged children do not eat most of their meals at home. Since the early 2000s, one of the most prominent efforts of China's Ministry of Education (MOE) has been the implementation of the rural primary school Merger Program (Liu, Zhang, Luo, Rozelle, & Shi, 2009). In recent years, enrolments in village-level rural primary schools have declined sharply (National Bureau of Statistics [NBS], 2006). In response, the Merger Program began to close down smaller schools in more remote villages and merge them with larger "central" schools. The idea was that with fewer schools, the quality of the facilities and teaching staff could be more effectively raised by concentrating investments. Nationwide, the number of primary schools in rural China fell by nearly 25% from 2001 to 2005 (NBS, 2006). Consequently, many rural students are no longer able to attend school in their home villages and have to room and board away from home. With the implementation of the primary school Merger Program, the number of boarding students has increased rapidly. By 2008, the number had grown to more than 30 million boarding students in primary and junior high school, and this means that these students are living and eating away from home (MOE, 2008).

What has been the response of the government to this new challenge to address the nutritional problems of students? And, what has been the effect on the nutrition and health of children? During the initial years of the Merger Program, the government began a number of investment efforts to improve the facilities and services for boarding students. Since 2004, the central government as well as many provincial/county government bodies have allocated billions of yuan for construction of boarding school facilities and improving dining facilities (Guowuyuan Bangongting, 2005; MOE, 2006). Surprisingly, however, little is published in the literature about the effectiveness of these initiatives.

In fact, there are reasons to believe that the rise of boarding schools has not been contributing to the elimination of malnutrition but, instead, may be exacerbating the problems of providing good nutrition to students. All one has to do is visit boarding schools in some of the more remote towns and villages of China's poor counties to see that there are serious nutrition problems. In most boarding school dormitory rooms, the food students have brought with them from home sits in old wooden foot lockers for the entire week (or fortnight). Bags of steamed buns turned dry and hard, boxes of biscuits and canisters of pickled vegetables, stored under the tightly-packed bunk beds of the students, are testimony that their diets are sorely lacking in protein and many other essential vitamins. Not surprisingly, such poor dietary habits mean that there is still widespread undernourishment. According to a recent provincial representative survey of primary schools in Shaanxi Province's poorest counties, more than one in four children are anaemic (Luo, Kleiman-Weiner, Zhang, Liu, & Rozelle, 2009).

Despite the importance of boarding school services on child nutrition intake and the opportunity boarding schools provide for China's government to tackle nutritional problems, little is known. Therefore, the overall goal of this paper is to provide a detailed, empirically-based description of boarding schools in China and the health and nutritional status of students who live in them. To achieve the overall goal we have three specific objectives. First, we document the nature of boarding schools, especially the student

dormitory and canteen facilities and services. Second, we will compare differences between the nutrition and food intake of boarding and non-boarding school students who are attending the schools. Finally, we will analyse the differences in the health and development of the boarding and non-boarding students.

Because this set of objectives is extremely ambitious, we must necessarily limit the scope. First, we will rely on a survey of primary schools in one poor province in northwest China, Shaanxi Province. While the survey was designed to be representative of Shaanxi's poorest counties, it may be that nutritional problems differ in the boarding schools in other parts of China. In addition, because of the cross-section nature of our data, we are unable to infer causality from our findings. In other words, if we find that boarding school students are more likely to be malnourished than non-boarding school students, we cannot say that it is their boarding school experience that is the cause of the poor nutrition. It is possible that boarding school students were already malnourished when they arrived at school. At the most, this paper will be able to describe the health and nutrition status of those in boarding schools, information that is still valuable for those who are interested in designing strategies for reducing the level of malnutrition in China.

Data sources

In this paper we use two sets of data on boarding schools and boarding students in Shaanxi Province. We collected both sets of data ourselves since we could not find any recent systematic information on rural primary schools (especially boarding schools) that was publically available. The field work teams were made up of the authors and graduate students from Northwest University in Xi'an.

The first data set includes school-level information on 144 primary schools that was collected in October 2007. The sample selection procedure used a randomized-stratified sampling approach. One of the benefits of doing the study in Shaanxi Province is that there are three different regions in the province. Each is representative of a different area of western China. Southern Shaanxi is located in a mountainous, subtropical area. Northern Shaanxi is centred on the Loess Plateau and borders the Ordos Desert. Central Shaanxi is representative of the plains region and is the best off in terms of income per capita when compared to Southern and Northern Shaanxi. Therefore, in choosing our sample we obtained a list of all counties in each of the three regions and selected four counties in Southern Shaanxi, four counties in Northern Shaanxi and two counties in Central Shaanxi. We conducted the survey in these 10 sample counties. Inside each sample county, the survey team obtained a list of all townships. The townships were ranked by per capita gross value of industrial output (GVIO), a variable that according to Rozelle (1996) allows researchers to more accurately divide the sample into wealth quantiles. From this list, the enumeration team then randomly selected three townships, one from each tercile (one from the richest one-third of the townships; one from the poorest one-third of the townships; and one from the middle-income townships). In each township we obtained a list of all *wanxiao* (or all schools with six grades, Grades 1 to 6). These schools – that is, all of the *wanxiao* in each sample town – became our set of sample schools. Of the 144 schools that we surveyed, 65 of them were boarding schools. Henceforth, we call this survey the *Shaanxi Primary School Canvas Survey* (or the Canvas Survey, for short).

During the execution of the Canvas Survey, the enumerators conducted a two-hour sit-down survey with the principal of each sample school and supplemented the questionnaire with information from records of the school. The main focus of the survey was to collect information about each school's facilities and services. We structured the questions in such

a way as to try to collect information on both the quantity and quality of the facilities and services. The most comprehensive section of the survey centred on collecting information about the dormitory and canteen facilities and services. We were interested in understanding how the schools provided nutrition and health care for the boarding students. Finally, in addition to the basic information of each sample school, we also collected information about each school's participation in the Merger Program.

While the Canvas Survey was conducted across a large set of schools and relied mostly on information provided by the principal, we also wanted to collect a more intensive set of data based on information provided by the students themselves, especially those living in boarding facilities. Therefore, we collected a second data set in May 2008 in a subset of the schools selected from the schools that were part of the Canvas Survey sample. Henceforth, we call this survey of the subset of schools the *Shaanxi Intensive Boarding School Student Survey* (or, for short, the Boarding Student Survey).

To conduct the Boarding Student Survey, we randomly selected 10 sample boarding schools from the 65 boarding schools in the Canvas Survey. In each of the schools, we surveyed all students in Grades 1 to 5. In total, the sample included 2014 school children (about 200 students per school).

The Boarding Student Survey included three main sections. In the first section, the enumerators asked the students to provide basic information about their family and the characteristics of their parents. For example, there are questions about the number of siblings and the age and education of each student's father and mother. The second section focuses on the food consumption of students and includes questions on nutrition and energy intake from different sources. We also collected general information that helps to indicate whether or not the nutrition and energy intake is enough to provide the students in boarding schools with good nutrition.

The third section of the Boarding School Survey collected basic anthropometric data on each of the sample students. To ensure the accuracy of the data, we collaborated with a team of nurses from the Xi'an Jiaotong University School of Medicine's nursing programme. A team of four nurses visited each of the sample schools. To collect the anthropometric data, the nursing teams used a high quality set of equipment approved by the Chinese Center for Disease Control for measuring the physical development of the sample students. Age information was taken from the birth records that are part of each student's school matriculation folder.

The organization of primary education in Shaanxi Province

The organization of primary education, the densities of schools, and the nature of the Merger Program varied greatly among the sample counties (Table 1). In the first round survey, we surveyed 144 sample schools in 10 counties. Although on average this means that we surveyed 14 schools per county (or five schools per township), in fact, the number of sample schools per county varied widely (column 1).

The survey data echoed the findings of national statistics which show the widespread reach of China's Merger Program. Of the total number of sample schools (144), 55 of them were providing education for primary students in 2007, and at some time between 2003 and 2007 were involved in a merger (Table 1, column 2). In the rest of the paper, as suggested by Liu et al. (2009), we call these *merger-host schools* (since they are hosting the students, *merger-guest students*, who used to be in other, no-longer-functioning *merger-guest schools*). The intensity of the merging activity in our sample townships/counties, however, was also highly variable (Table 1, column 3).

Table 1. The distribution of merged and non-merged sample schools across sample counties in Shaanxi Province, China, 2008.

County	Number of sample schools	Number of merger-host schools	Number of merger-guest schools closed between 2003 and 2007
Wuqi	4	4	51
Ganquan	10	4	24
Hengshan	23	4	9
Jiaxian	16	11	52
Qianxian	26	4	11
Tongguan	20	3	11
Mianxian	12	12	46
Zhashui	18	6	17
Yangxian	5	4	19
Baihe	10	3	8
Total	144	55	248

Data source: Authors' Canvas Survey

One of the most salient results of the Merger Program in our Shaanxi sample was that the number of boarding school students had risen. When averaging across all of the students in all of the schools – the 55 merger-host schools and the 89 (144 minus 55) schools that had never been involved in a merger – our data show that the share of students who were boarding students had increased from 13% in 2003 to 15% in 2007. In all 65 sample boarding schools (55 merger-host schools plus 10 schools that had never been involved in a merger), the share of students residing in boarding schools had reached more than 41%. In other words, in the boarding schools in our sample, more than two in every five students lived and ate most of their meals in school.

Finally, as more and more merger-guest schools had been closed down, the demand for boarding schools facilities and services had increased. In response to this demand, the number of boarding schools had risen (Figure 1, Panel A). Between 2003 and 2007, the share of schools offering boarding rose from 31% to 45%. In almost all cases, the new boarding schools were the result of merger-host schools (20 of them) changing themselves from non-boarding schools to boarding schools. The rise in the demand for dining services was even greater. In many cases, while some merger-guest students were able to commute every day to their new schools and continue to live at home, it was often difficult for them to go home for lunch at noon. As a result, the share of schools with student canteens increased from 35% in 2003 to 49% in 2007 (Figure 1, Panel B).

Facilities and services in China's rural boarding schools

Although the government has made an effort to invest in building new and renovating existing boarding school facilities, the most prominent results from our data were that rural China's boarding school facilities are still poor and frequently fall far short of meeting the needs of boarding students. For example, the dormitory space was far from adequate and frequently detrimental to the health of boarding students (Table 2, rows 1 and 2). Our survey showed that the average student has only 2.3 m^2 of space, less than the national standard (3.0 m^2). In many sample schools, the number of beds was less than the number of boarding students. On average each boarding student only had 0.8 beds. This means, of course, that students in many facilities have to share their beds night after night with other students. In 30% of boarding schools, on average, two children have to squeeze onto one bed. In other words, in these schools, all boarding school students share their beds,

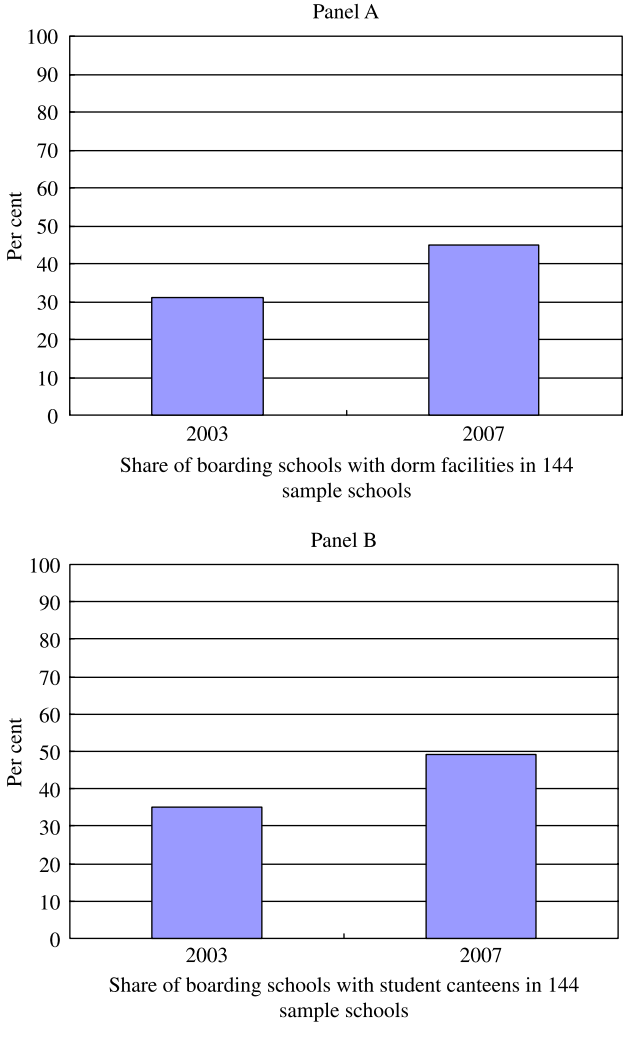

Figure 1. Percent of boarding schools with dormitory and canteen accommodation in Shaanxi Province, China, 2008. Data source: Authors' Canvas Survey.

a situation that does not facilitate good sleeping patterns and likely has adverse health consequences.

The facilities in many boarding schools do not promote basic health and cleanliness (Table 2, rows 3 & 4). Specifically, 23% of dorms did not even have towel racks on which students can hang wet towels. Only 62% of boarding schools had clothesline facilities that can be used to air out and clean bedding. Without such facilities, students in these dormitories are not able to carry out these basic tasks that are important for maintaining a healthy and comfortable environment.

Even more disturbing are the heating and ventilating systems (Table 2, rows 5 & 6). Although the winters in all parts of Shaanxi are cold (on average, the night time temperature in December/January in Shaanxi is -10°C), 41% of dormitories did not have any heating equipment. When they did, they were often the type of heaters that are dangerous; more than 50% of the boarding schools were heated by coal stoves (which can

Table 2. The characteristics of basic dorm facilities and canteen services in boarding schools in Shaanxi Province, China, 2008.

Items	Average or percentage
Dormitory area per capita (square metre)	2.3
Number of beds per capita (unit)	0.8
Dorms with towel-drying facilities (percentage)	77
Dorms with quilt-drying facilities (percentage)	62
Dorms with heating equipment (percentage)	59
Dorms with electric fan (percentage)	6
Dorms with toilet facilities in immediate vicinity of dorm (percentage)	60
There is electric light in toilet facilities (percentage)	49
Dorms with bathing facilities (for washing hands/taking baths) in immediate vicinity of dorm (percentage)	8
There is fire extinguisher in dorm (percentage)	28
There is fire hydrant near dorm (percentage)	6
There are carbon monoxide detectors in dorm (percentage)	0
There are smoke detectors in dorm (percentage)	0

Data source: Authors' Canvas Survey

let off dangerous carbon monoxide gases during the night). In fact, only 9% of the dormitories surveyed had heating systems that met basic safety regulations. During the summer months, only 6% of dorms have any fan units for ventilation.

China's rural boarding school dormitories are perhaps most under-equipped in the area of sanitation (Table 2, rows 7 to 10). Among all of the boarding schools with dormitories, only 60% had toilet facilities inside the dormitory facility. On average, the distance between the dorm and toilet facilities was 56 m. In several of the boarding schools, the distance exceeded more than 300 m. Moreover, the survey data showed that only 49% of restrooms had light at night. This means, of course, that it is inconvenient for young children who need to go to the toilet at night to do so. As a consequence, as any trip into a dormitory room reveals (through the smell of urine that is almost always present in any dorm room), there is a high incidence of bedwetting in dormitories. This behaviour is shameful for the bedwetter as well as uncomfortable and unhealthy for both the bedwetter and his/her dorm-mates (especially, the bed-mates). In interviews with almost all younger students, one of their main complaints of living away from home was this – they were simply afraid of going out to the toilet facility at night and ended up turning to bedwetting behaviour. In addition, almost no boarding schools had washrooms or bathing facilities in the dorm. Therefore, even if boarding school students were trained to practise basic sanitation, it was often difficult or impossible to do so.

Finally, the safety of students was often at risk (Table 2, rows 11 to 14). Only 28% of boarding schools had fire extinguishers. Even fewer (6%) had fire hydrant facilities. And, related to the inadequate heating systems, another danger for boarding students came from the complete absence of carbon monoxide and smoke detectors. None of the boarding schools with dormitories were fitted with these alarm systems, even those that used coal stoves for heating. In 2008, the seriousness of this absence was born out when 11 students in a dormitory in northern Shaanxi (in a school outside of our sample county) died from carbon monoxide poisoning (Huashangbao, 2008).

The survey also collected detailed information about canteen facilities and dining services, dimensions of boarding schools that are most relevant for those concerned about student malnutrition and health status. Of the 144 sample schools, 70 had canteens.

Table 3. The characteristics of student canteens in boarding schools of Shaanxi Province, China, 2008 (Number of sample schools with student canteen = 70).

Items	Average or percentage
There are tables and chairs in dining room (percentage)	33
Percentage of student canteens serving breakfast	30
Provide eggs for breakfast (percentage)	7
Provide soybean milk for breakfast (percentage)	6
Percentage of student canteen serving lunch	90
Provide meat, fish or eggs for lunch (percentage)	36
Frequency of meat, fish or eggs in one week (meals/week)	2.0
Percentage of student canteens serving dinner	79
Provide meat, fish or eggs for dinner (percentage)	27
Frequency of meat, fish or eggs in one week (meals/week)	1.8
Percentage of student canteens providing boiled water	85
Canteen managers understanding basic nutritional knowledge (percentage)	24
Cooking staffs without health certification (percentage)	21

Data source: Authors' Canvas Survey

While most boarding schools had canteens (62 of 65), there are three of them (about 5% of the total) that had no facilities to provide any dining services. Of the three boarding schools without canteens, two of them asked students to find local farm households to provide meals. In one boarding school, students had to rely completely on the food provisions they brought from home.

Having canteen facilities, however, does not guarantee adequate dining services. In fact, in many of the schools with canteens, basic facilities were unavailable (Table 3, row 1). There are obvious food safety dangers for boarding students. Only one-third of student canteens had tables and chairs. In most of the others, there were often not enough for all students. As a consequence, students often ended up eating outside in areas where it was dirty and inconvenient. Beyond tables and chairs, other equipment was almost completely absent (data not shown). Almost all schools had no ultraviolet disinfection equipment, refrigeration or hot water for washing dishes. Most principals told us the problem was less the cost of the equipment than it was the cost of operating them. Schools are given limited budgets to pay for electricity and other energy sources.

Perhaps in part due to the poor quality of the canteen facilities, dining services are also inadequate (Table 3, rows 2 to 11). For example, only 30% of canteens provided breakfast for boarding school students. When breakfasts were served, the menu consisted almost entirely of simple starches (e.g., steamed bread, corn porridge or noodle soup). In all of our sample canteens, only 7% of them provided eggs (and then not every day). In only 6% of student canteens was soybean milk served for breakfast. In addition, 10% of the student canteens did not provide lunch for students; in the case of the rest of those that did provide lunch, only 36% of them provided any meat, fish or eggs. In student canteens that did provide meat, fish or eggs, on average, these foods were served only twice per week. In all cases, these had to be purchased by the students using their own funds. In the case of dinner, only about 79% of the student canteens provided meals, and only 27% of these had foods with any protein. In fact, 15% of canteens still did not even provide boiled drinking water for students. While many students in these schools boiled their own water (on stoves that are brought from home), many others said they had to drink unboiled water, which may pose a serious health risk.

The source of the nutritional problems in boarding schools, according to our survey, may extend beyond the lack of financial resources. The survey found that the knowledge of basic nutrition and the familiarity with fundamental principles of management of the canteen cooking staff was poor. There were no guidelines or basic dietary standards for canteen workers. Only a handful followed recipes or had access to cookbooks. The contents of the food prepared by the canteen staff were almost always primarily simple starches. Rarely was there any consideration of protein or micronutrient requirements. In fact, when given a simple test, only 24% of the canteen managers could name the basic components of the nutrition pyramid (Table 3, row 12). In more than 20% of the canteens, despite national regulations (MOE & MOH, 2002), there had never been a sanitation certificate issued (row 13).

Nutrition intake of boarding school students

To have a clearer understanding of the effect that poor canteen facilities and inadequate dining services may have on boarding school students, we examine the results of the part of the survey where we asked students about their food/nutrition intake. Using the data from the Boarding Student Survey, we see that the protein intake of boarding students falls far short of what is needed. On average, only about 16% of boarding students had eaten (even one meal) that contained pork, beef, mutton or chicken during the three days (72 hours) prior to the survey (Figure 2, Panel A, left-hand bar).

The same is true for other sources of protein. For example, only about 10% of boarding students had eaten at least one meal with egg during the 3-day period prior to the survey (Figure 2, Panel B, left-hand bar). The main source of protein intake for boarding students is from tofu, a food made from soybeans. About 36% of boarding students had eaten one or more meals that contained at least one serving of tofu in the three-day period prior to the survey (Figure 2, Panel C, left-hand bar). Unfortunately, as is well known in the nutrition literature, the absorbable proteins in soy products are only available to the human body when the students are also eating the sufficient amounts of micronutrients, available in fruits and vegetables, which in many cases the students were almost certainly not getting.

Comparing the intake of proteins between boarding students (left-hand bar) and non-boarding student (right-hand bar) raises a number of issues (Figure 2, Panels A to C). First, and most importantly, it is clear from the comparisons that boarding school students are one of the more vulnerable segments of the population. The proportion of students who over the three-days prior to the survey had consumed meat or eggs was less than half that of non-boarding students (and significantly so). The point estimate of tofu consumption by boarding schools students was also lower than that for non-boarding school students. Without knowledge of the protein intake of boarding school students before entering boarding school (or without knowledge of their intake in the previous years), it is difficult to know if boarding schools are contributing to China's nutrition problem. However, what is clear is that the investments into boarding and canteen facilities and provision of dining services has not been successful, at least so far, in eliminating the poor nutrition that is being suffered by boarding students.

Second, while the nutrition intake of the comparison group (non-boarding students) in this analysis is considered inadequate, parents in these areas are also not providing their children with enough nutrition. In other words, part of China's continuing problem of poor nutrition extends beyond the school.

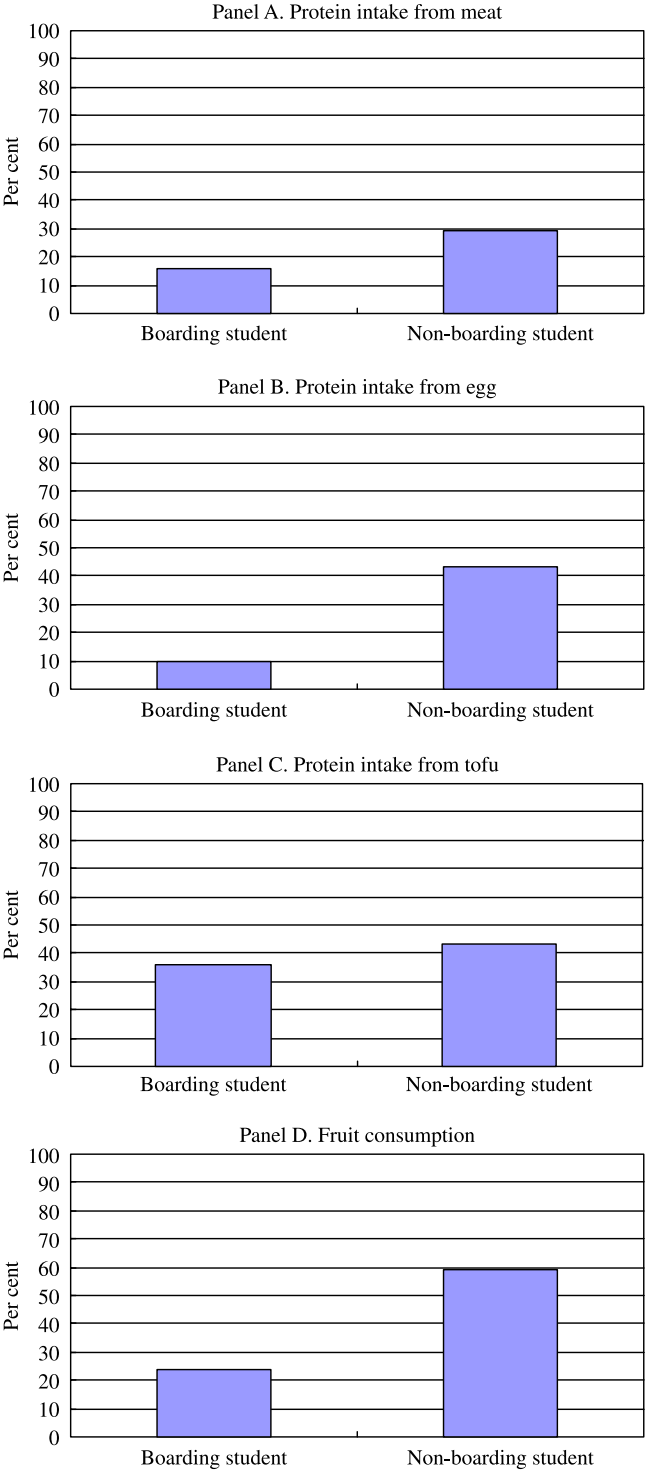

Figure 2. Share of students in sample schools and intake of protein and vitamin in Shaanxi Province, China, 2008. Data source: Authors' Boarding Student Survey.

Nutritional outcomes of students in China's boarding schools

While admittedly somewhat ad hoc, one of the most compelling measures of poor nutrition and health in boarding schools was revealed by asking the question of students during the Boarding Student Survey, "Do you ever feel hungry – to the point you suffer from hunger pains during class (or to the point that your hunger keeps you awake at night)?" Perhaps unsurprisingly, with such poor food provision and low intake of quality nutrition, 57% of boarding students reported that they sometimes or often felt hungry in class; 53% of boarding students reported feeling hungry at night to the point that it kept them awake (Figure 3, Panels A & B). While there was a high percentage of non-boarding students who reported feeling hungry in class (34%) or at night (27%), these levels were still half of the rates of students in boarding facilities.

Of course, the poor nutrition can be detrimental to the longer-term health and physical development of students in boarding schools. To understand the relationship between nutrition and health in our sample schools, in the rest of our analysis, we compare the height-for-age of our sample (boarding and non-boarding) students with that of a reference group of children and adolescents worldwide (WHO Multicentre Growth Reference Study Group, 2006). More specifically, in this paper we use the difference between a student's height and the median height of the average individual with the same age and gender in the WHO reference population. The basic principle of anthropometry is that prolonged or severe nutrient depletion eventually leads to retardation of linear (skeletal) growth

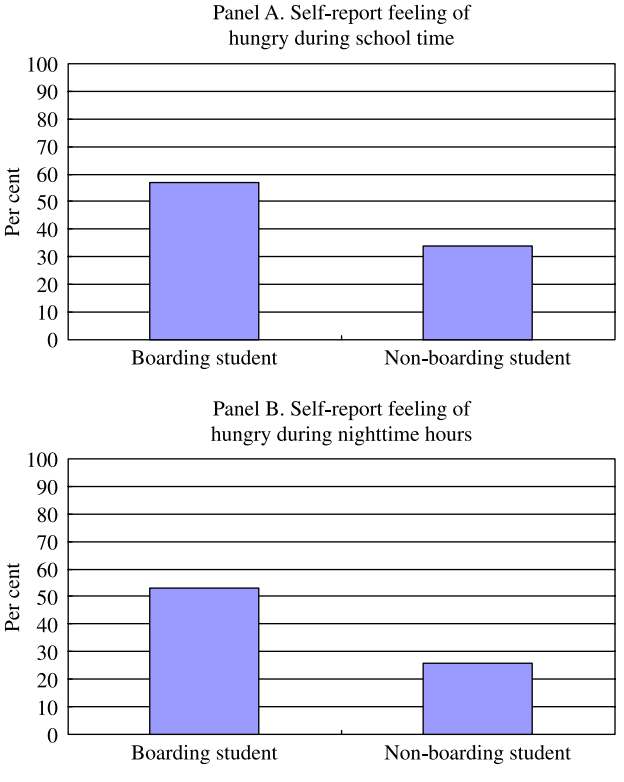

Figure 3. Self-reported episodes by students of "feeling hungry" in sample schools in Shaanxi Province, China, 2008. Data source: Authors' Boarding Student Survey.

in children (Morris, 2001). Because of this, height-for-age is a particularly good health indicator. Economists also often use height-for-age as a measure of both short- and long-term health status (United Nations Standing Committee on Nutrition, 2003; Behrman & Rosenzweig, 2002; Strauss & Thomas, 1998; Thomas, Strauss, & Henriques, 1991).

According to our survey data, most of the students in our sample schools (both boarding and non-boarding students) are under the median of the WHO reference; many sample students fall below the line that is drawn two standard deviations below the median, a threshold below which individuals are commonly considered to be stunted (or malnourished). For male students in our sample schools, only 16% are higher than the median height for the same age and gender in the WHO reference population. Most of the male students are below the median height line. More precisely, 69% of male students lie between the median height and median height minus 2 standard deviations. Most poignantly, the survey data shows that about 15% of male students in our sample schools are absolutely stunted (or suffering from malnutrition) according to the height-for-age *Z*-score (Figure 4, Panel A). (See the section on Multivariate Analysis below for the definition of height-for-age *Z*-scores.)

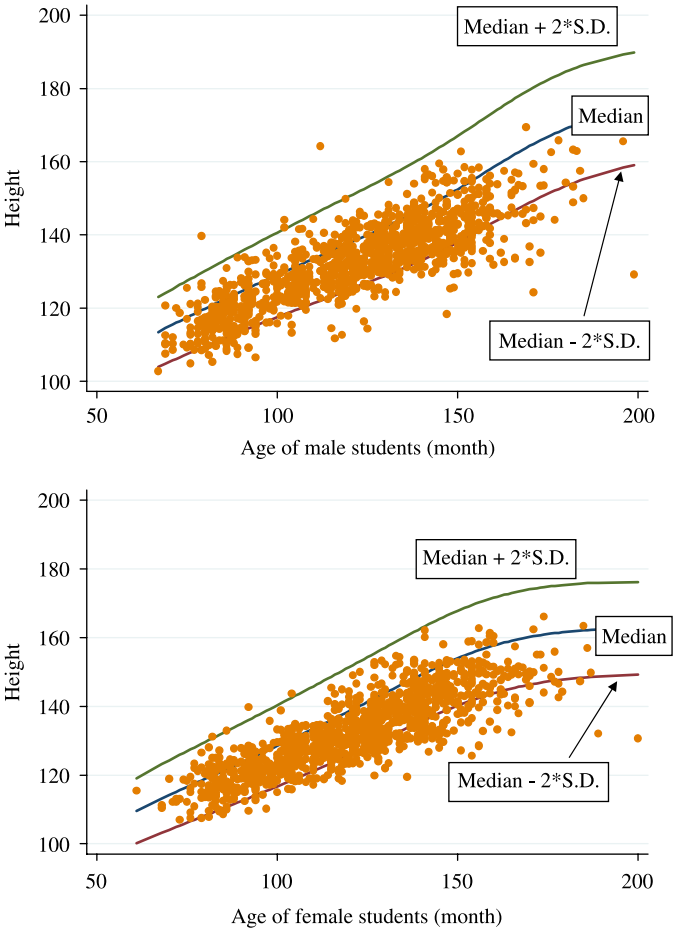

Figure 4. The distribution of height-for-age for sample elementary school students in Shaanxi Province, China, 2008. Data source: Authors' Boarding Student Survey.

The record of female students is even worse (Figure 4, Panel B). According to our data, 86% of female students in our sample schools are below the median height for the same age and sex in the WHO reference population. In total, 16% of female students in the sample schools are stunted.

One important (albeit difficult to interpret) characteristic of our findings is that the rate of stunting of our sample students is becoming worse for those in the older cohorts (Figure 4). For example, 21% of male students below 125 months are taller than the median height of the WHO reference group of the same age and sex; for male students aged 125 months or above, only 11% are taller than the median height of the reference group. Our data also shows that about 11% of male students below 125 months are stunted, while a much higher share (19%) of those above 125 months are. Similar trends can be seen in the case of female students. In fact, nearly one-quarter (24%) of female students who are over 125 months old are stunted.

When comparing the nutrition and health of boarding and non-boarding students (both male and female students combined) in the sample schools, the data demonstrate that boarding students are much worse off than non-boarding students (Table 4). Fully 23% of all boarding students (in Grades 1 to 5) are stunted (i.e., their height for their age and gender is two standard deviations below the median height of the WHO reference group; see Table 4, column 1, row 6). The rate of stunting of non-boarding students is much lower (11%; column 2, row 6). Interestingly, the rate of stunting grows over the years of elementary school by grade for boarding students (from Grades 1 to 5; column 1, rows 1 to 5) but not for non-boarding students (column 2).

When comparing the absolute deviation between the median height of sample students and the median height of the WHO reference group (by age and by gender), we find that the same patterns appear between male and female students and between boarding and non-boarding students, and for students as they advance into higher grades (Table 5). In general, we find that the height difference between boarding students (male and female, of all ages) and the median height of the WHO reference group is 8.6 cm, far more than that for non-boarding students (5.4 cm). Likewise, the stunting pattern for females is slightly more severe than that for males. And, in general, the rates of stunting rise with age.[4]

Multivariate analysis

As with the descriptive analysis, we also followed the literature (Chen & Li, 2009; Shariff, 1998; Strauss & Thomas, 1998; Thomas, Strauss, & Henriques, 1991) and used

Table 4. The height for age of sample students by grade in boarding schools of Shaanxi Province, China, 2008 (number of sample boarding schools = 10).

	Percentage of students with height below two SD of the median of WHO standard	
Grade	Boarding students	Non-boarding students
One	15	11
Two	16	8
Three	17	11
Four	28	13
Five	22	13
Average	23	11

Data source: Authors' Boarding Student Survey

Table 5. The height for age of sample students by grade and gender in boarding schools of Shaanxi Province, China, 2008.

		The difference (using median for age measure) between sample students (this study) and WHO standard (cm)		
Gender	Grade	(1) Boarding students	(2) Non-boarding students	(column 1 minus column 2) Difference (absolute, in cm)
Males	1	−6.6	−4.8	−1.8
Males	2	−6.5	−3.5	−3
Males	3	−7.2	−4.2	−3
Males	4	−8.8	−5.7	−3.1
Males	5	−9.8	−5.9	−3.9
Subtotal		−8.5	−5.1	−3.4
Females	1	−5.5	−3.9	−1.6
Females	2	−6.8	−5.2	−1.6
Females	3	−7.6	−5.5	−2.1
Females	4	−10.7	−7.8	−2.9
Females	5	−8.6	−6.7	−1.9
Subtotal		−8.9	−5.5	−3.4
Total		−8.7	−5.3	−3.4

Data source: Authors' Boarding Student Survey

the height-for-age *Z*-score (HAZ) as a measurement of child health. The HAZ is defined as follows:

$$HAZ_i = (h_{ij} - \bar{h}_j)/\delta_j$$

where h_{ij} is the observed height of child i in group j, where group is defined according to child sex and the birth month; for example, boys aged 100 months and girls aged 100 months are two different groups. The terms $\bar{h}_j$ and δ_j are the median and standard deviation of the height in group j, using the "reference" group of child and adolescent worldwide as defined by WHO (2006).[5]

We analysed the relationship between child health for boarding and non-boarding students with the following equation:

$$HAZ_i = \beta_0 + \beta_1 boarding_i + \beta_2 Z_i + \varepsilon_i \quad (1)$$

where HAZ_i, as defined above, is a measure of child health; $boarding_i$ is a variable to indicate each student's boarding status.[6]

In addition to the variables of interest (defined in the previous paragraph), we also controlled for other potential determinants of child health. In the empirical model (1), we include Z_i, a vector of control variables, which influence HAZ. The values (Z_i) may be divided into variables that relate to: the child's characteristics; parental characteristics; and characteristics of the child's household (Borooah, 2005; Chen & Li, 2009; Gibson, 2001; Linnemayr, Alderman, & Ka, 2008; Shariff, 1998). Following the international literature (especially given the descriptive findings above), we added a gender and grade variable to the right-hand side of equation (1) to control for child characteristics. To control for the parental influences, we included characteristics of both the child's mother and father (Chen & Li, 2009). Characteristics of the mother (including mother's education and whether or not the mother lives at home) are important factors for children's health

because, in general, mothers are the primary caregivers in rural China and typically prepare the family's meals. When the mother is more educated, she should have better knowledge about health care and nutrition, behave in a way that promotes a healthier child, and can provide a safer and more sanitary environment for her children (Behrman & Deolalikar, 1988, 1990; Currie & Moretti, 2003; Desai & Alva, 1998; Glewwe, 1999; Strauss, 1990; Thomas, Strauss, & Henriques, 1990, 1991). Although the literature provides evidence that it is the mother's characteristics that are of overwhelming importance in promoting child health, in many studies it has been found that the characteristics of the father may also matter. Therefore, we also added the father's characteristics, such as education and whether or not the father lives at home. In addition, we included the heights of both the mother and father to account for the effect of genetics and trait inheritability.

The model also included some other variables to account for a number of the other factors related to the child's family. The house value of the family was added to control for family wealth, since households with more wealth typically would be able to provide more nutritious food and better medical care (Case, Lubotsky, & Paxson, 2002; Smith, 1999). Another important variable, the number of siblings, was also added as a control variable because with more children, the parents would have less time and money for each child; as a result, it is expected that, *ceteris paribus*, the more siblings a child has, the poorer the child's health (Becker & Lewis, 1973).[7]

In estimating the model in equation (1), we ran both the simple model (without covariates) and the full model (with all of the covariates). In doing so, the regressions appear to be robust for all specifications (Table 6 and Appendix Table 2). The R^2 is about 0.1 when we control for covariates variables. Such a level of goodness of fit is reasonable

Table 6. Multivariable analysis of height-for-age.

	The difference between height of student and the median height of WHO reference in standard deviation (HAZ)	
Independent variables	(1)	(2)
Is boarding student or not (1 = yes, 2 = not)	−0.51 (−8.54)***	−0.35 (−5.37)***
Gender of student (1 = male, 0 = female)		0.12 (2.08)**
Grade 2 dummy		0.07 (0.66)
Grade 3 dummy		−0.05 (−0.49)
Grade 4 dummy		−0.23 (−2.52)**
Grade 5 dummy		−0.18 (−1.95)*
The value of family's house		0.00 (0.05)
Education of father		0.02 (2.44)**
Height of father		0.01 (2.79)***
Does father live at home? (1 = yes, 2 = no)		−0.10 (−1.60)
Education of mother		0.12 (3.75)***
Height of mother		0.02 (5.16)***
Does mother live at home? (1 = yes, 2 = no)		−0.01 (−0.13)
The number of siblings		−0.06 (−2.55)**
Constant	−1.14 (−31.4)***	−6.65 (−7.51)***
Observations	2014	2014
R-squared	0.04	0.08

Note: *t*-statistics in parentheses; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Data source: Authors' Boarding Student Survey

for cross-section data analysis using anthropometric measures. The control variables behave as expected and the effects are stable across each specification (Table 6 and Appendix Table 2).

More importantly, the estimated multivariate relationship between health and boarding status is similar to the finding of the descriptive analysis. In the simple linear regression (the simple model), boarding status (living in a boarding school) is positively correlated with the HAZ of the students (Table 6, column 1). The magnitude of the coefficient suggests that boarding school students are about half a standard deviation, or about 3 cm (Appendix Table 2, column 1), shorter than non-boarding students. Likewise, when we run the full model, the estimated relationship between boarding school status and HAZ is similar to that from the simple model (column 2). The magnitude of the coefficient is still large and significant, even after controlling for the other included covariates. Interestingly, the magnitude of the coefficient is consistent with the size of the difference in the descriptive statistics.

Conclusion

This paper documents the school dorm facilities, dining facilities and services provided by boarding schools in a sample of schools in one of the poorest provinces in northwest China. The analysis investigated the differences between boarding and non-boarding students in terms of nutritional status (as well as comparing them against a WHO reference group). We also looked at the relationship between a student's nutrition status and household characteristics, such as family wealth and the number of siblings in the family.

Echoing national statistics, we found that with the implementation of the Merger Program, the organization of rural primary education has been changing fast. While the number of schools has been falling, the number of boarding schools has been increasing to meet the new demand for boarding. The national government has, in fact, invested substantial sums into the new programmes and the associated facilities and services. However, the data from our survey showed that the dorm and canteen facilities and dining services are far from adequate. Field interviews also indicated that there is no curriculum or training for nutrition and health, which would be helpful in promoting better nutrition and health for rural boarding students. And, although stopping short of pinning the blame for the observed poor nutrition and health on rural elementary schools, it is plausible that boarding schools are part of the problem.

The descriptive and multivariable analysis, among other things, provided a clear picture of the patterns of malnutrition. According to our data, stunting is observed among all groups, but is more prevalent among boarding students than non-boarding students. It is also greater among female students than male students as well as higher among students in Grades 4 and 5 than those in Grades 1 and 2. This precise and convincing description of the pattern of malnutrition is in itself important as it will allow for targeting of future policies.

While we cannot definitively identify the sources of the problem, we can draw some generalities. First, and perhaps above all, it does appear as if malnutrition (or possibly the consequences of earlier malnutrition) is present in the population of boarding students in our sample at much higher rates than in the population of non-boarding students. We do not know from this analysis if their residence in the boarding schools has led to more severe malnutrition, but at the very least we know that the current set of initiatives for boarding schools is not helping to eliminate the problem. We also know from our analysis that if policy makers are serious about reducing malnutrition, targeting boarding students is a good way to help those who are among the most vulnerable.

There is one puzzle in our paper that also is difficult to definitively answer with the current study. According to our data, we found that the level of stunting among boarding students rose between Grade 1 and Grade 5 (peaking at Grade 4). The same pattern was *not* found for non-boarding students. So what is happening? Is this evidence of boarding school-induced malnutrition? In fact, there are two possible explanations. One could blame boarding schools – that the poor nutrition associated with living in a boarding school gradually takes its toll on the students, causing the rate of stunting to gradually rise. If this is what is happening, then any evaluation of the nation's Merger Program and the associated initiatives to expand boarding schools must count this as a huge negative cost.

However, there could be an alternative explanation. In fact, the population of boarding students is not static over time. In some parts of Shaanxi (as in the rest of China), villages have maintained "teaching points" (*jiaoxuedian*, or branch schools) that still offer teaching services for younger students (e.g., first and second graders) in remote villages. Because of this policy, the number of first and second graders that live in boarding schools is lower than the number of fourth and fifth graders. It could be that the rise in the observed rate of stunting between Grade 1 and Grade 4/5 is due to the fact that the new students who are entering the population of boarding school students in Grades 3, 4 and 5 are already stunted, relative to those who were in boarding schools from the first. This would mean that the nutrition of those students who are being taught in *jiaoxuedian* is actually worse off than those who are in boarding schools. Obviously, additional research is warranted to try to find out the true explanation. The answer to this question has implications for understanding the real sources of malnutrition and the policies to combat it.

Notes

1. Actually, there are still large gaps between rural and urban China even after decades of rapid development. In 2004, the urban to rural household per capita income ratio was 3.2 to 1. Furthermore, public services in rural China are severely under-provided compared to those in urban area. For example, during the 1990s and early 2000s, education spending per capita on urban children was about twice as high as on rural children and investment into the construction of facilities in urban areas (on a per capita basis) was about four times as great as on rural children. Therefore, in part as a result of this, the nutrition and educational status of rural Children is far poorer than that of urban China.
2. It is estimated that around 162 million children, and almost a billion people of all ages, are malnourished (Behrman, Harold, & Hoddinott, 2004). In developing countries, it is believed that almost 60 million children go to school hungry every day (Bundy et al., 2009).
3. Nutrition for school-aged children is equally important. The UN's World Food Program has assisted some 22 million children through school feeding programmes in 70 countries as a way to protect the poorest students in the world (Bundy et al., 2009).
4. When using an alternative measure of malnutrition (body mass index, or BMI) to test the robustness of the analysis, we found similar patterns for boarding and non-boarding students. Boarding students were more wasted than non-boarding students, according to the BMI measure, and female students had lower BMI scores than male students.
5. Although we give the definition of HAZ here in the multivariate analysis section, it is the same measure as that used in the descriptive analysis above.
6. To test the robustness of the effect, we also use the absolute deviation from the median height of the WHO reference ($Deviation_i = h_{ij} - \bar{h}_j$) as a dependant variable in the analysis. The results are reported in Appendix Table 1 and are similar to the HAZ analysis.
7. All summary statistics of control variables are listed in Appendix Table 1.

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Appendix

Appendix Table 1. Summary statistics of variables in analysis of height-for-age Z-score (number of observations = 2014).

	Mean	Standard deviation			
Height of father (cm)	171	6.5			
Height of mother (cm)	161	7.4			
Number of siblings (unit)	1.9	1.2			
	No house	Below 5 thousand yuan	Between 5 and 10 thousand yuan	Between 10 and 50 thousand yuan	More than 50 thousand yuan
The value of family's house (frequency)	139	583	548	493	251
	Illiterate	Primary school	Junior high school	Senior high school	College or above
Education of father (frequency)	163	810	820	158	63
Education of mother (frequency)	492	909	509	63	41
	At home	Not at home			
Does father live at home? (frequency)	1269	745			
Does mother live at home? (frequency)	1812	202			

Data source: Authors' Boarding Student Survey

Appendix Table 2. Multivariable analysis of height-for-age Z-score.

	The difference between height of sample students and that of WHO reference (cm)	
Independent variables	(1)	(2)
Is boarding student or not (1 = yes, 2 = not)	−3.16 (−10.4)***	−1.99 (−6.10)***
Gender of student (1 = male, 0 = female)		0.44 (1.51)
Grade 2 dummy		−0.15 (−0.28)
Grade 3 dummy		−0.93 (−1.90)*
Grade 4 dummy		−2.40 (−5.11)***
Grade 5 dummy		−2.23 (−4.80)***
The value of family's house		0.03 (0.29)
Education of father		0.09 (2.27)**
Height of father		0.04 (1.96)**
Does father live at home? (1 = yes, 2 = no)		−0.38 (−1.25)
Education of mother		0.55 (3.33)***
Height of mother		0.11 (5.51)***
Does mother live at home? (1 = yes, 2 = no)		−0.27 (−0.56)
The number of siblings		−0.31 (−2.59)***
Constant	−5.27 (−28.7)***	−30.02 (−6.72)***
Observations	2014	2014
R-squared	0.05	0.10

Note: *t*-statistics in parentheses; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Data source: Authors' Boarding Student Survey