



HHS Public Access

Author manuscript

Int J Educ Dev. Author manuscript; available in PMC 2015 November 23.

Published in final edited form as:

Int J Educ Dev. 2014 January 1; 34: 90–97. doi:10.1016/j.ijedudev.2012.07.003.

Poverty, Food Insecurity and Nutritional Deprivation in Rural China: Implications for Children's Literacy Achievement

Emily Hannum^{*}, Jihong Liu^{**}, and Edward Frongillo^{***}

^{*}Department of Sociology, 3718 Locust Walk, Philadelphia PA 19104

^{**}Arnold School of Public Health, University of South Carolina, Health Sciences Building, 208B, 800 Sumter Street, Columbia, SC 29208, jlui@mailbox.sc.edu.

^{***}Arnold School of Public Health, University of South Carolina, Health Sciences Building, 216B, 800 Sumter Street, Columbia, SC 29208, efrongillo@sc.edu

1 Introduction

According to guidelines developed by an expert working group of the American Institute of Nutrition (Cook and Frank 2008, p. 193), food insecurity is defined as “Limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire acceptable foods in socially acceptable ways.¹” Evidence suggests that insecure access to nutritious food remains a significant global problem. According to the Food and Agriculture Organization's *State of Food Insecurity in the World* (2011:45-46), 850 million people were undernourished worldwide during the period 2006-2008, including 129.6 million people, or 10 percent of the national population, in China.

Food insecurity has been linked to a wide variety of adverse health and developmental outcomes in children and adults—both nutrition-related and non-nutrition related (Cook and Frank, 2008; American Dietetic Association 2010). Food insecurity is associated with higher prevalence of inadequate intake of key nutrients (Rose, Habicht, and Devaney, 1998; Casey, Szeto, Lensing, Bogle, and Weber, 2001; Lee and Frongillo, 2001; Adams, Grummer-Strawn, and Chavez, 2003), risk of overweight status in women and some girls (Olson, 1999; Alaimo, Olson, and Frongillo, 2001; Laitinen, Power, and Jarvelin, 2001; Townsend, Peerson, Love, Achterberg, and Murphy, 2001; Dinour et al., 2007; but see Gundersen et al., 2012 for insignificant effects of food insecurity on children's overweight status in the US), depressive symptoms in adolescents (Alaimo, Olson, and Frongillo, 2002), poorer interpersonal relations, less self control, and non-cognitive skills impairments and general

Corresponding author; 215 898 9633 (f) 215 898 2124, hannumem@soc.upenn.edu.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

¹According to the same guidelines (Cook and Frank 2008, p. 193), a food secure household is one in which there is “Access by all people at all times to enough food for an active, healthy life. Food security includes, at a minimum: (1) the ready availability of nutritionally adequate and safe foods and (2) an assured ability to acquire acceptable foods in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies).

academic difficulties and social developmental delays in children (Kleinman et al., 1998; Murphy et al., 1998; Alaimo et al., 2001; Reid, 2000; Stormer and Harrison, 2003; Ashiabi, 2005; Howard 2011; Roustit, Harmelin, Grillo, Martin, and Chauvin, 2010; Howard, 2010). Results from a longitudinal study of welfare recipients in the United States show that household food insecurity is associated with poor physical and mental health of low-income black and white women (Siefert, Heflin, Corcoran, and Williams, 2004). Food insecurity is also associated with more behavioral problems (Olson, 1999; Slack and Yoo, 2005), poorer school performance (Olson, 1999; Alaimo et al., 2001; Dunifon and Kowaleski-Jones, 2003), and adverse health outcomes (Alaimo, Olson, Frongillo, and Briefel, 2001; Cook et al., 2004; Weinreb et al., 2002) in children. Data from the Early Child Longitudinal Study-Kindergarten Class show that reporting at least one indicator of food insecurity was significantly associated with impaired learning in mathematics from fall to spring of the kindergarten year (Winicki and Jemison, 2003) and with impaired learning in reading from kindergarten to third grade (Jyoti, Frongillo, and Jones, 2005). Belsky et al. (2010, p. 809) characterize “material hardship related to food”—food insecurity, food insufficiency, and hunger—as a “reliable correlate of cognitive, behavioral, and emotional problems among low income children,” but note that many, though not all, of the disadvantages are explained by other features of household structure.

The knowledge that we have about the consequences of food insecurity for children's well-being is limited in a number of ways. Relatively few studies have employed longitudinal data (Winicki & Jemison 2003; Jyoti et al. 2005). Most utilize data from developed countries, and most employ a fairly limited set of educational measurements. Focusing on the case of rural children in an impoverished province in western China, we address these limitations in this project. Our dataset includes household measures of food insecurity reported by mothers and measures of long-term nutrition status (measured anthropometry), as well as a purpose-designed literacy assessment administered to children. We combine these measures with detailed measures of socioeconomic status of households, a strategy that allows us a close look at links between food insecurity and poverty. Finally, we employ a longitudinal dataset that allows us to adjust for baseline school performance.

We begin with the descriptive task of establishing prevalence of food insecurity among children, and the relation of this issue to poverty and to measured anthropometry. Next, we address our main analytic question: whether food insecurity is linked to children's learning outcomes, measured by a literacy assessment, before and after adjusting for baseline school performance and long term nutrition (captured by anthropometry measures).

2 Food Insecurity, Undernutrition, and Education in China

Undernutrition persists as a problem in parts of rural western China. The prevalence of child stunting declined dramatically in China from 1992 onwards, but a significant divide separates Western and Eastern provinces and rural and urban areas. The ratio of the prevalence of stunting in rural and urban areas increased from 3.5 to 7.2 between 1992 and 2002 (Svedberg, 2006).

While inadequate nutrition remains a serious problem in China's poor rural households, studies of rural children's nutrition and schooling are few and largely descriptive. Jamison et al. (1986) linked nutrition to school achievement used a data set of 3000 children from five different provinces in China. Jamison and his colleagues found that height-for-age, a measure of long-term nutritional status, predicted school performance, measured by grade-for-age; similar findings prevailed through the 1990s, as shown in a replication using the China Health and Nutrition Survey data (Yu and Hannum 2007). Using data from northwest China, Yu and Hannum (2007) found that home nutrition environment, measured as a scale of food variety, was associated with household socioeconomic status and children's school performance, and operated as a significant mediator of poverty effects on schooling for children in early primary grades. We are not aware of published work linking food insecurity to school performance in China.

3 Data and Methods

3.1 Data

This study focuses on data from rural children who are residents of Gansu Province. Relative to China as a whole, Gansu Province exhibits high rates of illiteracy and prevalent poverty. As one of China's poorest provinces, Gansu provides a useful case study for investigating food insecurity-education linkages in a less developed setting. We employ data from the Gansu Survey of Children and Families (GSCF). In the summer of 2000, 2,000 children aged 9-12 and their families in 100 rural villages in Gansu Province were interviewed. The sampling strategy involved a multi-stage, cluster design with random selection procedures employed at each stage. At the final stage, children were sampled from lists of all 9 to 12 year-old children in selected villages, enabling us to avoid concerns about selection bias that afflict school-based samples. Questionnaires were designed for the sample children and their mothers, fathers, teachers, principals and village leaders. In 2004, original interviewees were revisited, as well as a new sample of oldest younger school-aged siblings.

3.2 Measures

We report results based on two measures of food insecurity. First, we employ a dichotomous measure, household food insecurity, which is based on mothers' responses to the following question: In the past year, which of the following statement describe best your family's food supply? The answer options are 1) often not having enough food; 2) Sometimes not having enough food; 3) Always having enough food. We defined a *food insecurity* dummy variable as "1" if the answers were 1) and 2), else 0. We show descriptives for this variable as reported by mothers in 2000 and 2004, but all analyses rely on the 2004 variable.

We also report results using a different food insecurity specification: a scale variable that we refer to as the food insecurity severity index.ⁱⁱ Mothers who reported being food insecure were asked a series of six questions, shown in Table 1, about actions that might be undertaken to respond to food shortages in the preceding year. If they answered that each

ⁱⁱCook and Frank (2008, p. 194) report on a standard Food Security Scale and a Children's Food Security Scale that have been scored and validated in the United

action had been taken, they were then asked about the frequency of the action. To create the scale, we generated six new variables—one for each of the six questions about the frequency with which each action had been taken. We set the frequency to 0 for food secure households and for households that reported not having taken the action specified in the original question. Other values for these questions were 1 “only in one or two months;” 2 “in some months, but not every month;” or 3 “in almost every month”. We then generated a summative scale of the standardized items ($\alpha=.7898$).

Child's long-term nutritional status is indicated by measured weight and height at Wave II. Using the U.S. CDC 2000 growth reference, we calculated height- and weight-for-age Z scores, and defined “stunting” as having a less than -2 height-for-age z score and “severely underweight” as having a less than -2 weight-for-age Z score.

Our main analytic outcome is a measure of school functioning: a purpose-designed literacy assessment, standardized (mean=0, sd=1).

Our analyses also include controls for socioeconomic background (mother's and father's years of education, wealth), demographic factors (age and sex), and prior educational performance (cognitive test scores in 2000, school based test scores in 2000, and years of education attained).

3.3 Analytic Approach

We first describe the scale of food insecurity and nutritional deprivation in rural Gansu. Next, we analyze food insecurity and nutritional deprivation measures as dependent variables, with an emphasis on the degree to which nutrition is linked to socioeconomic status. Finally, we conduct regression and propensity score matching analyses of the relationship of literacy achievement to food insecurity, before and after adjusting for long-term nutritional status, socioeconomic status, and children's prior academic performance. Most analyses will focus only on the original sample of target children, but for some regression models, we are able to use household random and fixed effects specifications that capitalize on sibling data collected from the eldest younger school-aged sibling in 2004.

4 Results

4.1 Prevalence of Food Insecurity and Nutritional Deprivation

Table 1 shows food insecurity reported by mothers of target children in 2000 and 2004. Food insecurity dropped substantially among the households under study in this period, from about one-fourth of households to 7 percent. Among food insecure households in 2004, 36 percent of mothers reported that their families went hungry because of insufficient food or money to buy food; 41 percent reported having had to depend on relatives or friends to give food; 49 percent reported that they or their family had borrowed money from relatives or friends to buy food; and 23 percent reported having to cut food available for children because there was not enough food or money. Also among food insecure households, 9 percent of mothers reported that adults had had to go a full day without food due to lack of money or food, and 6 percent of mothers in food insecure households reported that children had had to do so.

An illustration of the difference between food secure and food insecure households is evident in mother's reports of family consumption patterns in the past month. Mothers were asked how frequently they and their families consumed various categories of food, and response options were "almost never", "one to three times," and "once a week or more". Figure 1 shows the proportion of mothers reporting that their families "almost never" consumed various types of foods in the past month, by food insecurity status, from the 2004 data. The food types presented represent nutritious or "luxury" foods other than the staples of wheat-based foods (bread and noodles), potatoes, and yams. Figure 1 shows, first, that non-trivial proportions of food secure households in rural Gansu did not consume meat, eggs, fruit, or dairy products. Even for vegetables, which had the highest level of access among these food items, one in ten mothers in food secure households reported that her family almost never ate vegetables in the preceding month.

However, across the board, the lack of consumption of these foods was significantly more pronounced in food insecure households, and the difference, in some cases, was striking. For example, over three-fourths of mothers in food insecure households reported almost never consuming meat in the past month, compared to 39 percent of mothers in food secure households. Over half (57 percent) of mothers in food insecure households reported consuming no eggs, compared to 29 percent of mothers in food secure households. About 39 percent of mothers in food insecure households reported no consumption of vegetables, compared to 10 percent of mothers in food secure households. Corresponding numbers were 73 percent and 48 percent for fruits, and 96 percent and 79 percent for dairy products. All of these differences were statistically significant at conventional levels.

Table 2 shows nutritional status and food security measures for the target child, oldest younger school-age sibling, and combined samples. Table 2 shows that on average, target children are 1.24 standard deviations below the reference mean height-for-age, and 1.33 standard deviations below the reference mean weight-for-age. Using a two standard deviation cutoff, about one in five children in the target sample were stunted and about one in four were severely underweight. Corresponding numbers were not very different for the sibling and combined samples.

4.2 Social Location of Food Insecurity and Nutritional Deprivation

Poor nutrition and household food insecurity are closely linked to wealth. Figure 2 shows means and proportions for nutritional status and food insecurity measures by wealth quintile for the target child sample in 2004. The wealthiest children in the sample face less of a lesser risk for poor nutrition by the anthropometric measures. The poorest fifth of children in the sample are 1.9 times as likely to be stunted as the wealthiest children, and 1.7 times as likely to be severely underweight as the wealthiest children. The poorest fifth of children in the sample are five times as likely as the wealthiest fifth to be resident in food insecure households. The standardized food insecurity severity index shows that the poorest fifth of children face greater severity of food insecurity, compared to children in less poor households.

Table 3 illustrates further the links between poverty, nutritional deprivation, and food insecurity, modeling anthropometric measures and food insecurity as functions of

socioeconomic status and demographics. Table 3 confirms that Height-for-age is related to higher wealth (top two quintiles) and mother's education, as shown in the random effects specification. Moreover, as children get older, they fall behind in height-for-age, which is shown in both the random effects specification, and slightly more strongly in the fixed effects specification that accounts for unobserved household differences. Weight-for-age shows a significant benefit to children in the highest wealth quintile, and for children of better-educated mothers. Children fall behind with higher age, a finding present in both specifications, and girls have significantly higher weight-for-age than do boys.

The poorest children are also at high risk for food insecurity, by the mother report measures. Table 3 speaks to significant effects of wealth quintile on food insecurity for those in the top three wealth quintiles, net of parental education and other variables in the model. The probability of being in an insecure household decreases by about .06 for those in the wealthiest two quintiles, compared to the poorest (model 3a). This effect is substantively important, given that the estimated overall probability of food insecurity, all variables held to means, is about .06 (not shown). Wealth differences between the poorest fifth of households and other households are also present in model 3b, which uses the food insecurity severity measure. However, the proportion of variance explained in this model is very low. This situation may reflect an observation, based on the US literature, that while the populations affected by food insecurity and poverty overlap, they are not identical (Cook and Frank 2008).

4.3 Food Insecurity, Nutritional Deprivation, and School Functioning

Do these measures predict literacy achievement? Table 4 shows estimates from models of standardized literacy scores assessed in 2004 against the nutrition and food insecurity measures, along with socioeconomic status and prior achievement. In the baseline specifications that control for child age and sex alone (model 1) and then for socioeconomic status (model 2), we see that height-for-age and food insecurity are each significantly associated with literacy scores in 2004. The significant effect of height-for-age, which is a proxy for nutrition early in life, disappears in the model that incorporates controls for early academic achievement and educational attainment (end-of-term test scores and a cognitive test score, model 3a). The wealth effects also disappear in this specification. These findings suggest that nutritional status may be operating through conditioning early school experiences.

However, net of these controls, food insecurity is associated with about one-third of a standard deviation lower literacy score. These coefficients suggest non-trivial effects—they can be compared with the effect of a year of child's educational attainment, which yields about a .25 standard deviation increase in literacy scores (Table 3, model 3a). Finally, the food insecurity severity index similarly shows a highly significant effect, indicating that children with greater food insecurity severity achieve lower literacy scores.

A more conservative test of the food insecurity findings can be generated by using a propensity score matching approach. In this approach, food insecure households—the “treatment” group—are matched to other similar but not food insecure households. Next, the literacy difference between treatment and control groups is estimated on the matched

sample. We estimated the propensity to be in food-insecure households using the same independent variables as shown in model 3, Table 4.ⁱⁱⁱ Significant differences in predictors were across food insecure and food secure households were present for many variables in the unmatched sample, but these differences were eliminated for all variables in the matched sample (See appendix table A-2). Results show that, for the matched sample, the average treatment effect on the treated is $-.39$ standard deviations, which is in the range of estimates obtained in Table 4.

5 Discussion and Conclusions

Using data from a survey of children from 100 rural villages in Gansu Province, we have investigated the association of food insecurity with poverty, and then compared the literacy skills of children in food secure and food insecure households. We show, first, that poor nutrition and food insecurity are commonly associated with poverty: children in the poorest households are at elevated risk for nutritional deprivation and food insecurity. Next, we show that early nutritional status, proxied by height-for-age, was significantly associated with literacy achievement, but those results become insignificant once prior achievement is controlled. This finding suggests the importance of nutrition at early educational stages. Most strikingly, our results show that even in the most conservative regression models with full controls for socioeconomic status, prior educational achievement and early nutritional status, and in matched samples estimates, children in food insecure households have significantly lower literacy scores.

A logical and plausible inference from these findings is that nutritional deprivation and food insecurity are important mechanisms of the transmission of educational disadvantage for the poorest children in China. One could argue that our nutrition and food insecurity measures may operate in part as proxies for other unmeasured dimensions of poverty. Because of the careful measurement of wealth, parental education, and prior achievement, and our inclusion of these measures in our final model, we do not believe that our results can be fully accounted for by this problem. However, even if this problem is present, our findings lead to a still-useful conclusion that stunting and food insecurity are easily-measurable risk factors for educational disadvantage. Either a causal or a proxy interpretation of our findings suggests the importance of theorizing nutritional deprivation and food insecurity in conjunction with poverty, and incorporating these concepts as a matter of course in studies of childhood poverty and educational mobility.

ⁱⁱⁱWe use the *psmatch2* program in Stata to estimate propensity scores for glasses-wearing, with kernel matching. We use logit models for estimation of propensity scores. We imposed a common support structure (for a straightforward discussion of the implications of model choice, matching choice, and common support, see Caliendo and Kopeinig, 2008).

Appendix

Appendix Table A-1

Descriptive Statistics, Child, Sibling and Full Samples

| | N | Mean | Std. Dev. |
|--|------|-------|-----------|
| Child Sample | | | |
| Standardized Literacy Assessment | 1746 | 0.00 | 1.00 |
| Height-for-Age Z | 1731 | -1.24 | 1.02 |
| Weight-for-Age Z | 1716 | -1.33 | 1.10 |
| Food Insecurity, 2000 | 1999 | 0.26 | 0.44 |
| Food Insecurity, 2004 | 1866 | 0.07 | 0.26 |
| Severity of Food Insecurity (Index) | 1866 | 0.00 | 0.70 |
| Past Month, "Almost Never" Consumed... | | | |
| Meat | 1866 | 0.42 | 0.49 |
| Seafood | 1866 | 0.83 | 0.37 |
| Rice | 1866 | 0.29 | 0.45 |
| Eggs | 1866 | 0.31 | 0.46 |
| Vegetables | 1866 | 0.12 | 0.33 |
| Fruit | 1866 | 0.50 | 0.50 |
| Dairy | 1866 | 0.80 | 0.40 |
| Wealth Quintiles (Ref.=Poorest) | | | |
| Second | 1918 | 0.20 | 0.40 |
| Third | 1918 | 0.20 | 0.40 |
| Fourth | 1918 | 0.20 | 0.40 |
| Fifth | 1918 | 0.20 | 0.40 |
| Mother's Education (Years) | 1918 | 4.26 | 3.49 |
| Father's Education (Years) | 1918 | 6.95 | 3.60 |
| Mother Passed Away | 1916 | 0.01 | 0.09 |
| Father Passed Away | 1918 | 0.02 | 0.14 |
| Prior Cognitive Test (2000) | 1999 | 17.61 | 10.22 |
| Prior Math Achievement (2000) | 1980 | 71.42 | 15.85 |
| Prior Language Achievement (2000) | 1980 | 73.08 | 16.63 |
| Grade Attained | 1917 | 7.13 | 1.82 |
| Age | 1781 | 14.51 | 1.11 |
| Female | 1918 | 0.47 | 0.50 |
| Sibling Sample | | | |
| Height-for-Age Z | 710 | -1.16 | 1.23 |
| Weight-for-Age Z | 714 | -1.37 | 1.24 |
| Age | 759 | 12.06 | 1.97 |
| Female | 896 | 0.42 | 0.49 |

Appendix Table A-2

Comparison of Samples, Pre- and Post-matching

| | Sample | Mean | | Bias | | T-Test | |
|---|-----------|---------|---------|--------|-------------|--------|------|
| | | Treated | Control | % | % Reduction | T | P>T |
| Height-for-Age Z | Unmatched | -1.33 | -1.34 | 1.20 | | 0.15 | 0.88 |
| | Matched | -1.36 | -1.50 | 11.50 | -899.40 | 0.82 | 0.41 |
| Weight-for-Age Z | Unmatched | -1.38 | -1.19 | -16.90 | | -2.25 | 0.03 |
| | Matched | -1.49 | -1.50 | 1.00 | 93.80 | 0.08 | 0.94 |
| Wealth Quintile=2 | Unmatched | 0.30 | 0.20 | 22.60 | | 3.41 | 0.00 |
| | Matched | 0.27 | 0.30 | -8.00 | 64.50 | -0.55 | 0.58 |
| Wealth Quintile=3 | Unmatched | 0.16 | 0.20 | -11.60 | | -1.59 | 0.11 |
| | Matched | 0.16 | 0.17 | -0.70 | 94.30 | -0.05 | 0.96 |
| Wealth Quintile=4 | Unmatched | 0.09 | 0.21 | -34.00 | | -4.26 | 0.00 |
| | Matched | 0.09 | 0.08 | 0.70 | 98.00 | 0.06 | 0.95 |
| Wealth Quintile=5 | Unmatched | 0.07 | 0.21 | -39.50 | | -4.83 | 0.00 |
| | Matched | 0.09 | 0.07 | 4.70 | 88.20 | 0.42 | 0.67 |
| Mother's Education (Years) | Unmatched | 3.37 | 4.35 | -27.70 | | -4.09 | 0.00 |
| | Matched | 3.57 | 3.52 | 1.30 | 95.20 | 0.10 | 0.92 |
| Father's Education (Years) Indicator, Father Passed Away | Unmatched | 6.12 | 7.05 | -25.60 | | -3.73 | 0.00 |
| | Matched | 5.91 | 5.91 | 0.20 | 99.10 | 0.02 | 0.99 |
| | Unmatched | 0.01 | 0.02 | -6.90 | | -0.87 | 0.38 |
| | Matched | 0.02 | 0.02 | -0.90 | 87.00 | -0.05 | 0.96 |
| Prior Cognitive Test (2000) | Unmatched | 13.70 | 17.90 | -41.70 | | -4.72 | 0.00 |
| | Matched | 13.47 | 13.80 | -3.30 | 92.00 | -0.25 | 0.80 |
| Prior Math Achievement | Unmatched | 68.86 | 71.60 | -17.60 | | -1.93 | 0.05 |
| | Matched | 68.49 | 68.70 | -1.40 | 92.20 | -0.09 | 0.93 |
| Prior Language Achievement | Unmatched | 68.46 | 73.34 | -29.50 | | -3.27 | 0.00 |
| | Matched | 68.37 | 68.75 | -2.30 | 92.20 | -0.15 | 0.88 |
| Grade Attained | Unmatched | 5.77 | 6.44 | -29.90 | | -4.33 | 0.00 |
| | Matched | 6.68 | 6.78 | -4.40 | 85.40 | -0.38 | 0.70 |

| | Sample | Mean | | Bias | | T-Test | |
|--------|-----------|---------|---------|--------|-------------|--------|------|
| | | Treated | Control | % | % Reduction | T | P>T |
| Age | Unmatched | 13.59 | 13.79 | -11.30 | | -1.46 | 0.14 |
| | Matched | 14.39 | 14.43 | -1.90 | 82.80 | -0.23 | 0.82 |
| Female | Unmatched | 0.46 | 0.45 | 2.30 | | 0.32 | 0.75 |
| | Matched | 0.50 | 0.51 | -1.90 | 14.50 | -0.14 | 0.89 |

Source: Gansu Survey of Children and Families. Note: Indicator for mother passed away dropped due to collinearity.

References Cited

- Adams, Elizabeth J.; Grummer-Strawn, Laurence; Chavez, Gilberto. Food Insecurity is Associated with Increased Risk of Obesity in California Women. *Journal of Nutrition*. 2003; 133:1070–4. [PubMed: 12672921]
- Alaimo, Katherine; Olson, Christine M.; Frongillo, Edward A., Jr. Food Insufficiency and American School-Aged Children's Cognitive, Academic, and Psychosocial Development. *Pediatrics*. 2001; 108:44–53. [PubMed: 11433053]
- Alaimo, Katherine; Olson, Christine M.; Frongillo, Edward A., Jr.; Briefel, Ronette R. Food Insufficiency, Family Income, and Health in US Preschool and School-Aged Children. *American Journal of Public Health*. 2001; 91:781–6. [PubMed: 11344887]
- Alaimo, Katherine; Olson, Christine M.; Frongillo, Edward A. Family Food Insufficiency, but Not Low Family Income, is Positively Associated with Dysthymia and Suicide Symptoms in Adolescents. *Journal of Nutrition*. 2002; 132:719–25. [PubMed: 11925467]
- Alaimo, Katherine; Olson, Christine M.; Frongillo, Edward A., Jr. Low Family Income and Food Insufficiency in Relation to Overweight in US Children: Is there a Paradox? *Archives of Pediatrics Adolescent Medicine*. 2001; 155:1161–7. [PubMed: 11576013]
- American Dietetic Association. Position of the American Dietetic Association: Food Insecurity in the United States. *Journal of the American Dietetic Association*. 2010; 110:1368–1377. [PubMed: 20821887]
- Ashiabi, Godwin. Household Food Insecurity and Children's School Engagement. *Journal of Children & Poverty*. 2005; 11:3–17.
- Belsky, Daniel W.; Moffitt, Terrie E.; Arseneault, Louise; Melchior, Maria; Caspi, Avshalom. Context and Sequelae Of Food Insecurity In Children's Development. *American Journal of Epidemiology*. 2010; 172(7):809–18. (October 01). [PubMed: 20716700]
- Bundy, Donald; Burbano, Carmen; Grosh, Margaret E.; Gelli, Aulo; Jukes, Matthew; Lesley, Drake. *Rethinking School Feeding*. World Bank; Washington, DC: 2009.
- Caliendo M, Kopeinig S. Some Practical Guidance for the Implementation of Propensity Score Matching. *Journal of Economic Surveys*. 2008; 22(1):31–72.
- Casey, Patrick H.; Szeto, Kitty; Lensing, Shelly; Bogle, Margaret; Weber, Judy. Children in Food-Insufficient, Low-Income Families: Prevalence, Health, and Nutrition Status. *Archives of Pediatrics Adolescent Medicine*. 2001; 155:508–14. [PubMed: 11296080]
- Cook, John T.; Frank, Deborah A. Food Security, Poverty, and Human Development in the United States. *Annals of the New York Academy of Sciences*. 2008; 1136(1):193–209. [PubMed: 17954670]
- Dinour, Lauren M.; Bergen, Dara; Yeh, Ming-Chin. The Food Insecurity–Obesity Paradox: A Review of the Literature and the Role Food Stamps may Play. *Journal of the American Dietetic Association*. 2007; 107(11):1952–61. (11). [PubMed: 17964316]
- Dunifon, Rachel; Kowaleski-Jones, Lori. The Influences of Participation in the National School Lunch Program and Food Insecurity on Child Well-Being. *Social Service Review*. 2003; 77:72–92.

- Food and Agriculture Organization of the United Nations. The State of Food Insecurity in the World, 2011. Food and Agriculture Organization of the United Nations; Rome: 2011. available <http://www.fao.org/publications/sofi/en/>
- Gundersen, Craig; Lohman, Brenda J.; Garasky, Steven; Stewart, Susan; Eisenmann, Joey. Food Security, Maternal Stressors, and Overweight Among Low-Income US Children: Results from the National Health and Nutrition Examination Survey (1999–2002). *Pediatrics*. Sep; 2008 122(3):e529–40. (September 2008). [PubMed: 18762488]
- David, Holben. Position of the American Dietetic Association: Food insecurity in the United States. *Journal of the American Dietetic Association*. 2010; 110(9):1368–77. (9). [PubMed: 20821887]
- Howard, Larry L. Does Food Insecurity at Home Affect Non-Cognitive Performance at School? A Longitudinal Analysis Of Elementary Student Classroom Behavior. *Economics of Education Review*. 2011; 30(1)(2):157–76.
- Jamison, Dean T. Child Malnutrition and School Performance in China. *Journal of Development Economics*. 1986; 20:299–309.
- Jyoti, Diana F.; Frongillo, Edward A.; Jones, Sonya J. Food Insecurity Affects School Children's Academic Performance, Weight Gain, and Social Skills. *Journal of Nutrition*. 2005; 135:2831–9. [PubMed: 16317128]
- Kleinman, Ronald E.; Murphy, JM.; Little, Michelle; Pagano, Maria; Wehler, Cheryl A.; Regal, Kenneth; Jellinek, Michael S. Hunger in Children in the United States: Potential Behavioral and Emotional Correlates. *Pediatrics*. 1998; 101:e3. [PubMed: 9417167]
- Laitinen, Jaana; Power, Chris; Jarvelin, Marjo-Riitta. Family Social Class, Maternal Body Mass Index, Childhood Body Mass Index, and Age at Menarche as Predictors of Adult Obesity. *American Journal of Clinical Nutrition*. 2001; 74:287–94. [PubMed: 11522550]
- Lee, Jung S.; Frongillo, Edward A., Jr. Factors Associated with Food Insecurity among U.S. Elderly Persons: Importance of Functional Impairments. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*. 2001; 56:S94–99.
- Lee, Jung S.; Frongillo, Edward A., Jr. Nutritional and Health Consequences are Associated with Food Insecurity among U.S. Elderly Persons. *Journal of Nutrition*. 2001; 131:1503–9. [PubMed: 11340107]
- Lee, Jung S.; Frongillo, Edward A., Jr. Understanding Needs is Important for Assessing the Impact of Food Assistance Program Participation on Nutritional and Health Status in U.S. Elderly Persons. *Journal of Nutrition*. 2001; 131:765–73. [PubMed: 11238757]
- Murphy JM, Pagano Maria E. Nachmani Joan, Sperling Peter, Kane Shirley, Kleinman Ronald E. The Relationship of School Breakfast to Psychosocial and Academic Functioning: Cross-Sectional and Longitudinal Observations in an Inner-City School Sample. *Archives of Pediatrics Adolescent Medicine*. 1998; 152:899–907. [PubMed: 9743037]
- Olson, Christine M. Nutrition and Health Outcomes Associated with Food Insecurity and Hunger. *Journal of Nutrition*. 1999; 129:521.
- Reid, Lori L. The Consequences of Food Insecurity for Child Well-being: An Analysis of Children's School Achievement, Psychological Well-being, and Health. 2000.
- Rose, Donald; Jean-Pierre Habicht and Barbara Devaney. Household Participation in the Food Stamp and WIC Programs Increases the Nutrient Intakes of Preschool Children. *Journal of Nutrition*. 1998; 128:548–55. [PubMed: 9482762]
- Roustit, Christelle; Hamelin, Anne-Marie; Grillo, Francesca; Martin, Judith; Chauvin, Pierre. Food Insecurity: Could School Food Supplementation Help Break Cycles of Intergenerational Transmission of Social Inequalities? *Pediatrics*. 2010; 126(6):1174–81. [PubMed: 21098149]
- Siefert, Kristine; Heflin, Colleen M.; Corcoran, Mary E.; Williams, David R. Food Insufficiency and Physical and Mental Health in a Longitudinal Survey of Welfare Recipients. *Journal of Health and Social Behavior*. 2004; 45:171–86. [PubMed: 15305758]
- Slack, Kristen S.; Yoo, Joan. Food Hardship and Child Behavior Problems among Low-Income Children. *Social Service Review*. 2005; 79:511–36.
- Smith, Lisa C.; Haddad, Lawrence. Explaining Child Malnutrition in Developing Countries: A Cross-Country Analysis. International Food Policy Research Institute; Washington DC: 2000.

- Stormer, A.; Harrison, Gail G. [May 14, 2009] Does Household Food Security Affect Cognitive and Social Development of Kindergartners? (Paper CCPR-001-06).. University of California-Los Angeles: California Center for Population Research On-Line Working Paper Series. 2003. (<http://repositories.cdlib.org/ccpr/olwp/CCPR-001-06>)
- Townsend, Marilyn S.; Peerson, Janet; Love, Bradley; Achterberg, Cheryl; Murphy, Suzanne P. Food Insecurity is Positively Related to Overweight in Women. *Journal of Nutrition*. 2001; 131:1738–45. [PubMed: 11385061]
- Weinreb, Linda; Wehler, Cheryl; Perloff, Jennifer; Scott, Richard; Hosmer, David; Sagor, Linda; Gundersen, Craig. Hunger: Its Impact on Children's Health and Mental Health. *Pediatrics*. 2002; 110:e41. [PubMed: 12359814]
- Winicki, Joshua; Jemison, Kyle. Food Insecurity and Hunger in the Kindergarten Classroom: Its Effect on Learning and Growth. *Contemporary Economic Policy*. 2003; 21:145.
- Yu, Shengchao; Hannum, Emily. Food for Thought: Poverty, Family Nutritional Environment, and Children's Educational Performance in Rural China. *Sociological Perspectives*. 2007; 50:53–77.

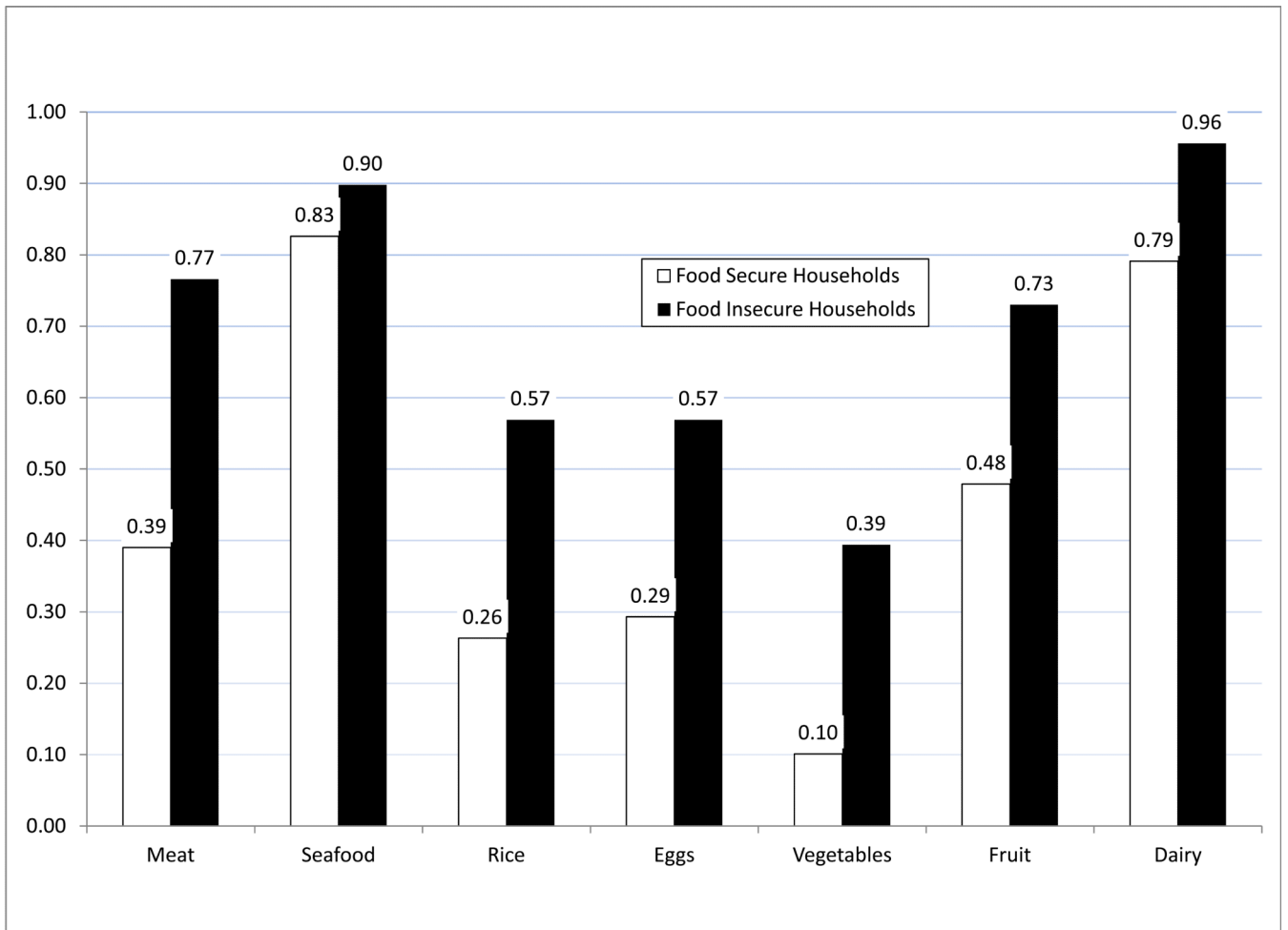
Food insecurity is a significant dimension of childhood poverty, but implications for schooling are poorly understood.

Analyses of nutrition, food security and literacy among children in 100 villages in northwest China are performed.

Long-term undernourishment and food insecurity strike the poorest disproportionately, but not exclusively.

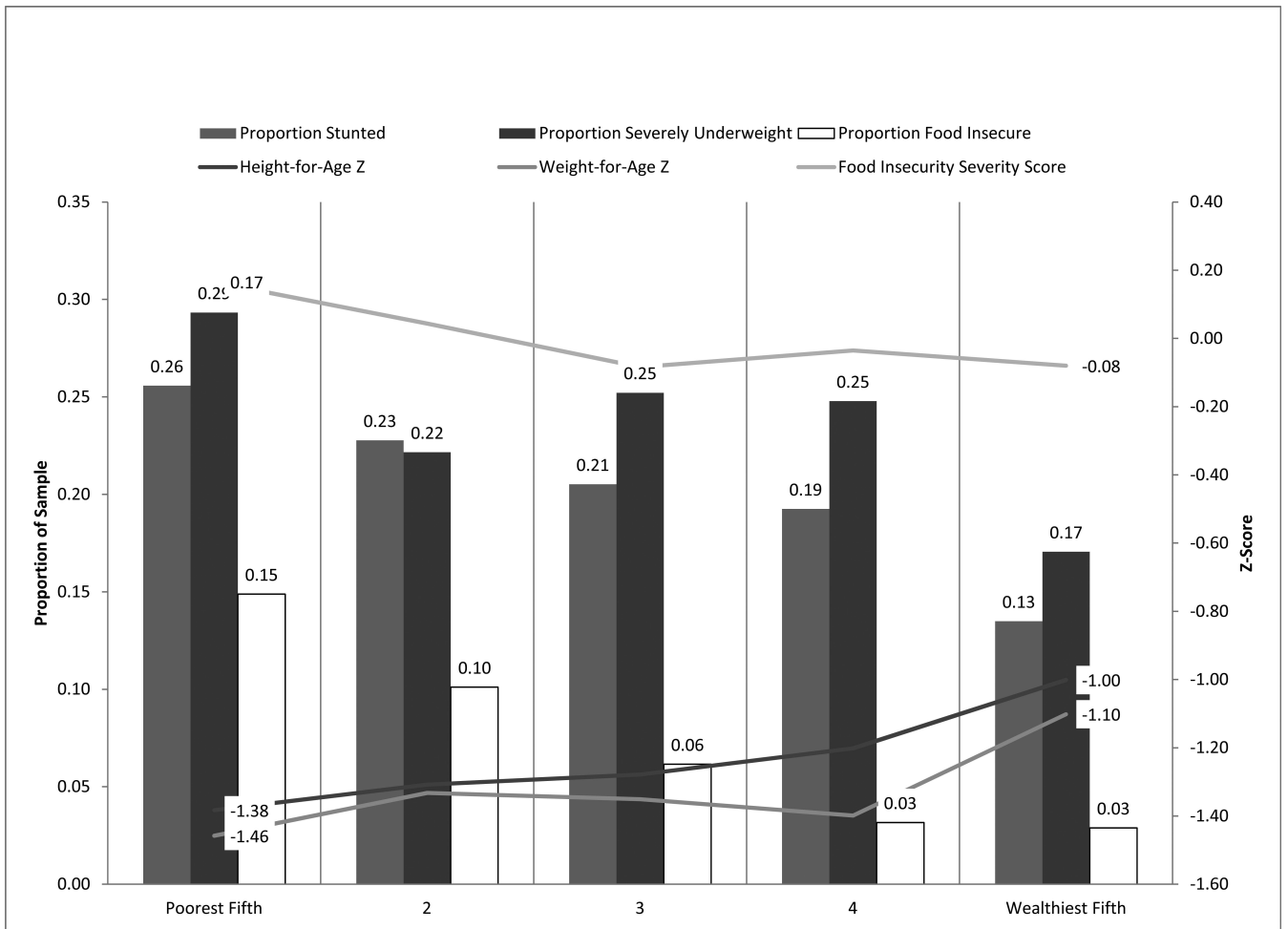
Long-term undernourishment matters for literacy via early achievement.

Adjusting for socioeconomic status, undernourishment, and prior achievement, food insecure children have lower literacy.



Note: All differences by household food insecurity status are significant at the .05 level or better. Source: Gansu Survey of Children and Families.

Figure 1.
 Proportion of Mothers Reporting that their Families “Almost Never” Consumed Each Food Type in the Past Month by Food Insecurity Status, 2004



Source: Gansu Survey of Children and Families.

Figure 2.
Food Security and Nutrition Measures by Wealth Quintile, 2004

Table 1

Food Insecurity Reported by Mothers of Target Children, 2000 and 2004

| | Mean | SD | N |
|---|------|------|-------|
| Food Insecure, 2000 | 0.26 | 0.44 | 1,999 |
| Food Insecure, 2004 | 0.07 | 0.26 | 1,866 |
| Food Insecurity Severity Index, 2004 | 0.00 | 0.70 | 1,866 |
| Among food Insecure in 2004, Proportion Reporting "Yes" for the Past Year: | | | |
| You or your family ever went hungry because you did not have enough food or enough money to buy food? | 0.36 | 0.48 | 137 |
| You or your family ever had to depend on relatives or friends to give you some food? | 0.41 | 0.49 | 137 |
| You or your family ever had to borrow money from relatives or friends to buy food? | 0.49 | 0.50 | 137 |
| Ever had to purposely cut the amount of food for children (under 16) because there was not enough food, or no money to buy enough food? | 0.23 | 0.42 | 137 |
| You or anyone in your family who is older than 16 ever had to go hungry for a whole day because there was no food? | 0.09 | 0.28 | 137 |
| Children (under 16) ever had to go hungry for a whole day because there was no food? | 0.06 | 0.24 | 137 |

Source: Gansu Survey of Children and Families, 2000 and 2004

Table 2

Nutrition and Food Security Measures, Child and Sibling Samples, 2004

| | Child Sample | | | Sibling Sample | | | Full Sample | | |
|---------------------------------|--------------|------|-------|----------------|------|-----|-------------|------|-------|
| | Mean | SD | N | Mean | SD | N | Mean | SD | N |
| Height-for-Age Z | -1.24 | 1.02 | 1,731 | -1.16 | 1.23 | 710 | -1.21 | 1.08 | 2,441 |
| Weight-for-Age Z | -1.33 | 1.10 | 1,716 | -1.37 | 1.24 | 714 | -1.34 | 1.14 | 2,430 |
| Proportion Stunted | 0.20 | 0.40 | 1,731 | 0.24 | 0.43 | 710 | 0.21 | 0.41 | 2,441 |
| Proportion Severely Underweight | 0.24 | 0.43 | 1,716 | 0.29 | 0.46 | 714 | 0.25 | 0.44 | 2,430 |
| Proportion Food Insecure | 0.07 | 0.26 | 1,866 | --- | --- | --- | --- | --- | --- |
| Food Insecurity Severity Index | 0.00 | 0.70 | 1,866 | --- | --- | --- | --- | --- | --- |

Source: Gansu Survey of Children and Families, 2004. Note: Stunting and wasting= <-2 Z score for height and for weight, respectively.

Table 3
 Analysis of the Social Location of Nutritional Deprivation and Food Insecurity, Child Sample, 2004

| | (1) | | | | (2) | | | | (3) | | | |
|--------------------------------------|-------------------------|------------------|-------------------------|------------------|-------------------------|------------------|-------------------------|------------------|---------------------------------------|-------------------|--|-------------------|
| | Height-for-Age Z-Scores | | Weight-for-Age Z-Scores | | Height-for-Age Z-Scores | | Weight-for-Age Z-Scores | | Marginal Effects, Logit Specification | | Regression of Food Insecurity Severity Index | |
| | coef | se | coef | se | coef | se | coef | se | coef | se | coef | se |
| Wealth Quintiles (Ref=Poorest Fifth) | | | | | | | | | | | | |
| Second | 0.085 | 0.072 | 0.135* | 0.076 | 0.135* | 0.076 | 0.135* | 0.076 | -0.017 | 0.011 | -0.124** | 0.054 |
| Third | 0.066 | 0.073 | 0.114 | 0.077 | 0.114 | 0.077 | 0.114 | 0.077 | -0.040*** | 0.010 | -0.248*** | 0.054 |
| Fourth | 0.175** | 0.073 | 0.076 | 0.078 | 0.076 | 0.078 | 0.076 | 0.078 | -0.061*** | 0.010 | -0.201*** | 0.054 |
| Wealthiest Fifth | 0.271*** | 0.075 | 0.279*** | 0.079 | 0.279*** | 0.079 | 0.279*** | 0.079 | -0.064*** | 0.010 | -0.249*** | 0.055 |
| Mother's Education | 0.023*** | 0.007 | 0.020*** | 0.008 | 0.020*** | 0.008 | 0.020*** | 0.008 | -0.001 | 0.002 | 0.005 | 0.005 |
| Father's Education | 0.006 | 0.007 | -0.005 | 0.008 | -0.005 | 0.008 | -0.005 | 0.008 | -0.003* | 0.002 | -0.006 | 0.005 |
| Age | -0.095*** | 0.012 | -0.112*** | 0.017 | -0.052*** | 0.013 | -0.084*** | 0.018 | -0.003 | 0.005 | -0.002 | 0.015 |
| Female | 0.060 | 0.042 | 0.129* | 0.069 | 0.163*** | 0.046 | 0.234*** | 0.075 | 0.008 | 0.011 | 0.044 | 0.034 |
| Constant | -0.177 | 0.171 | 0.276 | 0.228 | -0.859*** | 0.184 | -0.293 | 0.249 | | | 0.192 | 0.224 |
| Sample | Combined Sibling | Combined Sibling | Combined Sibling | Combined Sibling | Combined Sibling | Combined Sibling | Combined Sibling | Combined Sibling | Target Child Only | Target Child Only | Target Child Only | Target Child Only |
| N | 2,439 | 2,439 | 2,439 | 2,428 | 2,428 | 2,428 | 2,428 | 2,428 | 1,699 | 1,699 | 1,699 | 1,699 |
| rho | 0.236 | 0.535 | 0.196 | 0.518 | 0.196 | 0.518 | 0.196 | 0.518 | --- | --- | --- | 0.015 |

Notes:
 Parental education measures are set to 0 if parents have died. Models also include dummy variables indicating if mother died or father died.

*** p<0.01
 ** p<0.05
 * p<0.1.

Table 4

Models of Literacy, Target Child Sample, 2004.

| | (1) | | (2) | | (3a) | | (3b) | | | | | |
|-----------------------------------|---------------------------------------|------|-------|---|------|-------|--|-------|-------|---|-------|-------|
| | Baseline, Dichotomous Food Insecurity | coef | se | Socioeconomic Controls, Dichotomous Food Insecurity | coef | se | Prior ability and Achievement, Dichotomous Food Insecurity | coef | se | Prior ability and Achievement, Food Insecurity Severity Index | coef | se |
| Height-for-Age Z | 0.142 | *** | 0.034 | 0.106 | *** | 0.023 | 0.019 | 0.023 | 0.021 | 0.023 | 0.021 | 0.021 |
| Weight-for-Age Z | -0.014 | | 0.031 | | | | | | | | | |
| Food Insecurity | -0.524 | *** | 0.094 | -0.406 | *** | 0.094 | -0.335 | *** | 0.084 | -0.102 | *** | 0.037 |
| Age | 0.185 | *** | 0.022 | 0.173 | *** | 0.022 | -0.028 | | 0.023 | -0.026 | | 0.023 |
| Female | -0.242 | *** | 0.049 | -0.215 | *** | 0.047 | -0.158 | *** | 0.042 | -0.157 | *** | 0.043 |
| Wealth Quintiles (Ref.=Poorest) | | | | 0.131 | * | 0.076 | 0.046 | | 0.068 | 0.047 | | 0.069 |
| Second | | | | | | | | | | | | |
| Third | | | | 0.150 | ** | 0.076 | 0.045 | | 0.068 | 0.048 | | 0.068 |
| Fourth | | | | 0.173 | ** | 0.076 | 0.031 | | 0.068 | 0.043 | | 0.069 |
| Fifth | | | | 0.275 | *** | 0.078 | 0.065 | | 0.071 | 0.074 | | 0.071 |
| Mother's Education (Years) | | | | 0.037 | *** | 0.007 | 0.014 | ** | 0.007 | 0.014 | ** | 0.007 |
| Father's Education (Years) | | | | 0.026 | *** | 0.007 | 0.003 | | 0.007 | 0.004 | | 0.007 |
| Prior Cognitive Test (2000) | | | | | | | 0.012 | *** | 0.002 | 0.012 | *** | 0.002 |
| Prior Math Achievement (2000) | | | | | | | 0.005 | ** | 0.002 | 0.005 | * | 0.002 |
| Prior Language Achievement (2000) | | | | | | | 0.001 | | 0.002 | 0.002 | | 0.002 |
| Grade Attained | | | | | | | 0.246 | *** | 0.017 | 0.245 | *** | 0.017 |
| Constant | -2.356 | *** | 0.326 | -2.718 | *** | 0.320 | -1.978 | *** | 0.321 | -2.047 | *** | 0.321 |
| N | | | 1,511 | | | 1,526 | | | 1,521 | | | 1,521 |
| Adjusted r-squared | | | 0.090 | | | 0.135 | | | 0.308 | | | 0.304 |

Notes:

Parental education measures are set to 0 if parents have died. Models also include dummy variables indicating if mother died or father died.

*** p<0.01

.1 > p > .05
*
**

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 5

Propensity Score Matching Estimates, Effect of Food Insecurity on Standardized Literacy Achievement (Average Treatment Effect on the Treated, ATT), Child Sample, 2004

| Sample | Treated | Controls | Difference | S.E. | T-stat |
|----------------|--------------|--------------|--------------|-------------|--------------|
| Unmatched | -0.51 | 0.06 | -0.57 | 0.10 | -5.89 |
| <i>Matched</i> | <i>-0.50</i> | <i>-0.12</i> | <i>-0.39</i> | <i>0.12</i> | <i>-3.21</i> |

Note: Propensity score equations contain all variables shown Model 3a in Tables 4-6, with the dichotomous food insecurity measure as the treatment. Kernel matching is used.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript