

Article

Eating More but Not Better at School? Impacts of Boarding on Students' Dietary Structure and Nutritional Status in Rural Northwestern China

Qihui Chen ^{1,2} , Chunchen Pei ² and Qiran Zhao ^{1,2,*}

¹ Center for Food and Health Economic Research, China Agricultural University, Beijing 100083, China; chen1006@um.edu

² College of Economics and Management, China Agricultural University, Beijing 100083, China; cc.pei@cau.edu.cn

* Correspondence: zhaoqiran@cau.edu.cn; Tel.: +86-10-6273-8530

Received: 14 July 2018; Accepted: 1 August 2018; Published: 4 August 2018



Abstract: While the impact of boarding on students' development has attracted considerable attention from researchers and policy makers, rigorous analysis of students' food consumption behavior and nutritional status has been rare. This study fills this gap by analyzing data on nearly 7600 rural primary school students from two northwestern Chinese provinces, using students' home-to-school distance as an instrumental variable for their boarding status. Our estimation results suggest that boarding significantly reduces students' dietary diversity, as measured by a Diet Diversity Score constructed following guidelines provided by the Food and Agriculture Organization of the United Nations. While the reduced dietary diversity does not undermine students' overall nutrition intake, as measured by their body mass index (BMI) for age, it does increase their probability of being anemic. Further investigation reveals that boarders consume significantly less protein-rich food and significantly more carbohydrate-rich food than their non-boarding counterparts.

Keywords: boarding schools; food consumption; dietary structure; primary school; rural China

1. Introduction

One unintended consequence of China's one-child policy is the shrinking population of school-age children in its rural areas, where the total fertility rate dropped from nearly 4.0 in the mid-1970s to less than 1.5 in the recent decade [1–3]. Particularly, during the first decade of the new millennium, the number of rural children aged between 6–15 declined from 155.2 million to 83.4 million [4], which in turn caused a rapid decline in school enrollment in rural China. Enrollment in rural schools is further reduced by the massive outmigration of rural laborers: about 26 million (basic education) school-age children were brought to the cities by their migrant parents [5]. Currently, there are more than 30,000 rural primary schools nationwide that have fewer than 10 enrolled students; some schools, especially those located in remote mountainous areas, are only capable of recruiting new students every two or even more years [6], causing a substantial waste of (the already limited) educational resources in rural China.

In response to these problems, the Chinese government launched a national school merger program in 2001 [7]. The decade that followed witnessed a substantial reduction of approximately 200,000 rural primary schools; according to the National Bureau of Statistics, there were 416,198 and 210,984 rural primary schools in 2001 and 2010, respectively [4]. Today, boarding schools have become a major platform for providing and managing rural education in China. By 2015, the numbers of boarding students in primary and middle schools in rural China had reached, respectively, 9.55 million and 16.8 million, accounting for 14.4% and 58.6% of their respective populations [8]. In May 2018,

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 with developing China's rural education system [9]. To this end, boarding schools need to overcome a series of problems facing China's rural education system, among which child nutrition and health problems (e.g., malnutrition, poor vision, and parasite infection) are the most pressing [10]. What further complicates this task is the coexistence of food insecurity and inefficient food distribution problems. On the one hand, inadequate intakes of protein, carbohydrates, and fat are prevalent among rural school-age children in China [11], causing nearly 13 million of them to be stunted [12]. Anemia is also prevalent. For example, in rural areas of two northwestern Chinese provinces, namely, Ningxia and Qinghai, respectively 25.4% and 51.5% of primary-school students were found to be anemic [13,14]. However, on the other hand, nearly 10% of rural children in 17 Chinese provinces were found to be overweight, and nearly 5% were obese [15]. The interplay of nutrition-related problems among rural school-age children, the expected role of boarding schools in the development of China's rural school system, and the important role that child nutrition and health plays in determining one's educational and labor-market outcomes [16,17] naturally gives rise to two questions that are of great policy relevance: How does boarding affect students' food consumption behavior (in terms of dietary structure and adequacy) in rural China? Does it improve or undermine their nutritional status?

To help provide answers to these questions, this study empirically estimates the causal effects of boarding on students' dietary structure, adequacy, and nutritional status. In so doing, this study makes two empirical contributions to the literature. First, to our knowledge, this study is the first to estimate the causal effects of boarding on students' food consumption behavior and the resulting nutritional and health outcomes, at least in the context of rural China. While "boarding schools for the poor" in developed countries, such as in France [18] and the United States [19], have started to attract academic attention in recent years, how boarding affects students' dietary structure and nutritional status in China has rarely been examined in this emerging literature. Even among the few studies that have studied boarding students' nutrition and health in China, most of the analyses performed are descriptive in nature [20–23]; thus, whether their findings capture any causal effects of boarding is open to question. Another strand of recent studies conducted in developing-country settings have examined the impacts of providing school meals to poor students [24–27], but these studies are not focused on the role of boarding. Our study is complementary to these studies in that it provides useful information on how school meals should be provided.

Second, this study provides evidence on how schooling affects one's health outcomes from an often-overlooked angle. The majority of previous studies on the education–health relationship are concentrated on the impact of the *quantity* of education (e.g., years of schooling or the highest degree earned) on health behaviors and outcomes [28–31] (see also Glewwe and Miguel [17] for a thorough review of studies on the health–education relationship in developing countries). In contrast, our study examines how boarding, a particular way of *organizing* and *managing* education, affects one's nutritional and health outcomes.

The analysis of this study also overcomes two methodological problems that have plagued previous studies of boarding in China: (1) relatively small sample sizes, and (2) the lack of exogenous variations to identify boarding effects. More specifically, this study analyzes a large dataset of approximately 7600 rural primary-school students from two Northwestern provinces of China, exploiting geographical variations in students' home-to-school distance to create an instrumental variable for their boarding status (i.e., an exogenously-determined variable that affects the outcome of interest only through its impact on students' boarding status). School fixed effects are controlled for to avoid selection into pure boarding schools due to (very) long home-to-school distance. Also, to examine whether distance picks up some impact of remoteness, which may have direct effects on children's nutrition and health status, we perform instrumental-variable estimations over different ranges of home-school distance. Our estimation results suggest that boarding significantly reduces students' diet diversity, as measured by a Diet Diversity Score constructed following FAO guidelines

(adjusted to reflect the Chinese context) [32–34]. For example, while these guidelines suggest that school-age children should consume at least 25 g of fruit, only 70.7% of boarding students in our sample managed to reach this recommended level (compared to 84.2% of non-boarding students in the sample). While the reduced dietary diversity does not undermine students' overall nutrition intake, measured by their body mass index (BMI) for age z-scores (in fact, it slightly increases their BMI-for-age z-scores), it does increase students' probability of being anemic, which is an impact that is statistically significant at the 10% level. Further investigation on students' consumption of specific food items reveals significant substitutions between certain food groups. In particular, boarders consume significantly less meat but significantly more rice than their non-boarding counterparts.

2. Data

2.1. Survey and Sample

The data analyzed in this study were collected through a school-based survey conducted in Qinghai Province and Ningxia Autonomous Region in 2009. The study received ethical approval from the Stanford University Institutional Review Board (IRB) on 21 July 2009 (protocol number: 17071). All of the necessary permissions were obtained from the Chinese government as well. All of the participating children gave their assent to participate in the project; their legal guardians also provided consent. All of the study participants were aware of the (minimal) risks involved and understood that their participation was purely voluntary.

The project provinces, Qinghai and Ningxia, are relatively underdeveloped compared to other provinces of China. Official statistics indicate that per capita incomes of rural households in Qinghai and Ningxia are, respectively, 35.1% and 21.4% lower than the national figure [35,36], mainly due to their disadvantaged geographic locations, as well as harsh natural conditions such as the lack of irrigation water and arable land. As with other underdeveloped western regions in China, child malnutrition is prevalent in these two provinces. For example, as high as 51.5% and 25.4% of primary-school students were found to be anemic in Qinghai and Ningxia, respectively [14].

The sample of students was collected using a multi-stage, random sampling procedure. First, we obtained a list of all of the counties in each of the two regions, and assigned each county on the list a ranking according to the local gross value of industrial output (GVIO) per capita of each county in 2008 [37]. Based on this list, we randomly chose five poor counties from each of the two regions. A combination of official records was then used to identify all of the schools from these 10 counties with the following characteristics: (a) six grades (i.e., complete primary schools, or *wanxiao*); (b) boarding facilities; and (c) 400 or more enrolled students. Finally, we selected classes of fourth and fifth graders from each sample school. If a sample school had more than two classes in each grade, we randomly selected two classes from each grade. If a school had no more than two classes in each grade (which accounted for 90% of the cases in our project), all of the fourth and fifth-grade classes in this school were selected. All of the 7648 fourth and fifth graders enrolled in 74 schools (38 in Qinghai and 36 in Ningxia) in the survey year were included in our sample.

Information on sampled students' personal, family, and school characteristics was collected through a set of questionnaires. More specifically, students filled out a questionnaire on their personal information during class on a survey day. With the assistance from a nursing team trained in the Xi'an Jiaotong Medical School, we also collected health information from the sampled students; students' height, weight and hemoglobin (Hb) levels were measured using standard medical instruments by the nursing team. However, due to budgetary constraints, health information was collected only for about one half ($N = 3613$) of all of the sampled students. Information on students' family characteristics were provided by their parents through a take-home questionnaire that they filled out. Finally, information on basic teacher characteristics, such as educational background and teaching experience, as well as information on school facilities, were provided by the principals of the sampled schools.

Of all 7648 students, 7606 completed information on their personal and family characteristics, which we include in the analysis. To circumvent school-selection problems brought by non-local students, we dropped 184 observations from students whose home-to-school distance was more than 25 km (more observations will be dropped to assess the robustness of our estimation results below). The final sample included 7422 students. Note that the actual size of the analytical sample varied across different outcome variables due to missing information. For example, due to missing values of food-intake information, the sample used to examine students' dietary structure had 7128 observations.

2.2. Outcomes of Interest

The rich information contained in our data allowed us to examine a wide range of outcome variables measuring students' dietary diversity, adequacy, and their nutritional and health status.

A. Dietary Diversity. Information on a 24-h dietary recall of one's consumption of 33 food items in our data allowed us to construct a Dietary Diversity Score (DDS) to measure students' dietary diversity, based on guidelines provided by the Food and Agriculture Organization of the United Nations (FAO) [32]. The DDS counts the *number* of food categories, say, "Vitamin A-rich fruits" and "fish", that an individual consumed over the past 24 h. Such an index has been shown to be positively related to school-age children's nutrient adequacy status [38–40]. The standard FAO guidelines involve 14 food categories (Table 1, column 1), but due to data limitations, we modified the algorithm by combining six categories into three larger ones (e.g., we combined "dark green leafy vegetables" and "other vegetables" into "vegetables"), replacing two categories with their local counterparts (e.g., we replaced "legumes" with "soybean"), and dropping one category ("oil and fat") from the FAO list (Table 1, column 2).

Table 1. Comparisons of food categories involved in definitions of Dietary Diversity Score (DDS).

(1) Food Categories Involved in FAO Guidelines (FAO, 2008)	(2) Food Groups Used to Construct DDS in This Study
Grains	Grains
Vitamin A-rich vegetables and tubers	Tubers
White tubers	
Dark green leafy vegetables	Vegetables
Other vegetables	
Vitamin A rich fruits	Fruits
Other fruits	
Flesh meat	Flesh meat
Organ meat	Other meat
Eggs	Eggs
Fish	Fish
Legumes, nuts, and seeds	Soybean, nuts, and seeds
Milk and milk products	Milk and milk products
Oil and fat	(no corresponding category)

Notes: Given data limitations and local conditions, we combined "Vitamin A-rich vegetables", "dark green leafy vegetables", and "other vegetables" into "vegetables", combined "Vitamin A-rich tubers" and "white tubers" into "tubers", replaced "organ meat" with "other meat", replaced "legumes" with "soybean", and dropped the "oil and fat" group.

B. Dietary Frequency. One disadvantage of the DDS is that it does not take into account the actual *amount* of food consumed in each category. In poor rural areas of China, the DDS is likely to overstate a child's dietary adequacy if this child consumes foods in most DDS-related categories, but the amount of each food consumed is small. Although our data do not contain information on the specific amount of each food consumed, we use the 24-h recall information on the *frequency* of consuming food items in each category as an alternative measure. To further provide complementary information on students' dietary frequency, we resort to two other variables: whether they "feel hungry when having class

during the day” and whether they “feel hungry when going to sleep in the evening” in a usual school day.

C. Nutritional and Health Status. Finally, two variables are used to help assess how students’ dietary patterns translate into their overall nutritional status. The first is students’ body mass index (BMI) standardized by their gender and age (i.e., BMI-for-age z-scores), which reflects important aspects of their short-term nutritional intakes (e.g., overall nutritional intakes, being overweight or underweight). The second variable is an indicator of whether a student is anemic; since anemia is usually caused by iron-deficiency in one’s diet, this indicator helps assess whether boarding schools provide iron-sufficient meals to students. 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 [41]. Since the students involved in our study attend schools at altitudes of above 1000 m, 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) [42], which were used in a number of recent studies [43,44]: $Hb(\text{altitude adjusted}) = Hb(\text{unadjusted}) - 0.32 \times alt \times 0.0033 - 0.22 \times (alt \times 0.0033)^2$, with *alt* denoting altitude above sea level in meters.

As mentioned above, due to budgetary constraints, we were able to conduct physical examinations (measuring height, weight, and hemoglobin level) for only one half of the sampled students ($N = 3613$). Thus, information on BMI and anemia status is only available for these students. Table 2 presents the summary statistics of all of the variables used in the analysis.

Table 2. Summary statistics of variables, by boarding status.

Variables	Descriptions	Boarding		Not Boarding		Difference in Means (5) =(1)–(3)
		(1) Mean	(2) SD	(3) Mean	(4) SD	
<i>A. Outcome measures</i>						
DDS N	Diet Diversity Score (see Table 1 for its components)	4.78 2343	2.12	5.37 4785	2.11	−0.60 ***
Hungry during the day N	Dummy, =1 if feels hungry during the day	0.64 2431	0.48	0.65 4920	0.48	−0.01
Hungry in the evening N	Dummy, =1 if feels hungry in the evening	0.56 2421	0.50	0.46 4903	0.50	0.10 ***
BMI-for-age Anemia N	BMI-for-age z-score Dummy, =1 if being anemic	−0.80 0.30 1173	0.89 0.46	−0.88 0.27 2440	0.95 0.44	0.08 ** 0.04 **
<i>B. Personal/family char.</i>						
Grade	Dummy, =1 for fifth graders (=0 for fourth graders)	0.60	0.49	0.48	0.50	0.12 ***
Gender	Dummy, =1 for boys	0.52	0.50	0.51	0.50	0.01
Age	Age in months	141.3	15.2	136.2	14.4	5.03 ***
Han	Dummy, =1 for Han ethnic students	0.32	0.47	0.37	0.48	−0.05 ***
Number of siblings	Number of siblings a student has	2.45	1.34	2.44	1.26	0.01
Father's education	Father's years of schooling	5.97	3.68	6.75	3.78	−0.78 ***
Mother's education	Mother's years of schooling	3.23	3.65	3.92	4.05	−0.69 ***
Migrant father	Dummy, =1 if one's father is a migrant worker	0.48	0.50	0.50	0.50	−0.02
Migrant mother	Dummy, =1 if one's mother is a migrant worker	0.20	0.40	0.18	0.38	0.02 **
Asset holding	The log of the value of household assets (in yuan)	8.84	1.36	8.81	1.58	0.03
Distance to school	Distance from home to school (km)	3.69	3.57	1.73	2.36	1.96 ***
N		2448		4974		

Notes: 1. Source: author's survey. 2. *** $p < 0.01$, ** $p < 0.05$.

3. Estimation Framework

As a starting point, consider a statistical model that links a nutrition-related outcome (*Outcome*) of a generic student, say, DDS or BMI-for-age, and this student's boarding status (a dummy for *Boarding*):

$$Outcome = \beta_0 + \beta_1 \times Boarding + C\beta_2 + F\beta_3 + S\beta_4 + u \quad (1)$$

In Equation (1), other determinants of the outcome variable include a set of personal characteristics (C) such as age and gender, family characteristics (F) such as parental education and family wealth, school characteristics (S) such as cafeteria and dormitory conditions, as well as influences of unobserved factors captured by the error term u . If Equation (1) is correctly specified, then parameter β_1 measures the causal effect of boarding on the outcome of interest, which can be estimated by ordinary least squares (OLS) technique applied to the sample.

However, there are a number of problems that may lead to bias in the OLS estimate of β_1 . First, there may be some unobserved factors that affect both the boarding status and nutritional outcomes of the students, causing omitted variable bias in the estimate. Unobserved health endowment is one such factor. Genetically healthier children might have better nutritional outcomes because they need not spend as much energy fighting illnesses as do less healthy children. Compared to their less healthy counterparts, healthier children are also more likely to be enrolled as boarding students, because they need relatively less parental care. Thus, the omission of health endowment in the model may lead to an upward bias in the OLS estimate of β_1 . Second, there may be reverse causality operated from students' nutritional outcomes to their boarding status. For example, some parents, especially those who are relatively wealthy, may be concerned that the lack of parental care will undermine their children's nutritional status and thus decide not to register their children as boarding students. Such a decision will lead to a downward bias in the OLS estimate of β_1 . Since these problems can lead to biases in different directions, the ultimate direction of bias is theoretically ambiguous.

A standard solution is to find a source of exogenous variation in students' boarding status to identify the impact of boarding. Following the recent study by Li et al. [45], which adopted a strategy that is in the spirit of Card's seminal study [46], we use students' home-to-school distance (*Distance*, in log) as an instrument variable for their boarding status. To the extent that home-to-school distance is strongly correlated with students' boarding status (see Table 2, Panel B, and below) but does not directly affect their nutritional outcomes (this assumption will be relaxed below), it serves as a plausible candidate instrumental variable for *Boarding*. More specifically, we estimate Equation (1) together with the following first-stage regression equation in a two-stage least squares (2SLS) framework:

$$Boarding = \gamma_0 + \gamma_1 \times Distance + C\gamma_2 + F\gamma_3 + S\gamma_4 + v \quad (2)$$

Note that while geographic proximity has been widely exploited to construct instrument variables for schooling-related variables [45–48], there are three potential problems with this instrument variable 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 which case distance to school may pick up influences of unobserved school characteristics, such as, say, the quality of food supplied at school. Second, long distance suggests that some students may choose to attend (perhaps better) schools in other school districts where they do not belong. Third, long distance may reflect the remoteness of one's home location and the surrounding community, which may have a direct impact on one's nutritional status, since remoteness is likely to be correlated with the availability of nutritious foods.

To address the first problem, we replace the set of school characteristics (S) with a set of school fixed effects (FEs) in estimating equations (1) and (2). The conditioning on school FEs implies that the impact of distance on students' boarding status captured in the first-stage regression (Equation (2)) comes from within-school contrasts (as opposed to between-school contrasts) between students with different home-to-school distances. This approach also effectively controls for the influences of all

of the variables (observed or unobserved) that vary at the school level. Formally, we estimate the following two equations by 2SLS in the analysis:

$$Outcome = \beta_0 + \beta_1 \times Boarding + C\beta_2 + F\beta_3 + \sum \beta_{4k} D_k + u \quad (3)$$

$$Boarding = \gamma_0 + \gamma_1 \times Distance + C\gamma_2 + F\gamma_3 + \sum \gamma_{4k} D_k + v \quad (4)$$

where D_k is a dummy variable for school k in the sample.

Note that this conditioning approach can address neither the second problem (i.e., selection into non-local schools) nor the third problem (i.e., potential correlation between distance and remoteness of home locality). One solution is to find another suitable instrumental variable to facilitate an overidentification test. Unfortunately, this solution is not feasible given our available data. As an alternative, we address the second and the third problems indirectly by estimating the impact of boarding using observations within different ranges of home-school distance (e.g., <25 km, <20 km, <15 km, and <10 km). With regard to the second problem, the exclusion of students with long home-school distances from the analytical sample greatly reduces the concern of cross-district school selection, in that when the home-to-school distance is relatively short, say <10 km, the probability that a student attends a school in another school district is minimal. As far as the third problem is concerned, if remoteness is negatively correlated with food abundance at one's home location, foods at school are likely to be more abundant; this would predict an upward bias (i.e., more positive or less negative) in the instrument variable estimate of the impact of boarding (β_1). Thus, bias will be detected if we see a decline (i.e., less positive or more negative) in the instrument variable estimate of β_1 when the range of home-school distance is narrowed.

The next section discusses the results obtained by applying these approaches. All of the results discussed below are obtained using the Statistical/Data Analysis software package STATA 14. Estimates with a p -value ≤ 0.1 are considered significant.

4. Results

4.1. Descriptive Analysis

Before turning to our regression results, it is helpful to examine the descriptive statistics of the sample. Presenting summary statistics of all of the variables used in the analysis, Table 2 reveals a number of notable observations. First of all, there are significant differences in the dietary pattern between boarding and non-boarding students (Table 2, Panel A). Measured by the DDS, boarding students' dietary structure (mean DDS = 4.78/10) is significantly less diverse compared with non-boarding students' (mean DDS = 5.37/10). Yet interestingly, boarding students' less-diverse dietary structure does not lead to a decline in their body weight. In fact, their BMI-for-age z-scores (−0.80) are significantly higher than non-boarding students' (−0.88). However, boarding students' (less-diverse) diet structure does seem to undermine their dietary health to some extent; they are more likely to be anemic (30%) compared with non-boarding students (27%), suggesting the possibility of iron deficiency in the former's diet.

Note that these differences can only be interpreted as suggestive, as they are observed without controlling for the influence of potential confounding factors. In fact, boarding and non-boarding students are not directly comparable because there are many other differences between them. For example, Panel B of Table 2 suggests that boarders are in general older, more likely to belong in a non-Han ethnic group, and living farther away from school; their parents are also relatively less educated (5.97 years of education for their fathers and 3.23 years for their mothers) than non-boarding students' parents (6.75 years of education for their fathers and 3.92 years for their mothers). These observations suggest that in order to obtain more reliable estimates of the impacts of boarding, rigorous analysis that controls for the influences of confounding factors is needed. The following subsections report and discuss our regression results.

4.2. Impacts of Home-To-School Distance on Boarding

First, we turn to the results of the first-stage regressions, which are reported in Table 3. Using the full sample (with distance <25 km) in estimation, column (1) suggests a significantly positive impact of (the log of) distance to school on a student's probability of being a boarder. Other things being equal, doubling the home-to-school distance (i.e., a 100% increase in distance) raises the probability of boarding by 10.1%. The results remain very similar when the home-to-school distance is restricted to be <20 km, <15 km, and <10 km in columns (2)–(4). Also, recall that we collected information on BMI and Hb concentration level for only one-half of the sampled students. Yet restricting the sample to include only students with available BMI and Hb information yields a very similar result (column 5). F-tests for the significance of the instrumental variable (i.e., distance to school, in log) in these models yield F-statistics that are generally larger than 120, suggesting little concern of weak instrumental variable problems [49].

Table 3. Results of first-stage regressions. BMI: body mass index, FE: fixed effects, Hb: hemoglobin.

Outcome Variables	(1)	(2)	(3)	(4)	(5)
	Boarding	Boarding	Boarding	Boarding	Boarding
Sample	All (Distance < 25 km)	All (Distance < 20 km)	All (Distance < 15 km)	All (Distance < 10 km)	with BMI/Hb Information (Distance < 25 km)
Distance in log	0.101 *** (0.008)	0.101 *** (0.008)	0.101 *** (0.009)	0.101 *** (0.009)	0.098 *** (0.010)
Grade	0.062 ** (0.025)	0.063 ** (0.025)	0.066 *** (0.025)	0.061 ** (0.025)	0.065 ** (0.027)
Boy	−0.012 (0.010)	−0.012 (0.010)	−0.011 (0.010)	−0.011 (0.010)	0.001 (0.015)
Age	0.002 *** (0.000)	0.002 *** (0.000)	0.002 *** (0.000)	0.002 *** (0.000)	0.002 *** (0.001)
Han	0.001 (0.035)	0.002 (0.035)	0.003 (0.036)	0.003 (0.036)	0.029 (0.043)
Number of siblings	−0.003 (0.006)	−0.003 (0.006)	−0.003 (0.006)	−0.004 (0.005)	−0.007 (0.007)
Father's education	−0.003 * (0.002)	−0.003 * (0.002)	−0.003 * (0.002)	−0.003 (0.002)	−0.005 ** (0.002)
Mother's education	−0.002 (0.001)	−0.002 (0.001)	−0.002 (0.001)	−0.002 (0.001)	−0.001 (0.002)
Migrant father	−0.015 (0.013)	−0.015 (0.013)	−0.016 (0.013)	−0.016 (0.013)	−0.013 (0.016)
Migrant mother	0.005 (0.014)	0.004 (0.014)	0.006 (0.014)	0.012 (0.014)	−0.012 (0.018)
Asset holding in log	0.005 (0.004)	0.005 (0.004)	0.005 (0.004)	0.005 (0.004)	0.000 (0.004)
Constant	0.202 ** (0.076)	0.200 ** (0.076)	0.204 *** (0.077)	0.220 *** (0.080)	0.354 *** (0.090)
School FEs	Yes	Yes	Yes	Yes	Yes
N	7128	7102	7037	6819	3613
R ²	0.283	0.282	0.281	0.274	0.294

Notes: 1. Robust standard errors in parentheses, adjusted for clustering at the school level. 2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Somewhat surprisingly, the only other explanatory variables that have statistically significant predictive power for one's boarding status are age, grade, and father's education. What's more, the impact of father's education disappears when we focus on students whose home-to-school distances are less than 10 km. The lack of impact of parental education might be due to the low level of parental education in our sample (Table 2), but it could also mean that students' boarding status is not manipulated by their parents, and is thus likely to be exogenously determined.

4.3. Impacts of Boarding on Dietary Structure

Turning to the first set of our main findings, columns (1) and (2) of Table 4 report a statistically significant and negative impact of boarding on students' dietary diversity, as measured by their

DDS scores. OLS and 2SLS estimates point in the same direction. They suggest that out of the 10 food categories involved in the DDS (Table 1, column 2), boarding students consume 0.41–0.64 fewer categories a day than non-boarding students, all other things being equal. [The estimated impacts of other explanatory variables make intuitive sense. For example, household asset holding, parents' education, and their migration status all have positive impacts on students' DDS scores.]

Table 4. Estimated impacts of boarding on students' dietary diversity and adequacy. OLS: ordinary least squares, 2SLS: two-stage least squares.

Outcome Variables	Dietary Diversity		Dietary Adequacy			
	DDS		Feeling Hungry during the Day		Feeling Hungry in the Evening	
Method	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
Boarding	−0.394 *** (0.093)	−0.663 *** (0.229)	0.016 (0.014)	0.081 (0.050)	0.100 *** (0.019)	0.118 ** (0.052)
Grade	0.090 (0.110)	0.105 (0.105)	0.068 *** (0.017)	0.064 *** (0.017)	0.028 * (0.016)	0.027 * (0.016)
Boy	0.014 (0.042)	0.010 (0.042)	0.016 (0.011)	0.016 (0.011)	0.023 * (0.013)	0.023 * (0.013)
Age	0.003 (0.002)	0.004 (0.002)	−0.000 (0.000)	−0.001 (0.000)	0.001 (0.001)	0.001 (0.001)
Han	−0.101 (0.118)	−0.100 (0.113)	0.010 (0.019)	0.010 (0.019)	−0.010 (0.026)	−0.010 (0.026)
Number of siblings	−0.023 (0.023)	−0.022 (0.022)	−0.004 (0.005)	−0.004 (0.005)	0.003 (0.005)	0.003 (0.005)
Father's education	0.012 (0.007)	0.010 (0.007)	0.001 (0.002)	0.002 (0.002)	0.001 (0.002)	0.001 (0.002)
Mother's education	0.017 ** (0.006)	0.016 ** (0.006)	−0.005 ** (0.002)	−0.004 ** (0.002)	0.000 (0.002)	0.000 (0.002)
Migrant father	0.059 (0.049)	0.054 (0.049)	0.004 (0.012)	0.005 (0.012)	0.010 (0.014)	0.010 (0.013)
Migrant mother	0.137 * (0.075)	0.136 * (0.074)	−0.010 (0.017)	−0.010 (0.016)	0.016 (0.015)	0.016 (0.015)
Asset holding in log	0.049 *** (0.016)	0.050 *** (0.016)	0.002 (0.004)	0.002 (0.004)	0.002 (0.004)	0.002 (0.004)
Constant	5.716 *** (0.316)	5.749 *** (0.319)	0.616 *** (0.065)	0.610 *** (0.064)	0.323 *** (0.073)	0.320 *** (0.073)
School FEs	Yes	Yes	Yes	Yes	Yes	Yes
N	7128	7128	7351	7351	7324	7324
R ²	0.149	0.146	0.052	0.049	0.038	0.038

Notes: 1. The analytical sample includes students with home-to-school distance <25 km. 2. Robust standard errors in parentheses, adjusted for clustering at the school level. 3. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

To further see which food categories are being reduced from boarding students' daily diet, we estimate the impact of boarding on students' consumption of each specific food category involved in the DDS. Based on a linear probability model, OLS estimates (Table 5, column 3) suggest that boarding significantly reduces students' probability of consumption for eight of the 10 DDS-related food categories, with the two exceptions being grains and tubers. For example, boarding is estimated to reduce students' probability of consuming fruits by 9.0% and their probability of consuming flesh meat by 7.5%. While the corresponding 2SLS estimates (Table 5, column 4) are less significant, these estimates are quite comparable to their OLS counterparts both in sign and in size; standard Wu–Durbin–Hausman endogeneity tests detect virtually no significant differences between OLS (Table 5, column 3) and 2SLS point estimates (Table 5, column 4) at levels below 5%. In fact, 2SLS regressions manage to detect significant reductions (at the 10% level) in the consumption of five food categories (i.e., vegetables, fruits, flesh meat, fish, and bean products) due to boarding.

Table 5. Estimated impacts of boarding on students' dietary diversity and adequacy.

Outcome Variables	Consumption of Specific Food Items in the Past 24 h				Frequency of Consumption in the Past 24 h			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Method	Non-Boarding Mean	Raw Differences in Means	OLS	2SLS	Non-Boarding Mean	Raw Differences in Means	OLS	2SLS
Grains	0.959 [0.199]	0.001 (0.005)	0.005 (0.006)	−0.020 (0.018)	2.654 [1.789]	0.184 *** (0.045)	0.210 *** (0.056)	0.332 ** (0.145)
Tubers	0.712 [0.453]	0.001 (0.011)	0.013 (0.016)	0.010 (0.047)	1.483 [1.554]	0.020 (0.039)	0.091 * (0.047)	0.237 (0.150)
Vegetables	0.833 [0.373]	−0.077 *** (0.010)	−0.043 ** (0.017)	−0.080 * (0.041)	3.129 [3.181]	−0.347 *** (0.080)	−0.075 (0.101)	−0.096 (0.333)
Fruits	0.842 [0.365]	−0.135 *** (0.010)	−0.090 *** (0.017)	−0.156 *** (0.041)	2.871 [2.609]	−0.564 *** (0.066)	−0.302 *** (0.080)	−0.528 * (0.306)
Flesh meat	0.493 [0.500]	−0.066 *** (0.013)	−0.075 *** (0.024)	−0.130 *** (0.054)	0.961 [1.915]	−0.113 *** (0.035)	−0.099 ** (0.045)	−0.132 (0.111)
Other meat	0.256 [0.437]	−0.056 *** (0.011)	−0.035 *** (0.012)	−0.021 (0.043)	0.396 [0.815]	−0.106 *** (0.019)	−0.077 *** (0.021)	−0.029 (0.078)
Fish	0.132 [0.339]	−0.050 *** (0.008)	−0.034 *** (0.011)	−0.070 ** (0.032)	0.207 [0.625]	−0.082 *** (0.015)	−0.047 ** (0.018)	−0.103 * (0.057)
Eggs	0.309 [0.462]	−0.046 *** (0.011)	−0.034 * (0.018)	−0.058 (0.054)	0.434 [0.778]	−0.067 *** (0.019)	−0.037 (0.023)	−0.032 (0.074)
Dairy products	0.347 [0.476]	−0.072 *** (0.012)	−0.048 *** (0.017)	−0.033 (0.041)	0.555 [0.953]	−0.116 *** (0.023)	−0.062 ** (0.028)	0.041 (0.083)
Bean products/nuts	0.484 [0.500]	−0.089 *** (0.013)	−0.050 ** (0.022)	−0.093 * (0.051)	0.928 [1.340]	−0.136 *** (0.033)	−0.031 (0.047)	−0.151 (0.121)
N	4785	4785/2343	7128	7128	4785	4785/2343	7128	7128

Notes: 1. The analytical sample includes students with home-to-school distance <25 km. 2. Standard deviations in brackets; robust standard errors in parentheses, adjusted for clustering at the school level. 3. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

As pointed out above, information merely on whether one consumes a food category (and hence the resulting DDS) may mask a potential inadequacy of the amount of food consumed. Indeed, by estimating the impact of boarding on the consumption *frequency* of each food category involved (see columns 5 and 6 for summary statistics of these variables), columns (7) and (8) of Table 5 reveal that boarders consume grains and tubers significantly more frequently than non-boarders, which were not detected when we focused on examining the consumption probability of each food category in columns (3) and (4) of Table 5. These differences suggest that schools may perform substitutions between food diversity and food quantity when providing food to boarding students.

4.4. Impacts of Boarding on Dietary Adequacy and Nutritional Status

Do these substitutions affect students' dietary adequacy and nutritional status? Since our data do not contain direct information on students' overall energy (calorie) intakes, we rely on two sets of indirect measures to answer this question. The first set concerns whether boarding students are more likely to feel hungry in class during the day (Table 4, columns 3 and 4) and in the evening when going to bed (Table 4, columns 5 and 6) than their non-boarding counterparts. Both OLS and 2SLS estimates indicate that, all other things being equal, boarding students are more likely to feel hungry in the evening than non-boarding counterparts, although not during the day.

The second set includes two measures of students' nutritional status, BMI-for-age z-scores and the probability of being anemic, both of which are outcomes of their short-term nutrition intakes. In our sample, using BMI cut-off points recommended by the World Health Organization (WHO) [50], 10.52% of the students were characterized as being underweight (BMI < -2 standard deviations of the BMI-for-age z-score) and 2.24% were characterized as being overweight (BMI > +1 standard deviation of the BMI-for-age z-score); there are also 27.97% who suffered from anemia. While there is some evidence that boarding leads to an increase in students' BMI-for-age z-scores (Table 6, Panel A, columns 1 and 2), there is also evidence that it raises the incidence of anemia among students (Table 6, Panel A, columns 3 and 4). One might be concerned that the impact on BMI and the impact on anemia are estimated based on a much smaller sample, which may not be comparable to the full sample. Yet this concern is negligible, because the results on the DDS obtained using the sample with BMI and anemia information available (Table 6, Panel A, columns 5 and 6) are quite comparable to their counterparts obtained using the full sample (Table 4, columns 1 and 2).

Table 6. Estimated impacts of boarding on student's nutritional status.

Outcome Variables	BMI-for-Age		Anemia		DDS	
	(1)	(2)	(3)	(4)	(5)	(6)
Method	OLS	2SLS	OLS	2SLS	OLS	2SLS
<i>A. Distance < 25 km</i>						
Boarding	0.174 *** (0.039)	0.117 (0.137)	0.029 * (0.015)	0.111 ** (0.051)	-0.467 *** (0.115)	-0.844 *** (0.271)
N	3613	3613	3613	3613	3475	3475
R ²	0.153	0.153	0.274	0.269	0.169	0.163
<i>B. Distance < 20 km</i>						
Boarding	0.170 *** (0.040)	0.088 (0.139)	0.028 * (0.016)	0.107 ** (0.052)	-0.466 *** (0.115)	-0.851 *** (0.275)
N	3600	3600	3600	3600	3463	3463
R ²	0.154	0.152	0.275	0.269	0.168	0.163
<i>C. Distance < 15 km</i>						
Boarding	0.173 *** (0.040)	0.066 (0.141)	0.026 (0.016)	0.096 * (0.052)	-0.458 *** (0.115)	-0.789 *** (0.283)
N	3569	3569	3569	3569	3433	3433
R ²	0.154	0.152	0.276	0.272	0.169	0.165

Table 6. Cont.

Outcome Variables	BMI-for-Age		Anemia		DDS	
	(1)	(2)	(3)	(4)	(5)	(6)
Method	OLS	2SLS	OLS	2SLS	OLS	2SLS
<i>D. Distance < 10 km</i>						
Boarding	0.177 *** (0.038)	0.040 (0.141)	0.024 (0.016)	0.102 * (0.060)	−0.456 *** (0.112)	−0.775 *** (0.295)
N	3466	3466	3466	3466	3331	3331
R ²	0.158	0.155	0.276	0.271	0.172	0.168

Notes: 1. Robust standard errors in parentheses, adjusted for clustering at the school level. 2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Taken together, the above observations suggest two important patterns of food supply at rural schools. First, while schools manage to provide boarding students with sufficient food and energy, they may have to sacrifice diversity for quantity to some extent. In particular, although the increased grain consumption helps keep boarding students' body weight from dropping, the reductions in fruit and meat consumption impose some risks of anemia among boarding students. Second, perhaps due to the difference in the timing of food supply, boarding students are more likely to feel hungry in the evening, even though they have sufficient food intake, measured by their BMI-for-age z-scores. After all, students who feel hungry in the evening can find food at home, but may find it difficult to find food at school after the cafeteria is closed.

4.5. Robustness Checks and Heterogenous Effects of Boarding

It is important to ascertain whether the two patterns discussed above are sensible hinges on the reliability of our estimates. As discussed in Section 3, the major threats to our estimation are the potential correlation between home-to-school distance and the remoteness of one's home location, and the correlation between the distance to school and school selection across school districts. Both of these correlations may lead to a correlation between home-to-school distance and the error term in Equation (1), thereby undermining the validity of home-to-school distance as an invalid instrument variable for students' boarding status. To reduce these problems (and assess how these problems might affect our estimates), we re-estimate the models for the outcome variables of primary interest, i.e., DDS, BMI, and the probability of anemia, using subsamples with narrower ranges of home-to-school distance (i.e., <20 km, <15 km, and <10 km). As shown in panels B-D of Table 6, the instrumental variable estimates remain quite close to those reported in Panel A of Table 6, suggesting little concern of the two potential threats.

Finally, it is worth exploring how the impact of boarding may differ with students' gender, ethnicity, grade attended, and family background, in order to gain a deeper understanding of how boarding leads to its effects. The results reported in Table 7 suggest that while boarding has a significantly negative impact on dietary diversity for almost all of the subgroups, its impact on the incidence of anemia is more heterogeneous. More specifically, children with relatively more advantageous backgrounds, e.g., boys (Panel B), fifth graders (Panel D), children from families with higher levels of asset holding (Panel J), and children from Ningxia (which has a higher GDP per capita than Qinghai; Panel N), are more likely to be anemic while boarding. This suggests that for these more advantageous groups of students, schools fail to serve as a perfect substitute for their families in supplying nutritious foods, although these students are able to eat more at schools (measured by their BMI-for-age z-scores).

Table 7. Estimated impacts of boarding on student's nutritional status.

Outcome Variables	(1)	(2)	(3)	(4)	(5)	(6)
	BMI-for-Age	Anemia	DDS	BMI-for-Age	Anemia	DDS
	<i>A. Girls</i>			<i>B. Boys</i>		
Boarding	−0.044 (0.181)	0.012 (0.082)	−0.984 ** (0.421)	0.258 (0.174)	0.202 ** (0.084)	−0.699 * (0.380)
N	1729	1729	1705	1803	1803	1770
R ²	0.140	0.294	0.176	0.199	0.256	0.187
	<i>C. Fourth grade</i>			<i>D. Fifth grade</i>		
Boarding	−0.053 (0.196)	0.100 (0.087)	−1.329 *** (0.371)	0.155 (0.176)	0.148 ** (0.058)	−0.569 (0.349)
N	1734	1734	1716	1798	1798	1759
R ²	0.185	0.290	0.185	0.164	0.291	0.222
	<i>E. Ethnic minority</i>			<i>F. Ethnic Han</i>		
Boarding	0.126 (0.152)	0.098 (0.066)	−0.664 ** (0.321)	0.053 (0.279)	0.119 (0.097)	−1.068 * (0.576)
N	2301	2301	2271	1231	1231	1204
R ²	0.167	0.316	0.182	0.183	0.152	0.193
	<i>G. Mother's years of schooling < 6</i>			<i>H. Mother's years of schooling ≥ 6</i>		
Boarding	0.184 (0.181)	0.129 (0.085)	−0.806 ** (0.338)	0.078 (0.188)	0.067 (0.081)	−0.869 ** (0.367)
N	1751	1751	1723	1781	1781	1752
R ²	0.184	0.333	0.179	0.160	0.236	0.179
	<i>I. Household asset < median</i>			<i>J. Household asset ≥ median</i>		
Boarding	0.175 (0.200)	0.083 (0.060)	−0.780 ** (0.345)	0.079 (0.179)	0.145 * (0.082)	−0.685 * (0.402)
N	1754	1754	1735	1778	1778	1740
R ²	0.154	0.279	0.149	0.191	0.289	0.215
	<i>K. Qinghai</i>			<i>L. Ningxia</i>		
Boarding	0.493 (0.363)	0.118 (0.182)	−0.351 (0.722)	0.001 (0.142)	0.107 ** (0.046)	−1.009 *** (0.279)
N	1221	1221	1198	2311	2311	2277
R ²	0.146	0.333	0.196	0.091	0.112	0.153

Notes: 1. Robust standard errors in parentheses, adjusted for clustering at the school level. 2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Concluding Remarks

While “boarding schools for the poor” have recently emerged as a new policy instrument for achieving educational equity in western countries, China has been constructing boarding schools to accommodate its poor rural students for nearly two decades. Since the implementation of a national School Merger program in 2001, boarding schools have become a major platform for providing and managing rural education in China. While the impact of boarding on students' cognitive development has attracted increasing attention from both the academia and the policy circle, little has been done to understand how boarding affects students' food consumption behavior and their nutritional status, which may be a channel through which boarding affects students' cognitive development.

Exploiting exogenous variations in students' home-to-school distance to identify the causal effect of boarding in rural northwestern China, this study yields two important findings. Firstly, while rural schools manage to provide boarding students with sufficient calories, they sacrifice dietary balance for dietary adequacy to some extent. Boarders are found to consume significantly less protein-rich food and significantly more carbohydrate-rich food than their non-boarding counterparts. The only

insignificant differences are found in the consumption of grains and tubers, presumably because these two food items are widely accessible in rural northwestern China. Although such a dietary structure slightly increases boarders' BMI-for-age z-scores, it also significantly increases their probability of being anemic. Secondly and perhaps more importantly, the increase in the probability of being anemic is more likely to be observed among students with more advantageous backgrounds, which suggests that for these students, rural schools fail to serve as a perfect substitute for their families in supplying nutritious foods. In parallel, this also suggests that the health status of students with more disadvantageous backgrounds is relatively poor; thus, boarding does not significantly affect their chance of being anemic.

These findings have profound implications. In particular, diet imbalance caused by boarding, as well as the resulting negative effects on rural students' health (i.e., reduced protein intake, increased carbohydrate, and increased risk of anemia), may lead to other problems that we are unable to investigate in this study. For example, reduced protein consumption may result in an insufficient intake of amino acids, which may in turn lead to muscle wasting and physical weakness. It may also undermine student's immune system (because protein is a key component of one's immune system) and bone health (because protein intake can help increase calcium absorption) [51]. Meanwhile, the increased consumption of refined carbohydrates may raise one's blood glucose levels, resulting in an increased risk of type 2 diabetes [52]. Also, child anemia has been found to be negatively correlated with educational outcomes such as grades, attendance, and test scores [53–55]. Thus, an immediate policy implication is for rural schools to provide more balanced, nutritious meal plans to boarding students, which is expected to greatly help improve their academic performance, health, and even future labor-market outcomes. It is comforting to see that some western Chinese provinces, such as Shanxi, have started to investigate dining conditions in rural schools, aiming to "standardize the process of school-meal supply, maintain a high level of food safety at school, and promote diet balance among students" [56]. Further research that examines the educational management–nutrition/health–academic performance nexus is also likely to be fruitful in the context of rural China.

Author Contributions: Conceived and designed the experiments: Q.C.; Performed the experiments: Q.C.; Q.Z.; Analyzed the data: C.P.; Q.Z.; Contributed reagents/materials/analysis tools: Q.C.; Q.Z.; Wrote the paper: Q.C.; Q.Z.; C.P.

Funding: This research was funded by the National Science Foundation of China, grant number [71603261], the Ministry of Education of China Humanities and Social Science project, grant number [18YJC790010] and the Fundamental Research Funds for the Central Universities grant number [2018JG001, 2018QC066].

Acknowledgments: The authors thank the three anonymous reviewers for their helpful comments on an earlier version of this article. We are grateful for supports from of the Center for Food and Health Economic Research (CFHER) at the China Agricultural University for their helpful comments. We also thank Mengqi Cui and Haoze Li for excellent research assistance. All remaining errors are ours.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Attane, I. China's Family Planning Policy: An Overview of Its Past and Future. *Stud. Fam. Plann.* **2002**, *33*, 103–113. [[CrossRef](#)] [[PubMed](#)]
2. Feeney, G.; Wang, F.; Zhou, M.; Xiao, B. Recent Fertility Dynamics in China: Results from the 1987 One Percent Population Survey. *Popul. Dev. Rev.* **1989**, *15*, 297. [[CrossRef](#)]
3. 2010 Sixth National population census data Gazette. Available online: http://www.gov.cn/test/2012-04/20/content_2118413.htm (accessed on 2 May 2018).
4. National Bureau of Statistics. *China Statistical Yearbook*; China Statistical Press: Beijing, China, 2011.
5. All-China Women's Federation. A study of the situation of left-behind children and migrant children in rural China. 2013. (In Chinese)

6. Wang, L. Exploring how to improve quality of small rural schools—a summary of experiences from a bottom-up approach. In *Annual Report on China's Education*; Yang, D., Yang, M., Huang, S., Eds.; Social Sciences Academic Press: Beijing, China, 2017; (In Chinese). ISBN 978-7-5201-0552-1.
7. State Council. Decision on Reforming and Developing the Basic Education Sector. 2001. Available online: http://old.moe.gov.cn/publicfiles/business/htmlfiles/moe/moe_16/200105/132.html (accessed on 2 May 2018).
8. Ministry of Education. The Ministry of Education's rEsponse to Recommendation 1207 of the Fourth Session of the 12th National People's Congress. 2016. Available online: http://www.moe.edu.cn/jyb_xxgk/xxgk_jyta/jyta_jcys/201610/t20161019_285634.html (accessed on 10 June 2018).
9. State Council. Guidance on Comprehensively Strengthening the Construction of Small Rural Schools and Boarding Schools in Townships and Towns. 2018. Available online: http://www.gov.cn/xinwen/2018-05/02/content_5287481.htm (accessed on 9 June 2018).
10. Yue, A.; Tang, B.; Shi, Y.; Tang, J.; Shang, G.; Medina, A.; Rozelle, S. Rural education across China's 40 years of reform: Past successes and future challenges. *China Agric. Econ. Rev.* **2018**, *10*, 93–118. [[CrossRef](#)]
11. Piernas, C.; Wang, D.; Du, S.; Zhang, B.; Wang, Z.; Su, C.; Popkin, B.M. Obesity, non-communicable disease (NCD) risk factors and dietary factors among Chinese school-aged children. *Asia Pac. J. Clin. Nutr.* **2016**, *25*, 826–840. [[CrossRef](#)] [[PubMed](#)]
12. Liang, R. Fighting Rural Child Malnutrition in China. UNICEF East Asia Pacific. WWW Document. 2013. Available online: http://www.unicef.org/eapro/media_20532.html (accessed on 9 March 2018).
13. Luo, R.; Kleiman-Weiner, M.; Rozelle, S.; Zhang, L.; Liu, C.; Sharbono, B.; Shi, Y.; Yue, A.; Martorell, R.; Lee, M. Anemia in Rural China's Elementary Schools: Prevalence and Correlates in Shaanxi Province's Poor Counties. *Ecol. Food Nutr.* **2010**, *49*, 357–372. [[CrossRef](#)] [[PubMed](#)]
14. Luo, R.; Zhang, L.; Liu, C.; Zhao, Q.; Shi, Y.; Miller, G.; Yu, E.; Sharbono, B.; Medina, A.; Rozelle, S.; et al. Anaemia among Students of Rural China's Elementary Schools: Prevalence and Correlates in Ningxia and Qinghai's Poor Counties. *J. Health Popul. Nutr.* **2011**, *29*. [[CrossRef](#)]
15. Chen, Y.S.; Zhang, Y.M.; Kong, Z.X.; Yu, J.J.; Sun, T.T.; Zhang, H.Y. The prevalence of overweight and obesity in children and adolescents in China. *Chin. J. Dis. Control. Prev.* **2017**, *21*, 866–869. (In Chinese)
16. Currie, J. Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development. *J. Econ. Lit.* **2009**, *47*, 87–122. [[CrossRef](#)]
17. Glewwe, P.; Miguel, E.A. Chapter 56 The Impact of Child Health and Nutrition on Education in Less Developed Countries. In *Handbook of Development Economics*; Elsevier: New York, NY, USA, 2007; Volume 4, pp. 3561–3606, ISBN 978-0-444-53100-1.
18. Behaghel, L.; de Chaiseartine, C.; Gurgand, M. *Ready for Boarding? The Effects of a Boarding School for Disadvantaged Students*; Warwick Economics Research Paper No. 1059; University of Warwick: Coventry, UK, 2015.
19. Curto, V.E.; Fryer, R.G. The Potential of Urban Boarding Schools for the Poor: Evidence from SEED. *J. Labor Econ.* **2014**, *32*, 65–93. [[CrossRef](#)]
20. Shu, B.; Tong, Y. Boarding at school and students' well-being: The case of rural China. In Proceedings of the Population Association of America 2015 Annual Meeting, San Diego, CA, USA, 30 April–2 May 2015.
21. Wang, A.; Medina, A.; Luo, R.; Shi, Y.; Yue, A. To Board or Not to Board: Evidence from Nutrition, Health and Education Outcomes of Students in Rural China. *China World Econ.* **2016**, *24*, 52–66. [[CrossRef](#)]
22. Fang, Z.; Tang, Z.; Wang, Q.; Liu, Z.; Yang, H.; Jiang, Y.; Liu, X.; Huang, K.; Lu, W. Student's nutrition status of students in boarding schools in poor areas of Guangxi province in 2010. *Chin. J. School Health* **2012**, *33*, 205–206. (In Chinese)
23. Luo, R.; Shi, Y.; Zhang, L.; Liu, C.; Rozelle, S.; Sharbono, B. Malnutrition in China's rural boarding schools: The case of primary schools in Shaanxi Province. *Asia Pac. J. Educ.* **2009**, *29*, 481–501. [[CrossRef](#)]
24. Adroque, C.; Orilicki, M.E. Do in-school feeding programs have an impact on academic performance? The case of public schools in Argentina. *Educ. Policy Anal. Arch.* **2013**, *21*, 1–23. Available online: <http://www.redalyc.org/articulo.oa?id=275029728050> (accessed on 29 July 2018).
25. Kazianga, H.; de Walque, D.; Alderman, H. Educational and Child Labour Impacts of Two Food-for-Education Schemes: Evidence from a Randomised Trial in Rural Burkina Faso. *J. Afr. Econ.* **2012**, *21*, 723–760. [[CrossRef](#)]
26. McEwan, P.J. The impact of Chile's school feeding program on education outcomes. *Econ. Educ. Rev.* **2013**, *32*, 122–139. [[CrossRef](#)]

27. Singh, A.; Park, A.; Dercon, S. School Meals as a Safety Net: An Evaluation of the Midday Meal Scheme in India. *Econ. Dev. Cult. Change* **2014**, *62*, 275–306. [[CrossRef](#)]
28. Arendt, J.N. Does education cause better health? A panel data analysis using school reforms for identification. *Econ. Educ. Rev.* **2005**, *24*, 149–160. [[CrossRef](#)]
29. Groot, W.; Maassen van den Brink, H. The health effects of education. *Econ. Educ. Rev.* **2007**, *26*, 186–200. [[CrossRef](#)]
30. Braakmann, N. The causal relationship between education, health and health related behaviour: Evidence from a natural experiment in England. *J. Health Econ.* **2011**, *30*, 753–763. [[CrossRef](#)] [[PubMed](#)]
31. Parinduri, R.A. Does Education Improve Health? Evidence from Indonesia. *J. Dev. Stud.* **2017**, *53*, 1358–1375. [[CrossRef](#)]
32. FAO (Food and Agriculture Organization of United Nations). Guidelines for Measuring Household and Individual Dietary Diversity, Version 4. Available online: http://agrobiodiversityplatform.org/files/2011/05/guidelines_MeasuringHousehold.pdf (accessed on 4 August 2018).
33. He, Y.; Zhai, F.; Yang, X.; Ge, K. The Chinese Diet Balance Index Revised. *Acta Nutrimenta Sin.* **2009**, *31*, 532–536. (In Chinese)
34. Du, S.; Ma, G. Dietary guidelines for school-age children in China (2016) and its interpretation. *Acta Nutrimenta Sin.* **2017**, *39*, 1–4. (In Chinese)
35. National Bureau of Statistics. *China Statistical Yearbook*; China Statistical Press: Beijing, China, 2010.
36. National Bureau of Statistics. *China Statistical Yearbook*; China Statistical Press: Beijing, China, 2017.
37. Rozelle, S. Stagnation Without Equity: Patterns of Growth and Inequality in China's Rural Economy. *China J.* **1996**, *35*, 63–92. [[CrossRef](#)]
38. Ruel, M.; Graham, J.; Murphy, S.; Allen, L. *Validating Simple Indicators of Dietary Diversity and Animal Source Food Intake that Accurately Reflect Nutrient Adequacy in Developing Countries*; Report Submitted to GL-CRSP; Global Livestock Collaborative Research Support Program: Davis, CA, USA, 2004.
39. Steyn, N.; Nel, J.; Nantel, G.; Kennedy, G.; Labadarios, D. Food variety and dietary diversity scores in children: Are they good indicators of dietary adequacy? *Public Health Nutr.* **2006**, *9*, 644–650. [[CrossRef](#)] [[PubMed](#)]
40. Kennedy, G.L.; Pedro, M.R.; Seghieri, C.; Nantel, G.; Brouwer, I. Dietary Diversity Score Is a Useful Indicator of Micronutrient Intake in Non-Breast-Feeding Filipino Children. *J. Nutr.* **2007**, *137*, 472–477. [[CrossRef](#)] [[PubMed](#)]
41. WHO (World Health Organization). Iron Deficiency Anaemia: Assessment, Prevention, and Control. A Guide for Programme Managers. Available online: http://www.who.int/nutrition/publications/en/ida_assessment_prevention_control.pdf (accessed on 6 June 2018).
42. CDC (Centers for Disease Control and Prevention). Criteria for anemia in children and childbearing-aged women. *Morb. Mortal. Wkly. Rep.* **1989**, *38*, 400–404.
43. Nestel, P. *Adjusting Hemoglobin Values in Program Surveys*; ILSI Human Nutrition Institute: Washington, DC, USA, 2002.
44. Zimmermann, M.B.; Hurrell, R.F. Nutritional iron deficiency. *The Lancet* **2007**, *370*, 511–520. [[CrossRef](#)]
45. Li, X.; Zhu, Z.; Song, Y.; Wu, Y. The impact of boarding on the reading ability of children in poor areas of China: Evidence from 137 boarding schooling in Hebei and Sichuan provinces. *China Rural Surv.* **2018**, *2*, 129–144. (In Chinese)
46. Card, D. Using geographic variation in college proximity to estimate the return to schooling. In *Aspects of Labour Market. Behavior: Essays in Honor of John Vanderkamp*; Christofides, L.N., Grant, E.K., Swidinsky, R., Eds.; University of Toronto Press: Toronto, Canada, 1995; pp. 201–222.
47. Altonji, J.G.; Elder, T.E.; Taber, C.R. An Evaluation of Instrumental Variable Strategies for Estimating the Effects of Catholic Schooling. *J. Hum. Resour.* **2005**, *XL*, 791–821. [[CrossRef](#)]
48. Chen, Q.; Xu, J.; Zhao, J.; Zhang, B. Endogenous schooling, school proximity and returns to rural schooling in Northwestern China. *China Agric. Econ. Rev.* **2017**, *9*, 270–286. [[CrossRef](#)]
49. Bound, J.; Jaeger, D.A.; Baker, R.M. Problems with Instrumental Variables Estimation when the Correlation between the Instruments and the Endogenous Explanatory Variable is Weak. *J. Am. Stat. Assoc.* **1995**, *90*, 443–450. [[CrossRef](#)]
50. WHO (World Health Organization). Growth reference 5–19 years. Available online: http://www.who.int/growthref/who2007_bmi_for_age/en/ (accessed on 21 July 2018).

51. Kerstetter, J.E.; O'Brien, K.O.; Insogna, K.L. Low Protein Intake: The Impact on Calcium and Bone Homeostasis in Humans. *J. Nutr.* **2003**, *133*, 855S–S861S. [[CrossRef](#)] [[PubMed](#)]
52. Gross, L.S.; Li, L.; Ford, E.S.; Liu, S. Increased consumption of refined carbohydrates and the epidemic of type 2 diabetes in the United States: An ecologic assessment. *Am. J. Clin. Nutr.* **2004**, *79*, 774–779. [[CrossRef](#)] [[PubMed](#)]
53. Halterman, J.S.; Kaczorowski, J.M.; Aligne, C.A.; Auinger, P.; Szilagyi, P.G. Iron Deficiency and Cognitive Achievement Among School-Aged Children and Adolescents in the United States. *Pediatrics* **2001**, *107*, 1381–1386. [[CrossRef](#)] [[PubMed](#)]
54. Bobonis, G.J.; Miguel, E.; Puri-Sharma, C. Anemia and School Participation. *J. Hum. Resour.* **2006**, *XLI*, 692–721. [[CrossRef](#)]
55. Luo, R.; Shi, Y.; Zhang, L.; Liu, C.; Rozelle, S.; Sharbono, B.; Yue, A.; Zhao, Q.; Martorell, R. Nutrition and Educational Performance in Rural China's Elementary Schools: Results of a Randomized Control Trial in Shaanxi Province. *Econ. Dev. Cult. Chang.* **2012**, *60*, 735–772. [[CrossRef](#)]
56. Ministry of Education. To Build Small Rural Schools and Boarding Schools in Townships and Towns, We Should Pay Attention to these Five Key Words. Available online: http://www.moe.gov.cn/jyb_xwfb/xw_fbh/moe_2069/xwfbh_2018n/xwfb_20180511/mtbd/201805/t20180514_335856.html (accessed on 28 July 2018).



© 2018 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).