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CHILD AGE AND GENDER DIFFERENCES IN FOOD SECURITY IN A LOW-INCOME INNER-CITY POPULATION

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ABSTRACT

A long literature in economics concerns itself with differential allocations of resources to different children within the family unit. In a study of approximately 1,500 very disadvantaged families with children in Boston, Chicago, and San Antonio from 1999 to 2005, significant differences in levels of food allocation, as measured by an indicator of food "insecurity," are found across children of different ages and genders. Using answers to unique survey questions for a specific child in the family, food insecurity levels are found to be much higher among older boys and girls than among younger ones, and to be sometimes higher among older boys than among older girls. Differential allocations are strongly correlated with the dietary and nutritional needs of the child. However, the differences in allocation appear only in the poorest families with the lowest levels of money income and family resources in general, and most differences disappear in significance or are greatly reduced in magnitude when resources rise to only modest levels. Differences in food insecurity across different types of children therefore appear to be a problem primarily only among the worst-off families.

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A large and multi-threaded literature has examined parental allocations of resources to different children across a wide variety of areas. The classic Becker and Tomes (1976) study suggesting that parents provide educational resources differently to children with different ability endowments set off a significant strand of literature which is continuing (e.g., Behrman et al., 1982; Cunha and Heckman, 2007; Aizer and Cunha, 2012). Another large strand has studied different parental food and health allocations to children in developing countries, including differences across children by birthweight, other health endowment indicators, and gender (Pitt et al., 1990 is an early study followed by many more). In the U.S., a smaller thread has asked if parental resources are related to child health (e.g., Datar et al., 2010; Del Bono et al., 2012), while a sizeable literature has examined differences in parental allocations by child gender, particularly differences in parental time inputs and other variables that might explain gender gaps in test scores, noncognitive traits, education levels, and other outcomes (Lundberg, 2005; Goldin et al., 2006; Dahl and Moretti, 2008; Fryer and Levitt, 2010; Bertrand and Pan, 2013; Autor et al., 2016).

This paper contributes to the literature on differential parental allocations to children by examining whether a child's "food security," a variable correlated with child food consumption, differs by the child's age and gender in low-income families in the U.S. Differential food allocations to children have been thought to be primarily a problem in developing countries, not in a prosperous country like the U.S., yet it is also known that poverty is stubbornly high in the

U.S. and that a large fraction of families is extremely poor, living on very meager resources (Edin and Shaefer, 2013). Consequently, differences in food inputs across children may arise among very low income families. The data used here cover only low-income families, which are the families where differential food allocations across different children are mostly likely to appear.

This paper is the first to examine whether food security differs across children of all different ages and genders in very poor families and whether meager resources impel parents to make difficult food allocation decisions within the family, and using a food security measure well aligned with that of the U.S. Department of Agriculture (see below). While the National Health and Nutrition Examination Survey (NHANES) has asked questions regarding individual children's food security, the questions covered a shorter period than ours, and the questions differed by age of child, making it difficult to compare them across those ages. (Bhattacharya and Currie, 2001; Nord, 2013).[1] Also, the Child Development Study of the Panel Study of Income Dynamics (PSID), while not having questions on food insecurity per se, does have questions for children 10-17 about how many days the children had eaten breakfast foods of different types in the past week. Using these data, Woodward and Ribar (2012) found gender and age differences in quantity and types eaten.

[1] The questions differed for children younger than 12 and 12 and older, and adult proxies answered the questions for younger children while older children answered on their own. The NHANES food insecurity question for the child used by Bhattacharya and Currie (2001) consisted of a single question, "had enough to eat." The authors found that boys fared worse than girls on this dimension. Bhattacharya et al. (2004) analyzed later NHANES data which had two questions on food insecurity, also only for those 12 and over, concerning how many days in the past month the adolescent skipped meals, but the study did not examine food insecurity as an outcome per se.

A sizable literature exists on U.S. food security, where the term is conceptually defined as having “access by all people at all times to enough food for an active, healthy life” (Coleman-Jensen et al., 2015). The converse of food security, food insecurity, is regularly measured by a set of survey questions developed by the U.S. Department of Agriculture (USDA) in 1995 and asked annually since then in the Current Population Survey (CPS). The questions ask if the adults or children in a household have experienced a range of food deprivations in the last twelve months because of a lack of money, ranging from mild instances of worrying about running out of food to more severe instances of having to skip eating for an entire day. The USDA has set specific thresholds of food insecurity based on reports of multiple food intake problems in the answers to the survey questions (USDA, 2014). Previous research using the CPS and other survey data sets that ask food security questions has identified a long list of correlates of food insecurity, including low income, not owning a home, low levels of education, living in a family with an unmarried household head and unmarried status in general, minority race-ethnicity status, living in a household with adults with physical or mental disabilities, the presence of substance abuse in the family, poor child care arrangements, and disadvantageous parenting styles, among other conditions (Gundersen et al., 2011; Gundersen and Ziliak, 2014). Triggering events for food insecurity include shocks to income, job loss, disruption to housing arrangements, and the occurrence of other crises.

This paper departs from these studies by making use of a unique survey that measured food insecurity for a specific, randomly selected child in a sample of low income families, permitting an examination of how insecurity varies at the individual child level. Such an investigation has not been possible heretofore, except for the studies of adolescents referenced above, because the standard USDA questions only ask about food insecurity for the children in the household as a whole.

However, while individual food insecurity has not been comprehensively examined in the literature for data reasons, a related issue about intrafamily allocations has been investigated, namely, whether food insecurity differs between adults as a whole and children as a whole. This can be investigated because the USDA questions are asked separately for adults and for children. Studies of the data on this issue have led to what is known as the "child protection hypothesis," which posits that adults sacrifice their own food security before allowing their children to experience it. Simple evidence for this hypothesis is that, within families, food insecurity levels for adults as a whole are higher than those of the children as a whole (Coleman-Jensen et al., 2015; Kirkendall et al., 2013). The analysis here, measuring food insecurity at the individual child level, can pursue this question further by asking whether adults sacrifice their own food security differentially for children of different ages and genders.

The data set for this study was developed from a survey of very low income families in the high-poverty neighborhoods in three large U.S. cities from 1999 to 2005. The sample is a particularly disadvantaged one relative to the general low income population. The respondents were mostly Black and non-Black Hispanic and hence mostly minority, and the survey oversampled single-mother families and families on welfare (although sampling weights allow an adjustment for this). While the results presented here cannot be generalized to a nationally representative sample of low income families, very disadvantaged minority families in U.S. inner cities are a group known to be particularly vulnerable to a variety of deprivations and constitute a population of special policy concern. Future research can determine whether the results found here extend to other groups.

There are several notable findings from the analysis of these data. First, the data are overwhelmingly consistent with the child protection hypothesis, for adult levels of food insecurity are much greater than those of the child. Second, the data show strong evidence that food insecurity is positively correlated with the age of the child, and for both adult and child food insecurity. Third, smaller but noticeable gender differences in food insecurity appear in the data, with the strongest effects for adolescents where insecurity (both child and adult) is higher for boys than for girls. Thus, contrary to the hypothesis in the son preference literature (e.g., Dahl and Morretti, 2008), the data here imply daughter preference. Fourth, a large fraction of the age difference in insecurity is explained by differential food needs, consistent with intuition and with a simple economic model outlined in the paper which shows that individuals in the family who have higher and therefore more costly food needs end up with a lower probability of their needs being satisfied. Fifth, age and gender differences are strongly correlated with whether the family has cash income below the poverty line or is experiencing some form of financial strain; families with income above the poverty line or not experiencing such strain generally have much smaller, and often insignificant, differences in food insecurity by age and gender of the child. Sixth, differences in food insecurity by age and gender of the child are much stronger for families with unmarried mothers than those with married mothers, and for those families without established routines like eating together at breakfast and lunch than for families with such routines.

This study relates to, but is separate from, the literature on child diet quality and nutrition, since the food insecurity questions asked in the data used here and by the USDA concern quantity and not quality of food consumed. Bhattacharya and Currie (2001) and Bhattcharya et al. (2004) both found that food insecurity was only weakly related, at best, to diet quality and nutritional status for children 12-17. Ver Ploeg (2009) also examined those outcomes for children 12 and over and found that boys have better nutritional status on some nutrients but worse status on others. As we note in our Conclusions, further work on the relationship between diet quality and nutritional status across children of different ages and genders would be worthwhile.

The next section discusses the data and presents the basic results. The following section lays out a simple optimizing model of parental behavior to guide thinking about possible causes, particularly the relative roles of parental preferences for different children versus differences in their production functions. The sections that follow examine the roles of differential dietary and nutritional needs, family structure and levels of family organization, and level of family resources.

Data and Initial Results

<u>Data</u>. The Three-City Study (TCS) was a longitudinal survey of approximately 2,400 low-income families living in Boston, Chicago, and San Antonio. When they were first surveyed in 1999, each of the families had a household income below 200 percent of the poverty line, had at least one child 0 to 4 or 10 to 14 years of age, and was living in a low- and moderate-income neighborhood. The data constitute a random sample of the population with these characteristics. In addition, because the study was intended to focus on the children of low-income families after 1990s welfare reform, one "focal" child in the family in either the 0-4 or

10-14 age range was randomly selected for special data collection. The households were interviewed three times from 1999 to 2005. By the end of the survey, the children who were initially 0-4 had grown to 6-10 and the children who were initially 10-14 had grown to 16-20, thus providing us with an artificial cohort spanning the full age range of children 0-20 (although we only consider children 0-18). The survey collected a wide range of information on employment, income, family structure, welfare participation, characteristics of the focal child's caregiver (usually the mother), and food security in each of the three waves of interviews. In addition, the interview collected data on several variables, including financial strains, family routines, and social networks, not present in most other studies but which will be shown to be related to the main findings.

Most of the families were headed by a single mother but a few married families were sampled as well. The vast majority of the sample was either Hispanic or Non-Hispanic Black and hence heavily minority, reflecting the characteristics of the low-income neighborhoods of the cities.[2] While, as noted above, the income cutoff was a relatively high 200 percent of the poverty line, the sample was very poor and disadvantaged, with quite low levels of education as well as poor physical and mental health.[3] While the trends in unemployment rates and welfare caseloads in the three states over the period 1999-2006 were similar to those in other states, the findings below should not be generalized to populations other than very disadvantaged, mostly

[2] Details of the design can be found in Winston et al. (1999).

[3] Frogner et al. (2009) summarized the findings on the welfare receipt, employment, and income levels of the sample. Two studies of food security with these data have been conducted (Depolt et al., 1999; Moffitt and Ribar, 2016), but these did not focus on the age and gender characteristics of the child as this study does. Other studies using the data can be found on the project website at http://web.jhu.edu/threecitystudy.

Non-Hispanic Black and Black populations, without further research.

The TCS survey asked only a subset of 8 of the standard 18 USDA food security questions from the CPS. The 8 are shown in Appendix 1. The first 4 questions are identical to 4 of those in the adult portion of the USDA battery and were selected to reflect the questions about more severe hardships. The second 4 were drawn from the 8 in the child-related portion of the USDA battery but were modified to ask about hardships of only the focal child in the household rather than of all children. The 4 questions that were chosen were also those concerning more severe hardships. The 8 questions were asked in identical form in all three waves of the TCS survey.

For families with children, the USDA analyzes the answers to its 18 questions by summing the number of positive answers and then creating binary variables for whether the sum is greater than particular cutoffs. For example, the USDA defines "Low Food Security" as answering 3 or more of the 18 questions affirmatively and "Very Low Food Security" (VLFS) as answering 8 or more of the 18 questions affirmatively (Coleman-Jensen et al., 2015). The USDA also creates binary variables for food insecurity among children using the sum of affirmative answers to the 8 children-related questions alone. Here we take a broader approach to the definitions by using both binary indicators based on cutoffs of the sums of the TCS questions, but also using the sums themselves which are continuous measures of food insecurity. The sums have a larger range than the binary variables, obviously, and hence contain more variation and should contribute more statistical power to the analysis. On the other hand, if there are nonlinearities in the relationship between the covariates and the sums, the binary outcomes might provide more statistical power if the nonlinearity is strong around the cutoff point. We therefore employ both binary and summation measures.

As emphasized earlier, we also distinguish between answers to the four food insecurity questions asked about the adults and the four asked about the focal child. We use six outcome variables in our analysis below, defined with the following acronyms:

1. VLFS: binary variable equal to 1 if 2 or more of the 8 TCS questions are answered affirmatively
2. VLFSA: binary variable equal to 1 if at least 1 of the 4 adult questions is answered affirmatively
3. VLFSC: binary variable equal to 1 if at least 1 of the 4 child questions is answered affirmatively
4. SUM: sum of the affirmative answers to the 8 questions
5. SUMA: sum of the affirmative answers to the 4 adult questions
6. SUMC: sum of the affirmative answers to the 4 child questions

The first variable, VLFS, represents an approximation to the USDA Very Low Food Security binary indicator. We do not examine the less severe USDA Low Food Security indicator because it cannot be distinguished from VLFS with the TCS food hardship items. Our choice of a cutoff of 2 or more for the definition of our VLFS is based on an extensive preliminary analysis using the 18 USDA questions (in their 1999 survey), which we used to determine what cutoff should be used for the 8 TCS questions to classify families into VLFS status most closely to the same way they would be classified if all 18 USDA questions were used. Our analysis, reported in Appendix 2 and also detailed in Moffitt and Ribar (2016), shows that the cutoff of 2 achieves the maximal congruence with the USDA measure.

However, because only 4 questions were asked of the adults and of the focal child, and because the distribution of the answers is concentrated at the lower end of their sum distribution (see below), we define their binary indicators, VLFSA and VLFSC, as answering at least one of the questions affirmatively.[4] Finally, the three SUM variables are simply defined as the sum of the affirmative answers to the 8 questions for the household as a whole, and over the 4 questions for the adults and the focal child, respectively.

Table 1 shows the means of these six measures for our analysis sample, which is the pooled sample over all three interviews of all children 18 and under for whom the caregiver of the focal child was the same and present at all three waves (1,463 children, for a total of 4,229 pooled observations over all three waves). A little under 8 percent of all families experienced VLFS, with a slightly higher rate among families in which the focal child was a boy rather than a girl (8 percent versus 7.6 percent). Still, the gender difference is statistically insignificant (10 percent level). But the frequency of food insecurity reports is much higher among adults than for the focal child, with 12 percent of the former reporting at least one problem but only 3.9 percent of the latter. This is strongly consistent with the child protection hypothesis cited in the Introduction.[5] No gender differences appear in either the adult or child binary indicators, however. For the variables representing the sums of the answers to the questions, only conditional means are shown in the table (the unconditional means are the product of the binary indicator means and the conditional means). Again, the mean number of reports of insecurity is

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[4] An analysis similar to that for VLFS discussed in Appendix 2 shows that this binary indicator for the 4 child questions most closely approximates the USDA Very Low Food Security Among Children indicator which uses all 8 USDA child questions (Moffitt and Ribar, 2016).

[5] The economic model in the next step will reinterpret the child protection hypothesis as a matter of allocating food to the individuals where the marginal product is highest.

higher for adults than for children, and the gap between whether the focal child is a boy or girl widens for the adult reports, with adults reporting more hardships if the focal child is a boy.

The lower portion of the table shows differences by the age of the child, using three common demarcations of stages of childhood, 0-5, 6-11, and 12-18. The results are broadly consistent across all six of the insecurity outcomes and tend to show that food insecurity, whether for the household as a whole, for adults, or for the focal child, tends to rise with the age of the focal child. But for the binary indicators, the age gradient is somewhat steeper for boys than girls. The increase in adult insecurity with the age of the child is inconsistent with a simple version of the child protection hypothesis, which would suggest that adults protect adolescents less than young children. But it could also be interpreted as suggesting that food insecurity among adolescents would be even greater than it is, were adults not to sacrifice some of their own food consumption. Of course, no other variables have been controlled for yet which might explain the pattern of adult food insecurity with the age of the child in other ways.

Gender differences also appear in these separate age means that were not apparent in the means taken over all ages, but they are not large in magnitude. There is a slight tendency for insecurity reports to be higher for the youngest girls than for the youngest boys but the opposite for adolescent boys and girls. However, this pattern is not present in a consistent way for the conditional SUM measures.

Initial Multivariate Results. Tables 2 and 3 show initial estimation results of multivariate models for the six measures of food insecurity. We estimate random effects probit models for the three binary outcomes and random effects ordered probit models for the three SUM variables, in all cases using survey weights to correct for the oversampling of certain segments of the target population. The control variables and their means are shown in Appendix Tables 3A to 3C.

Table 2 shows the results, first with a simple additive age-gender specification and then with age and gender interacted, but just for the overall family binary indicator for Very Low Food Security. Taking the control variables first, most results are similar to those in the literature. Having income below the poverty line and having an unmarried caregiver, for example, increase the probability of experiencing VLFS, as does having a disabled caregiver.[6] Having more adults in the family also increases the probability while having more other young children in the family decreases it. Being a recipient of SNAP lowers the probability of having VLFS. This result differs from many estimates of positive effects in the literature which are usually thought to occur because of selection bias.[7] The negative sign in this sample suggests that very little if any selection bias is likely present, and this may be, in turn, because of the homogeneous nature of the TCS sample (all from inner city poor neighborhoods, all very disadvantaged, etc.).

Turning to the main results, column (1) shows that the strong age effects present in the raw means in Table 1 are maintained even while controlling for these covariates, with families with a younger focal child still having significantly lower probabilities of VLFS than those with

[6] Additional equations were estimated which decomposed both family income and the poverty-status dummy into permanent and transitory components, measured, respectively, by the mean of each variable over the three waves and the family's deviation from the mean in each wave. The results (available upon request) show a significant negative effect of permanent income on food insecurity and significant positive effects of both permanent and transitory poverty status on food insecurity. However, the coefficients on child age and gender were not affected, so these results are not shown.

[7] See the discussion in Gregory et al. (2016). Our result has also been found in previous studies using these data (DePolt et al., 2009; Moffitt and Ribar, 2016).

children 12-18 (there is no significant difference between the 0-5 and 6-11 child families, however). Further, the coefficient on gender is insignificant, suggesting no average differences between families with girls and boys. Indeed, this has been found in some other studies as well (e.g., Nord, 2013), leading some analysts to conclude that there are no gender differences in food security in the U.S. But examining gender groups separately by age (column (2)) shows that this is not the case. While the same age pattern found for both genders combined is found for families with boys and girls separately--although the age gradient is steeper for those with boys--families with a boy focal child 12-18 have significantly greater probabilities of VLFS than those with a girl focal child in the same age range (probit coefficient = -.334). Just the opposite is the case for families with very young children, where having a boy focal child 0-5 results in a lower probability of having VLFS than having a girl focal child in the same age range (-.522 vs -.835).[8]

Table 3 shows, in the upper panel, the coefficient estimates on the age-gender variables from specifications that have the same control variables as column (2) from Table 2 but estimated for all six outcome measures. The age gradient is maintained for almost all outcomes, with the exception of girls 6-11 for some of the outcomes. The age gradients for adult food insecurity are generally smaller than the age gradients for child insecurity. The gender gradients are, however, considerably smaller for the adult and child insecurity measures than they were for overall VLFS. The gender gaps at 0-5 and 12-18 are no longer significant, and the gap at 6-11 is only significant for some outcomes.

The implied magnitudes of the differences translated into probabilities of insecurity (i.e.,

[8] Any pairwise difference between two age-gender categories which is statistically significant at the 10 percent level is indicated in the table. Any such comparison with no significance level shown is statistically insignificant.

marginal effects) are arguably more relevant and are shown in the bottom portion of the Table. The age gradients are particularly strong for males, with 12-18 males having between 5 and 8 percentage points higher food insecurity than 0-5 boys. Girls 12-18 also have higher food insecurity than younger girls, but the magnitude of the gap is generally smaller with 0-5 girls and generally larger with 6-11 girls than for the same gaps for boys. There is no consistent pattern in whether these age gradients are larger for adult food insecurity than for the focal child, with the adult gradient sometimes larger than for the child but often in the other direction as well. The gender differences are only significant at conventional levels for overall food insecurity and for VLFS for adults and never significant for child measures, implying that any gender effects are manifest more in adult food insecurity differences. Where significant, the gender gradients imply the same reversal from younger ages to older ages, but the magnitudes are largest for the middle, 6-11 age group.

A Simple Economic Model

A simple economic model can help frame these results and help formalize at least some of the possible explanations for the differences in food security across members of the household. One possibility is that adults and children, and children of different ages and genders, have different nutritional needs, which could lead to different quantities of food being required to reach a given level of food well-being. However, there is no automatic implication that food insecurity differentials will exist for this reason because it is a matter of choice of how much money is spent on food for different family members, and it could be that enough is spent to equalize food security levels across family members, for example. The model below will clarify this. Different nutritional needs could also be traced to differences in the activity levels of adults and children and for different ages and genders of children, which might generate different nutritional intakes to satisfy. A second possibility is that adults and children, and children of different ages and genders, may have different non-food needs. A household with a given income faces a decision over which goods to allocate to different family members, and consumption of clothing, housing (bedroom size, e.g.), and medical care all compete for the household dollar. Even without differences in nutritional needs, a household may allocate its income differently across different goods for different family members if non-food needs differ. A third possibility is that food consumption for children has important future consequences which may be more important than for adults, and may have consequences for future health, education, and earnings. In addition, the importance of food intake for future outcomes may differ for children of different ages and gender, and early child food intake may have implications for health and well-being at later child ages. A fourth possibility is that a household simply has different preferences for members with different characteristics. A fifth is that the age and gender composition of the children are related to household capabilities and functioning, such as financial management, family organization, and family routines, as will be discussed in more detail below.

There have been a few models in the food insecurity literature which focus on some of these aspects of household decision making (Barrett, 2002; Gundersen and Gruber, 2001; Meyerhoefer and Yang, 2011; the last of these draws on Cawley (2004)). However, none of these frameworks attempts to model differences between adults and children or between children of different characteristics. The studies cited in the introduction (Becker and Tomes, 1976;

Behrman et al., 1982; Aizer and Cunha, 2012) are more relevant because they focus on individual child allocations, where one of the central questions is whether allocations are reinforcing or compensating, i.e., whether children with higher ability or health endowments receive greater or fewer resources than children with lower ability or health endowments. In all these studies, the traditional household production framework is the workhorse model, and that is the same here.

Many of the issues can be seen with a model of a household composed of adults and a single child. Let the household problem be to

$$\underset{F_A, F_C, O_A, O_C, H}{\text{Max}} \quad U(S_A, S_C, N_A, N_C, H, Y_C) \qquad (1)$$

subject to the constraints

$$S_i = f(F_i; X_i) \quad \text{i=A,C} \qquad (2)$$

$$N_i = g(O_i; X_i) \quad \text{,i=A,C} \qquad (3)$$

$$Y_C = h(S_C, N_C; X_C) \qquad (4)$$

$$M = H + p \cdot (F_A + F_C) + q \cdot (O_A + O_C) \qquad (5)$$

where S_A is adult food security, S_C is food security of the child, N_A is adult non-food security (i.e., security arising from non-food consumption, somehow defined), N_C is non-food security of the child, H is public goods consumption within the household, and Y_C is a future outcome (health, education, earnings) of the child. Food security is here assumed to be a continuous measure of food intake which can generate discrete indicators such as those used in the food security literature. Non-food security is set up to parallel food security, solely for the purpose of formality. Both food and non-food security are generated by production functions *f* and *g*, with positive first and negative second derivatives, with inputs of the adults' and child's food consumption, F_A and F_C, and non-food consumption, O_A and O_C, respectively. The functions depend on X_A and X_C, the individual characteristics of the adult or child, most prominently age and gender. Future outcomes for the child are affected by food and non-food security and also depend on child characteristics, X. Household income, M, is allocated to current food and non-food consumption to adults and the child, with prices p and q, respectively.

Our interest in this model is in the food allocation to the adults versus the child, which is governed by the marginal condition

$$U_1 f'(F_A; X_A) = U_2 f'(F_C; X_C) + U_6 h_1(S_C, N_C; X_C) f'(F_C; X_C) \quad \textbf{(6)}$$

The term on the LHS and the first term on the RHS show that if either the marginal utilities of increasing food security for the adults and the child differ, or the marginal product of additional food allocations on food security differs, food allocations will also tend to differ. The second term on the RHS shows simply that if food security affects future child outcomes, food allocations will tend to be greater to the child than to the adults even if the production functions and marginal utilities of the adult and the child are the same.[9] Ignoring these future outcomes

[9] Adult outcomes such as health and hence wage rates could also be affected by lack of sufficient food intake. These are simple examples of investments in health capital, as originally

and just examining the other two terms also clearly shows that even if marginal utilities are the same, more food will be allocated to the child if the marginal product of a given amount of food in the production of food security is higher for the child, which is plausible because children have lower food requirements than adults. However, note that there is no need in this model for the levels of food security to be equalized between the adults and the child, because it is only the marginal products (weighted by marginal utilities and ignoring future payoffs) that are equalized. At the optimum, adult food security could be greater, equal, or less than that of the child. On the other hand, it is plausible that (1) the marginal product of incremental food consumption is higher for the child at low levels of F, (2) but its marginal product declines more rapidly than for the adults, and (3) the marginal product of F for adults is greater than that of the child at higher levels of F. In that case, it is plausible that the household first devotes food consumption to the child and then to the adults thereafter, stopping at a point where resources limit further consumption but at a level where S is lower for adults. This would be consistent with the child protection hypothesis.

A model with multiple children speaks more directly to the issues raised by the results reported in the previous section. Now let the model be:

$$\underset{F_A, F_{C_1}, \ldots, F_{C_n}, O_A, O_{C_1}, \ldots, O_{C_n}, H}{Max} \quad U\left(S_A, S_{C_1}, S_{C_2}, \ldots S_{C_n}, N_A, N_{C_1}, N_{C_2}, \ldots N_{C_n}, H, Y_{C_1}, Y_{C_2}, \ldots, Y_{C_n}\right) \qquad \textbf{(7)}$$

subject to the constraints

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emphasized by Grossman (1972).

$$S_i = f(F_i; X_i) \quad , i = A, C_1, C_2, \dots, C_n \tag{8}$$

$$N_i = g(O_i; X_i) \quad , i = A, C_1, C_2, \dots, C_n \tag{9}$$

$$Y_i = h(S_i, N_i; X_i) \quad , i = C_1, C_2, \dots, C_n \tag{10}$$

$$M = H + p \cdot (F_A + \Sigma F_i) + q \cdot (O_A + \Sigma O_i) \tag{11}$$

for i=1,…,n children each with characteristics X_i. The marginal condition for relative food allocation between child i and child j is

$$U_{C_i} f'\left(F_{C_i}; X_i\right) + U_{Y_i} h_1\left(S_{C_i}, N_{C_i}; X_i\right) f'\left(F_{C_i}; X_i\right) = U_{C_j} f'\left(F_{C_j}; X_j\right) + U_{Y_j} h_1\left(S_{C_j}, N_{C_j}; X_j\right) f'(F_{C_j}; X_j) \tag{12}$$

Once again, greater allocations of food will tend to be made to those with higher marginal products in either the production of food security or in future payoffs from increased food security, ignoring differences in marginal utilities. Both of these are likely to be greater for younger than older children, and the presence of dynamic complementarities (Cunha and Heckman, 2007) could generate an additional incentive to allocate more resources to younger children. Gender differences are not so clear. One possibility is that the rate of return to future earnings in investing in children is greater for girls because they have a higher likelihood of going to college relative to food investments in boys for building strength in non-college jobs. There could also be gender differences in activity levels, and more active children may have greater nutritional needs, although this would suggest a higher allocation to older children and to boys. Note that, similarly to the case of adults vs. children discussed above, there is no necessity for levels of food security to be equalized across children, for only the marginal gains in utility from incremental food allocations are equalized.

A question to be examined below is whether any differences in food allocations and resulting food security tend to diminish as income rises. In the model as stated, there is no reason for those differences to decline because the continuous variable for food security could increase without bound. However, the empirical work here is based instead on discrete indicators of low food security. As income rises, it should be expected that food allocations rise and that means that food security does as well and, after a point, all individuals in the family are likely to have passed whatever threshold is determining the discrete indicators. Therefore it should be expected that these between-children differences in the food security indicators will decline and will decline for all household members as income rises. However, there is still an important empirical question of exactly how high income has to rise before the differences in the indicators start to narrow.

As noted in the Introduction, individual-level food security should be correlated with individual food consumption, but they are not equivalent because some of the questions ask about hunger, which is a different thing. For example, older children with higher food needs could be allocated more food but still could be hungrier than younger children. In fact, that is the main interpretation of the results in the next section. The same goes for adults versus children. This weakens the link between the food insecurity indicators we have and the quantity of consumption.

Another factor not in this model is the choice of food quality and nutrition. Low income families may save money by purchasing low-quality, non-nutritious food which comes at the expense of future health and other outcomes. Existing evidence suggesting that child obesity is negatively correlated with SES suggest that this might be the case, but other measures of nutrient intake and diet quality are only weakly correlated with poverty status (Bhattacharya and Currie, 2001; Bhattacharya et al., 2004). However, for present purposes, any positive impact of family income on nutrition and diet quality would imply that the levels of food insecurity measured by the questions used here and those asked in USDA surveys underestimate the deleterious consequences of food deprivation, for food deprivation found in response to these questions must occur despite any efforts by parents to feed their children with lower-priced foods.

The model implies that the optimal food and non-food allocations to different children should be a function of income, the relative prices of food and non-food individualized consumption goods, and the parameters of the production and utility functions. The data set available here has no information on most of these variables, including the core choice variables which are the food and non-food allocations. Consequently, only reduced form equations for the main outcome variables in the data, the food security levels of the focal child and of the adults, can be estimated. These equations have to be interpreted as reduced forms of the production functions for S, obtained by solving for the optimal allocations of F and O and substituting those into the equation.

However, several important aspects of possible correlates of age and gender gaps between children can be examined. First, data are available on the nutritional needs of children of different ages and genders, and these can be used to explore the degree to which they can explain the gaps (these variables should be thought of as being included in the *X* vector). Second, data are available on family structure, which can be used to explore whether the gaps are related to the marital status of the mother, as suggested by Bertrand and Pan (2013) for gender gaps alone. The data set here also has a measure of whether the household is well organized in a sense to be defined below. Third, data are available on family income, of course, but also on other aspects of resource availability, including resources from the family's network. These can be used to explore whether the age and gender gaps shrink as resources rise, as predicted by the model (Autor et al., 2016, have found recently that gender gaps rise with the level of the disadvantage, while Bhattacharya and Currie, 2001, found that gender caps in diet quality did not rise with income). Also available in the data is a variable for whether the family has difficulty meeting its desired expenditure ("financial strain"), which is both a measure of financial management skills of the parents as well as hardships that result from short-term shocks to resources (e.g., Bray 2001 detected these separate dimensions in an analysis of responses to financial stress questions in Australia). With respect to financial management, a qualitative study by Edin et al. (2013) found that low-income parents invest enormous amounts of time in deciding where to shop for food, finding where the best prices are, looking for sales, planning meals around inexpensive foods, and managing their budget in general, and that some parents are more skilled at that activity than others. Mullainathan and Shafir (2014) have emphasized the cognitive challenges that low-income individuals face in making rational decisions. A quantitative analysis by Gundersen and Garasky (2012) had a measure of financial management skills and found that such skills reduce the incidence of food insecurity. With respect to the hardship element, Joyce et al. (2012) documented that children's food problems and hunger rarely happen in isolation but rather often co-occur with a constellation of other financial and non-financial hardships. The financial strain variable used below may capture both the management and hardship dimensions.

Nutritional Needs

Two measures of nutritional needs by the age and gender of children are available, one developed by the USDA used to set SNAP benefit levels and one from the Institute of Medicine. Regarding the first of these, the USDA has for many years estimated the cost of purchasing a minimally adequate diet for individuals of different ages and genders. The methodology uses dietary guidelines established for different ages and genders and determines the market basket of different food groups needed to meet the Recommended Daily Allowances (RDAs) for 15 essential nutrients (U.S. Department of Agriculture, 1999). Specific low-cost options for weekly meals which attain these RDAs are then calculated by obtaining prices for different foods which together will yield this outcome. The minimal cost of that bundle of meals is called the Thrifty Food Plan (TFP) and is widely used to assess the adequacy of family incomes to achieve minimally nutritious diets as well as being used by USDA to set SNAP allotments.[10]

Table 4 shows the 1999 USDA TFP weekly food costs for individuals of different ages and genders in a family of four. Food costs for children less than 12 do not differ by gender but rise significantly with age. Gender differences in food costs appear for older children and adults but those are also modest in size, but some of the age differences (e.g., between adolescents and

[10] Caswell and Yaktine (2013) and Ziliak (2016) critique the TFP measure by noting that it assumes that families purchase the lowest-cost foods and devote large amounts of time in food preparation. This implies that the TFP may underrepresent the cost for the average family which cannot devote that degree of time and must purchase higher-price food items.

those under 12) are larger. Given these differences, a family with limited financial resources may choose to forgo expenditures for adolescents with their high food costs in favor of protecting younger children and maintaining their food input at nutritionally adequate levels. Or, in the language of the model, the marginal product of a given amount of food expenditure may be greater for those with lower nutritional needs.

We follow a three-step method to determine how much of the age-gender gaps can be explained by nutritional needs. The first step is to use Table 4 to assign a TFP value to each focal child in the sample, using that focal child's age and gender.[11] We then reestimate the food insecurity equations in Table 3 but substitute the TFP variable for the focal child for the five age-gender indicators in that equation. The third step is to use these estimated equations to predict what the age-gender food security gaps would be based solely on TFP differences. By comparing the predicted gaps to the actual ones, we can assess how much of the observed, actual gap can be explained by differential nutritional needs.

The estimates of the coefficients on the focal child TFP variable are positive and strongly significant for all six measures of food insecurity, with t-statistics ranging from 3 to 5 (not shown). But the main question is how much they explain the differences in marginal effects shown in the lower panel of Table 3. The predicted differences from the TFP estimates are given in Table 5, which should be compared to those in Table 3. For boys, differences in TFP explain a major part of the age gaps, ranging from a low of about one-fourth of the actual gap to all of it (or, in a couple of cases, more than all of it). Most of the values are in the one-half to two-thirds

[11] As noted in the footnote to Table 4, those figures differ by family size, so this must be taken into account in the assignment.

range for both the binary and SUM measures, and usually a larger fraction is explained for girls than for boys. But TFP nutritional needs explain almost none of the gender gaps that were significant in Table 3, which is not surprising given that the TFP does not have a gender component below age 15 and only a modest component at ages 15-18.

A second measure of nutritional needs is produced by the Institute of Medicine as part of its series of Dietary Reference Intakes (DRIs), which have replaced the old RDAs, and are calculated as estimated average requirements for over 20 nutrients by age and gender.[12] While most DRIs vary with age in the expected way, no gender differences for children 8 and below are estimated and those for children over 8 are usually small. For the purpose of this exercise, the three nutrients with the strongest gender differences above age 8—Vitamin A, Zinc, and Magnesium—were purposely selected to obtain an upper bound on how much these nutrient indices can explain the gender gap. For all three, boys were estimated to have higher requirements than girls. The three-step procedure used to estimate the influence of TFP values was then duplicated—first determining the value of each nutrient for each focal child, then reestimating the food insecurity equation by replacing the age-gender dummies with the three nutrient values for the focal child, then predicting the age-gender gaps implied by those nutrient values alone. Table 6 shows the predicted age and gender gaps from these nutrient values alone, which should again be compared to the bottom panel of Table 3. For the age gaps, these nutrient values generally explain even more of the gaps for boys than the TFP values did, but the opposite is generally true for girls, where these nutrients more often than not explain less than

[12] http://www.nationalacademies.org/hmd/Activities/Nutrition/SummaryDRIs/DRI-Tables.aspx.

the TFP values (with some exceptions). For gender gaps, while these nutrients explain little of the gaps for younger girls, they explain much more of the gaps for teenage boys and girls and, again, in some cases, explaining all or more than all of it. While the nutrients selected were intentionally those which had large gender gaps for teenagers, this does suggest that nutrient requirements have the potential to explain much of the gap for that age group.

These results therefore imply that differences in nutritional needs “explain” a large fraction of the age differences in food insecurity across children. As noted previously, the needs differences explain the food insecurity differences only in the sense that they imply that parents do not allocate food expenditures across children to equalize levels of food insecurity, which does not imply that they do not allocate more expenditure per se to children with higher needs—just not enough to reduce their food insecurity levels to those of children with lower needs. These findings are consistent with the production function model outlined in the previous section.

Family Structure and Organization

The influence of family structure on child outcomes has been discussed in the literature, as noted above. While all families in this sample are poor and have children, both married and unmarried mothers are included, and unmarried mothers in this case are equivalent to single parents.[13] While the marital status variable was a statistically insignificant determinant of the level of food insecurity in Table 2, this is an average effect over married and unmarried mother

[13] The data have a measure of cohabitation as well, but it was tested and found to have the same effect as being unmarried.

families and does not imply that the effects of age-gender composition might not vary by marital status.

Single parenthood could have many different channels of effects on food allocations to different children (holding mother's employment and family income fixed). Low-income male spouses may, on average, have different preferences over food allocations than wives, for example, either by gender or by age of the child. Having a male spouse to help with household production in other aspects may free up time for the wife to devote to food preparation and to ensure that all children are obtaining needed food consumption. Indeed, having a husband present may allow the mother to spend more time simply monitoring the food consumption of their children. Wives may have superior knowledge of the food security production functions than husbands, and possibly better knowledge of the future payoffs to children of different ages from increased food allocations. The net effect of these and related considerations on age and gender differences in food security are not clear and should be an empirical matter to resolve.

Table 7 shows the results of estimating random effects probit equations for the overall binary indicator of food insecurity, VLFS, and that for adults and children, VLFSA and VLFSC, respectively. Only binary indicators are examined here, for brevity (results using the SUM measures add very little). Estimates for VLFSC for children with married mothers are not possible because no observations have positive VLFSC, which is partly a result of small sample size but also an indicator, in and of itself, of a difference between the two types of mothers. As the table shows, there is a marked difference in the age and gender patterns of food insecurity for children in families with unmarried and married mothers, especially for the age patterns. For both boys and girls, large and statistically significant differences between younger children and older children in families where the mother is unmarried essentially disappear completely in significance for children in families where the mother is married.[14] For gender, there is an anomalous result for younger children, where a significant gender gap appears only for married mothers, but for older children, the occasional significant gender difference for unmarried mothers is not present for married mothers. Overall, these results suggest that family structure does have an impact and in the direction suggested by prior work.[15]

The data also have a measure of household organization which is rarely available in other data sets, with questions aimed at ascertaining whether the family had established routines--whether they had a time when everyone talks or plays quietly, whether the children go to bed at the same time every night, whether they all eat dinner together every evening, and whether at least some of them eat breakfast together (see Appendix Table 3C). Developmental psychologists have found that having such family routines is correlated with positive developmental outcomes for children. In our case, the last two questions are also directly related to whether the children are eating with the rest of the family, which could be related to monitoring of food intake by the adults.

We construct a variable defined as whether the sum of the responses to the four equations is below or above the median sum in the full sample, and define this as having Low or High Family Routines. Entering this variable linearly into the food insecurity questions reported

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[14] The VLFSC estimates for children with unmarried mothers are almost identical to those in Table 3 but this is simply because children with married mothers are not contributing to the coefficients.

[15] E.g., Bertrand and Pan (2013) found that gender differences in outcomes (not inputs per se) among adolescents were affected by family structure, consistent with Table 7. The relationship between family structure and age gaps among children have been less examined in the literature.

previously shows that having family routines above the median has a strongly significant negative effect on food insecurity. Table 8 shows the results when the binary indicator probits for food insecurity are estimated separately for those with Low and High values of the routine index. The results show that there are many cases where age or gender differences are significant and large for those with low values of family routines which are much reduced in magnitude and sometimes in significance for those with high family routine values. This is especially the case for boys, where the age differences for children in families with high routine values are a half or less as large as those in families with low values. For girls, effects are insignificant for overall food insecurity (VLFS) (although larger in magnitude for families with low family routine values) and there is one unexpected result for young girls for adult food insecurity, but for child food insecurity the significant effects for low-routine-value families are rendered insignificant for families with high values. Gender differences are not significant much of the time in general, but in two cases a significant gender difference among young girls and boys which is significant in families with low routines values disappears for families with high values. In one case, for older boys and girls, an effect (VLFS) is moved slightly over the borderline of 10 percent significance for high routine value families but the magnitude is essentially the same.

Thus while there are occasional exceptions for some gender and age groups, the general tendency of the results suggests strongly that family structure and family organization and joint eating patterns affects the magnitude and presence of age and gender differences in food security between different children in the family. The effects are strongest in unmarried families and in those with low levels of family organization and who tend not to eat together.

Income, Financial Strain, and Networks

As noted in the theoretical discussion and as is intuitively obvious, the fraction of family members experiencing food intake deficiencies below a fixed threshold should decline as income rises. In addition, while there is no necessary relationship between age-gender differences and income as income rises but food deficiencies are still below the threshold, it should not be surprising if all differences narrow as they all approach zero. But what the rate of decline is as income rises, and at exactly what point the differences begin to narrow or disappear, is an empirical question. The data being employed here were drawn from a sample of households with family income less than or equal to 200 percent of the poverty line, which means that it is still, by any definition, a low-income sample. Whether within-family food security differences narrow as income rises up to the 200 percent of poverty level is not obvious.

A measure of total family cash income has been included in all estimated equations thus far, as is traditional in the literature on food insecurity, in addition to a dichotomous measure of whether that income is below the poverty line. The coefficients on income are usually statistically insignificant but those on the poverty status variable are always strongly significantly positive for all outcomes—overall, adult, and child (see Table 2 for the first of these)--indicating a positive association between food insecurity of the family and having income below the poverty line. Here, the approach to examining whether the age-gender differences fall as income rises is simply to estimate the equations separately for families with income below the poverty line and those above it, to determine if those differences change with income category. Two other measures of family income resources are available in these data. One is a measure of what is termed “financial strain,” which is constructed from a set of six questions asking the caregiver how often her household had to borrow to pay bills, had to put off buying something it needed, could not afford to do things “for fun”, had difficulty paying bills, could not afford the housing, food, and clothing they needed, or generally ended up with not enough money (see footnotes to Appendix Table 3C).[16] These questions were aimed at determining more accurately the family’s financial situation than just their family income but could be interpreted as reflecting either financial management or hardships resulting from negative shocks (see above for evidence on such shocks). A family that is an ideal rational economic agent which is experiencing a fixed level of income at all times should not be expected to have to borrow, to put off buying items, to pay bills unless it has unusual intertemporal preferences, for all these activities just push off consumption challenges to the future. Of course, low income families may not fit that ideal type and may exhibit behavioral responses, cognitive challenges, or simply poor financial management skills that prevent them from fixing consumption at a permanent level to match their income (see literature references above). But the situation is likely to be worse for a family experiencing transitory shocks, either to income or to consumption needs (sick child, need to buy school supplies in September, and a host of others), and this may cause short-term problems of the type described by these financial strain questions. The approach taken here will be similar to that for poverty status, by estimating separating equations for those who are experiencing high levels of financial strain and those who are not, to determine if

[16] The one question that asked about not having enough food could reflect food insecurity rather than the other way around. However, it does not have any necessarily relationship to the relative values of food insecurity across children of different ages and genders, which is the focus here.

within-family food allocations differ by the two types of families, and no attempt will be made to distinguish between these two explanations for any differentials.

Finally, the data also have responses to a set of questions asked about the family's access to a supportive social network, asking whether the household caregiver had access to people "who will listen," who will help with child care, with small favors, or who will loan money (again see footnotes to Appendix Table 3C). Having a strong network implies that monetary or in-kind resources are available in case of negative shocks and hence has an insurance value to a family, and thus constitutes another measure of resources, albeit a different aspect of resources than poverty status or financial strain.[17] While 70 percent of the sample reported positively to at least one of the four questions, 30 percent responded negatively to all four. Not answering any of the four positive implies a very limited social network and a high degree of financial vulnerability to income or consumption shocks. As with the poverty status and financial strain variables, the approach here will be simply to estimate the equations separately for families with lower and higher levels of network support to determine if age and gender differences in food insecurity differ for the two types of families.

Tables 9A, 9B, and 9C show the results of the estimation for the three different measures of resources, again only for the binary indicators of food insecurity for brevity. Table 9A shows major differences in age-gender differentials in almost all measures of food insecurity between

[17] Martin et al. (2004), in a small sample of families in Connecticut, found that an index of social capital--which includes trust, reciprocity, and social networks--was positively associated with household food security, and that neighbor reciprocity was particularly strongly so associated. Edin et al. (2013) found that the availability of kin networks was extremely important in combating food crises by invitations from those kin to eat at their house, but that many families have no networks at all and have a much more difficult time in coping.

families with income below and above the poverty line. For example, while age differences for boys are strong and significant in families with below-poverty level income, they disappear in significance or are greatly weakened in families with higher incomes. Several gender differences in families with below-poverty incomes are statistically and economically significant, and all of those disappear completely for families with incomes above the poverty line. Only the age differences for girls do not follow this pattern, where differentials are sometimes stronger in families with higher incomes for food insecurity measured in the family overall or among adults, although the pattern for child food insecurity again shows significant effects for lower income families and insignificant ones for higher income families. It is fair to conclude from these results that the general tendency, even if not present for every age-gender comparison, is for differentials to fall if income simply rises above the poverty line, usually to statistical insignificance.

The results for the impact of financial strain shown in Table 9B are similar but not quite as systematic across all comparisons. Again the most marked changes are for boys, where age differences fall in magnitude and/or significance when financial strain falls.[18] However, for girls the age differences move more uniformly to smaller magnitudes and insignificance, unlike the pattern of poverty status just discussed. A more mixed pattern appears for gender differences, where magnitudes and significance levels are sometimes higher and sometimes lower in families with lower levels of financial strain. To the extent that this variable is measuring the response to transitory shocks in income or consumption, it could be that they result in changes in food

[18] For the differential between boys 0-5 and 12-18 in VLFSA, the differential falls in magnitude when strain falls but so does the standard error, moving the p-value just under 10 percent.

allocations that are different than changes in response to changes in permanent income or resources.

Finally, the effects are considerably weaker for the impact of networks, as shown in Table 9C. While age differences in VLFSA for boys, age differences in VLFS and VLFSC for girls, and some gender differences are lower in families with stronger networks, there is no difference in differentials for boys in VLFS, and gender differences are sometimes greater and sometimes smaller in families with networks of different strength. It may be that the network questions underlying the index mix different kinds of effects, with some of them (e.g., having someone else take care of a child) possibly increasing differentials rather than decreasing them.

The three measures of family resources examined in this section do not uniformly and consistently support the hypothesis of smaller food insecurity differentials as resources rise for all age-gender categories, the strong effects for cash income—which arguably is the most likely to have that expected in the first place--as well as the somewhat weaker effects for financial strain and network strength show a clear general tendency in that direction.

Summary and Conclusions

Food insecurity as measured here and in the literature is an indirect measure of food allocation, and differences in that insecurity between adults and children and between children of different ages and genders therefore indirectly measures differences in that allocation across family members. The analysis here, using unique data identifying food insecurity for children of different ages and genders along with insecurity for adults, has uncovered major differences in family food allocations between different members of the unit. Levels of food insecurity of children are much greater for older children than for younger children of either gender, for example. In addition, food insecurity of adults, which is greater in level than for children as a whole (as found in prior work), differs by the age of the child, with adults experiencing greater levels of food insecurity when the child is older rather than younger. Gender differences also appear but are smaller in magnitude and less often statistically significant. Where they appear, they imply that boys experience higher levels of food insecurity than girls, especially among older children.

The age differences are strongly correlated with nutritional and dietary needs, for age differences in those needs usually explain a large fraction, if not all, of the food insecurity differences. Food allocations are made first to younger children, with their more modest needs and presumably higher marginal payoffs in terms of current and future health and well-being, and to older children only secondarily. The greater levels of low adult food allocations when children are older are likely an attempt to forestall even greater levels of food insecurity than would otherwise be the case and presumably occur after the food needs of the youngest children are met. However, gender differences in dietary needs are much smaller than age differences and, unless food allocations are based only on specific nutrients for which gender differences in needs are particularly large, do not explain much of the (fewer) gender differences in the data.

The evidence strongly suggests that lack of resources is responsible for the different food allocations to different children, with simple money income providing the strongest indicator. When family cash income simply rises to the official government poverty line (currently about $25,000 for a family of four), most age and differences in food insecurity, both of the child himself or herself and of the adults, falls greatly in magnitude and, more often than not, falls to statistical insignificance. Additional evidence comes from a measure of financial strain among households, which also shows that families under higher levels of such strain generally exhibit stronger age differences in food insecurity and that those with lower levels of strain have smaller and often insignificant insecurity differences.

There is some indication that levels of family organization are responsible for at least some of the age and gender differences, for families that have established family routines, including eating together at breakfast and dinner, have smaller age differences in food insecurity. Smaller age and gender differences occur among families with married mothers than unmarried mothers, which could reflect a number of possible channels, including family stress and time to devote to ensuring food allocations to the children in the family.

The results here should by far not be the last word on the subject, but should instead suggest further work to explain possible reasons for within-family differences in food allocations and policy measures to reduce them. Although they mainly occur only among the poorest families in the society, the magnitudes of the differences across children are large and worthy of concern and attention. In addition, surveys which have data on quantities of food consumed and on diet quality and nutrition for individual children of different ages and genders, like the NHANES and the PSIDC-CDS, could be further examined in light of the results found here.

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Table 1. Mean Values of Food Security Indicators, by Age and Gender

	All Children	Male	Female
All Ages			
VLFS	.078	.080	.076
VLFSA	.121	.120	.121
VLFSC	.039	.037	.041
SUM*	3.38	3.48	3.28
SUMA*	1.99	2.14	1.85
SUMC*	1.79	1.74	1.82
By Age:			
VLFS			
0-5	.056	.045	.067
6-11	.061	.062	.060
12-18	.115	.138	.096
VLFSA			
0-5	.083	.073	.094
6-11	.110	.126	.093
12-18	.168	.171	.166
VLFSC			
0-5	.012	.012	.012
6-11	.027	.025	.030
12-18	.018	.080	.076
SUM*			
0-5	3.30	3.47	3.14
6-11	3.31	3.64	2.94
12-18	3.61	3.59	3.62
SUMA*			
0-5	2.10	2.18	2.03
6-11	1.96	2.07	1.83
12-18	2.13	2.23	2.03
SUMC*			
0-5	1.87	1.81	1.94
6-11	1.72	2.26	1.29
12-18	1.83	1.72	1.94

Notes:
N=1,463 (first wave only) for All Ages, N-4,229 (all three waves) for the By Age means
*For those with VLFS=1, VLFSA=1, and VLFSC=1, respectively.

Table 2. Coefficients from Probit Random Effects Estimation of VLFS Models

Variable	(1)	(2)
Age and gender variables		
Female	-.055	--
	(.105)	
Age 0-5	-.500*	--
	(.132)	
Age 6-11	-.442*	--
	(.123)	
Age 0-5 female[1]	--	-.522*^
		(.170)
Age 6-11 female	--	.-626*
		(.176)
Age 12-18 female	--	-.334*^
		(.153)
Age 0-5 male	--	-.835*
		(.177)
Age 6-11 male	--	-.588*
		(.160)
Control variables		
Hispanic	-.020	-.000
	(.227)	(.223)
Non-Hispanic Black	.098	-.147
	(.214)	(.216)
Log real monthly income	-.017	-.020
	(.056)	(.055)
Income below poverty line	.550*	.548*
	(.131)	(.129)
Own home	-.451*	-.448*
	(.174)	(.175)
Own car	-.191*	-.184*
	(.106)	(.107)
No. adults	.108*	.096*
	(.058)	(.057)
No. Boys 0-5	-.311*	-.315*
	(.116)	(.118)
No. Boys 6-11	.032	.022
	(.084)	(.084)
No. Boys 12-18	.051	.043
	(.052)	(.053)

Table 2, Continued. Coefficients from Probit Random Effects Estimation of VLFS Models

Variable	(1)	(2)
No. Girls 0-5	-.315*	-.312*
	(.116)	(.109)
No. Girls 6-11	.012	.015
	(.064)	(.066)
No. Girls 12-18	.053	.058
	(.054)	(.053)
Not Employed	.014	.013
	(.110)	(.110)
High School	-.062	-.078
	(.126)	(.127)
College	.095	.061
	(.148)	(.150)
Married	-.324*	-.320*
	(.134)	(.134)
Disabled	.504*	.510*
	(.113)	(.114)
Fair or poor health	.150	.152
	(.103)	(.103)
TANF recipient	-.118	-.120
	(.118)	(.118)
SNAP recipient	-.290*	-.293*
	(.120)	(.121)
SBP recipient	-.154	-.157
	(.150)	(.153)
NLSP recipient	.307*	.295*
	(.167)	(.169)
WIC recipient	.162	.164
	(.111)	(.112)
Boston	-.389*	-.384*
	(.161)	(.156)
Chicago	-.581*	-.586*
	(.167)	(.167)
Constant term	-1.89*	-1.72*
	(.337)	(.335)
$Sigma^2$	1.00*	.990*
	(.109)	(.109)
Log likelihood	-1005.6	-1000.8

Notes:
Standard errors in parentheses
*Significant at the 10% level
+Significantly different from Age 12-18 female

^Significantly different from Age 0-5 male
Survey weights used in the estimation
[1]Indicator for 12-18 male omitted
[2]Standard error of the composite error term.

Table 3

Age-Gender Coefficients and Marginal Effects from Probit and Ordered Probit Estimation of Food Security Models

Variable	VLFS	SUM	VLFSA	SUMA	VLFSC	SUMC
Coefficient Estimates[1]						
Age 0-5 Female	-.522*^	-.451*$^{+}$	-.385*$^{+\#}$	-.383*$^{+}$	-1.329*$^{o+}$	-1.225*$^{o+}$
	(.170)	(.132)	(.130)	(.125)	(.284)	(.272)
Age 6-11 Female	-.626*	-.472*$^{\wedge}$	-.348*$^{+\#}$	-.440*$^{+\#}$	-.714*$^{+\wedge}$	-.702*$^{+}$
	(.175)	(.132)	(.127)	(.130)	(.262)	(.266)
Age 12-18 Female	-.334*$^{\wedge}$	-.098$^{\wedge}$	-.044$^{\wedge}$	-.129$^{\wedge}$	-.103$^{\wedge\#}$	-.072$^{\wedge\#}$
	(.153)	(.115)	(.112)	(.111)	(.204)	(.196)
Age 0-5 Male	-.835*	-.627*$^{\#}$	-.588*$^{\#}$	-.563*$^{\#}$	-1.285*	-1.197*
	(.177)	(.130)	(.129)	(.123)	(.305)	(.284)
Age 6-11 Male	-.588*	-.268*	-.150	-.211*	-.932*	-.871*
	(.160)	(.114)	(.1119)	(.111)	(.255)	(.236)
Marginal Effects						
Age Differences (Relative to 12-18)						
Male						
0-5	-.074*	-.060*	-.078*	-.079*	-.056*	-.053*
	(.018)	(.014)	(.020)	(.020)	(.013)	(.012)
6-11	-.061*	-.034*	-.027	-.038	-.049*	-.047*
	(.018)	(.015)	(.022)	(.021)	(.013)	(.011)
Female						
0-5	-.017	-.037*	-.052*	-.039*	-.048*	-.048*
	(.013)	(.014)	(.020)	(.020)	(.010)	(.010)
6-11	-.024*	-.039*	-.047*	-.046*	-.034*	-.036*
	(.013)	(.013)	(.019)	(.018)	(.011)	(.010)
Gender Differences (Male Minus Fem)						
0-5	-.019*	-.010	-.019	-.018	.001	.000
	(.011)	(.009)	(.014)	(.015)	(.005)	(.005)
6-11	.002	.018*	.028*	.031*	-.007	-.005
	(.012)	(.010)	(.018)	(.016)	(.007)	(.007)
12-18	.038*	.013	.007	.022	.008	.006
	(.017)	(.015)	(.021)	(.020)	(.012)	(.011)

Notes: Standard errors in parentheses; survey weights used
*Significant at the 10% level (from the omitted group, 12-18 male)
[+]Significantly different from Age 12-18 female, 10% level
[^]Significantly different from Age 0-5 male, 10% level
[#]Significantly different from Age 6-11 male, 10% level
[o]Significantly different from Age 6-11 female, 10% level
[1]Indicator for 12-18 male omitted
Marginal effects calculated by setting all Control variables to their means, all age-gender variables to zero, and calculating baseline probabilities from predicted values of Prob(VLFS=1), Prob(VLFSA=1), Prob(VLFSC=1), Prob(SUM>1), Prob(SUMA>0), and Prob(SUMC>0). Then, for each age-gender group, the six predicted probabilities are recalculated using the estimated coefficient for that group, and the difference from the baseline probability is the marginal effect. Standard errors are derived by bootstrapping.

Table 4. Weekly Cost of Food Under Thrifty Plan, June 1999

Child	
1-2 years	$15.50
3-5 years	16.70
6-8 years	20.70
9-11 years	24.50
Male	
12-14 years	25.30
15-19 years	26.10
20-50 years	28.00
51 years and over	25.30
Female	
12-19 years	25.30
20-50 years	25.20
51 years and over	24.80

Notes:
For a family of four only. Costs for other families are scaled up and down to account for economies of scale.
Source: http://cnpp.usda.gov/Publications/FoodPlans/1999/CostofFoodJun1999.pdf, accessed September 9, 2014.

Table 5

Age-Gender Differences in Marginal Effects Arising
From Differences in TFP Nutritional Needs Alone

Variable	VLFS	SUM	VLFSA	SUMA	VLFSC	SUMC
Age Differences						
(Relative to 12-18)						
Male						
0-5	-.036*	-.064*	-.060*	-.051*	-.042*	-.047*
	(.011)	(.015)	(.014)	(.015)	(.007)	(.008)
6-11	-.013*	-.020*	-.021*	-.018*	-.021*	-.023*
	(.004)	(.005)	(.006)	(.006)	(.005)	(.005)
Female						
0-5	-.035*	-.063*	-.059*	-.050*	-.041*	-.046*
	(.011)	(.015)	(.014)	(.014)	(.007)	(.008)
6-11	-.012*	-.023*	-.019*	-.016*	-.019*	-.021*
	(.004)	(.006)	(.005)	(.005)	(.004)	(.005)
Gender Differences						
(Male Minus Fem)						
0-5	.000	.000	.000*	.000*	.000*	.000*
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
6-11	-.001*	-.001*	-.001*	-.001*	-.001*	-.001*
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
12-18	.001*	.001*	.001*	.001 *	.001*	.002*
	(.000)	.000)	(.000)	(.000)	(.000)	(.000)

Notes:
See Table 3 notes.

Table 6

Age-Gender Differences in Marginal Effects Arising
From Differences in DRI Nutritional Needs Alone

Variable	VLFS	SUM	VLFSA	SUMA	VLFSC	SUMC
Age Differences						
(Relative to 12-18)						
Male						
0-5	-.055*	-.049*	-.063*	-.063*	-.050*	-.049*
	(.013)	(.012)	(.016)	(.017)	(.010)	(.010)
6-11	-.036*	-.035*	-.040*	-.046*	-.033*	-.034*
	(.010)	(.009)	(.012)	(.012)	(.008)	(.008)
Female						
0-5	-.020*	-.030*	-.045*	-.031*	-.039*	-.038*
	(.010)	(.011)	(.016)	(.016)	(.007)	(.007)
6-11	-.036*	-.019	-.018	-.032*	-.011*	-.011*
	(.013)	(.012)	(.017)	(.017)	(.009)	(.010)
Gender Differences						
(Male Minus Fem)						
0-5	.000	.000	.000	.000	.000	.000
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
6-11	.005*	.002	.001	.005	-.001	.001
	(.002)	(.002)	(.003)	(.003)	(.001)	(.001)
12-18	.036*	.019	.018	.032*	.011	.011
	(.013)	(.012)	(.017)	(.017)	(.009)	(.010)

Notes:
See Table 3 notes.

Table 7

Age-Gender Differences in Marginal Effects for Families
With Unmarried and Married Mothers

	VLFS		VLFSA		VLFSC
	Unmarried	Married	Unmarried	Married	Unmarried
Age Differences					
(Relative to 12-18)					
Male					
0-5	-.084*	-.006	-.098*	-.012	-.058*
	(.020)	(.008)	(.022)	(.020)	(.016)
6-11	-.060*	-.004	-.012	-.011	-.051*
	(.022)	(.011)	(.025)	(.018)	(.016)
Female					
0-5	-.049*	.026	-.067*	-.004	-.047*
	(.017)	(.016)	(.020)	(.030)	(.013)
6-11	-.035*	.004	-.035	-.039	-.034*
	(.017)	(.021)	(.021)	(.031)	(.013)
Gender Differences					
(Male Minus Fem)					
0-5	.005	-.030*	-.006	-.040*	.002
	(.013)	(.017)	(.018)	(.022)	(.006)
6-11	.014	-.006	.048*	-.004	-.004
	(.018)	(.022)	(.022)	(.025)	(.009)
12-18	.040*	.001	.025	-.032	.013
	(.021)	(.010)	(.025)	(.028)	(.018)

Notes:
All Families with Married Mothers have VLFSC=0.
See Table 3 notes.

Table 8

Age-Gender Differences in Marginal Effects for Families
With Low and High Family Routines

	VLFS		VLFSA		VLFSC	
	Low	High	Low	High	Low	High
Age Differences						
(Relative to 12-18)						
Male						
0-5	-.099*	-.041*	-.106**	-.061*	-.070*	-.024*
	(.021)	(.019)	(.024)	(.025)	(.018)	(.011)
6-11	-.053*	-.035*	-.006	-.017	-.053*	-.023*
	(.022)	(.018)	(.029)	(.025)	(.017)	(.010)
Female						
0-5	-.019	-.007	-.033	-.064*	-.059*	-.012
	(.017)	(.012)	(.025)	(.024)	(.014)	(.010)
6-11	-.027	.004	-.040	-.041	-.051*	-.003
	(.022)	(.015)	(.025)	(.025)	(.014)	(.009)
Gender Differences						
(Male Minus Fem)						
0-5	-.047*	.004	-.066*	.011	-.004	.002
	(.017)	(.012)	(.018)	(.015)	(.006)	(.010)
6-11	.007	-.000	.041	.032	-.005	-.006
	(.026)	(.014)	(.033)	(.023)	(.013)	(.006)
12-18	.033	.038*	.006	.008	.007	.014
	(.023)	(.019)	(.026)	(.030)	(.017)	(.011)

Notes:
See Table 3 notes.

Table 9A

Age-Gender Differences in Marginal Effects for Families
With Income Below and Above the Poverty Line

	VLFS		VLFSA		VLFSC	
	Below	Above	Below	Above	Below	Above
Age Differences						
(Relative to 12-18)						
Male						
0-5	-.114*	-.019	-.111*	-.044*	-.091*	-.008
	(.025)	(.012)	(.027)	(.022)	(.018)	(.008)
6-11	-.097*	-.008	-.064*	.015	-.078*	-.010
	(.022)	(.013)	(.027)	(.026)	(.019)	(.080)
Female						
0-5	.001	-.019*	-.033	-.067*	-.049*	-.004
	(.018)	(.011)	(.022)	(.022)	(.011)	(.010)
6-11	-.020	-.012	-.040*	-.045*	-.027*	-.009
	(.014)	(.010)	(.022)	(.026)	(.011)	(.009)
Gender Differences						
(Male Minus Fem)						
0-5	-.039*	-.002	-.033*	-.006	-.004	-.005
	(.015)	(.007)	(.018)	(.011)	(.005)	(.005)
6-11	-.001	.003	.020	.028	-.013	-.002
	(.018)	(.011)	(.024)	(.024)	(.012)	(.007)
12-18	.003	-.001	.044*	-.031	.037*	-.002
	(.011)	(.013)	(.024)	(.025)	(.019)	(.008)

Notes:
See Table 3 notes.

Table 9B

Age-Gender Differences in Marginal Effects for Families
With High and Low Levels of Financial Strain

	VLFS		VLFSA		VLFSC
	High	Low	High	Low	High
Age Differences					
(Relative to 12-18)					
Male					
0-5	-.094*	-.018	-.053	-.044*	-.086*
	(.032)	(.016)	(.035)	(.021)	(.020)
6-11	-.088*	-.017	-.015	.017	-.072*
	(.028)	(.011)	(.034)	(.018)	(.021)
Female					
0-5	.003	-.002	-.013	-.005	-.074*
	(.030)	(.003)	(.033)	(.004)	(.019)
6-11	-.030	.014	-.057*	-.001	-.046*
	(.025)	(.016)	(.032)	(.009)	(.021)
Gender Differences					
(Male Minus Fem)					
0-5	-.050*	.005	-.065*	.001	-.003
	(.027)	(.014)	(.034)	(.009)	(.015)
6-11	-.011	.009	.018	.023*	-.016
	(.027)	(.014)	(.074)	(.013)	(.016)
12-18	.047	.022*	-.024	.040*	.009*
	(.031)	(.013)	(.031)	(.018)	(.022)

Notes:
See Table 3 notes.
All families with low levels of Financial Strain have VLFSC=0.

Table 9C

Age-Gender Differences in Marginal Effects for Families
With Weak and Strong Networks

	VLFS		VLFSA		VLFSC	
	Weak	Strong	Weak	Strong	Weak	Strong
Age Differences						
(Relative to 12-18)						
Male						
0-5	-.074*	-.072*	-.091*	-.079*	-.032*	-.044*
	(.030)	(.014)	(.034)	(.017)	(.019)	(.020)
6-11	-.054*	-.058*	.043	-.041*	-.011	-.046*
	(.034)	(.015)	(.039)	(.023)	(.021)	(.015)
Female						
0-5	-.042*	-.005	-.034	-.058*	-.072*	-.024*
	(.027)	(.013)	(.031)	(.017)	(.020)	(.011)
6-11	-.025	-.024*	.004	-.062*	-.060*	-.015*
	(.026)	(.013)	(.035)	(.022)	(.019)	(.008)
Gender Differences						
(Male Minus Fem)						
0-5	.015	-.030*	-.017	-.025*	-.008	.004
	(.025)	(.009)	(.030)	(.013)	(.014)	(.018)
6-11	.018	.002	.078*	.018	.016	-.007
	(.032)	(.010)	(.046)	(.021)	(.017)	(.012)
12-18	.047	.036*	.041	-.004	-.032	.024*
	(.036)	(.017)	(.033)	(.022)	(.025)	(.122)

Notes:
See Table 3 notes.

Appendix 1

Food Hardship Questions in the Three-City Study

Adult Caregiver

ST8 – At any time in the past 12 months, did you or other adults in your household cut the size of your meals or skip meals because there wasn't enough money for food?

ST9 – At any time in the past 12 months, did you or any other adults in your household not eat for a whole day because there wasn't enough money for food?

ST10 – In the past 12 months, were you ever hungry but didn't eat because you couldn't afford enough food?

ST11 – Sometimes people lose weight because they don't have enough to eat. In the past 12 months, did you lose weight because there wasn't enough food?

Focal Child

ST12 – At any time in the past 12 months, did you cut the size of any of [CHILD]'s meals because there wasn't enough money for food?

ST13 – At any time in the past 12 months, did [CHILD] skip a meal because there wasn't enough money for food?

ST14 – Did this happen...(frequency)?

ST15 – At any time in the past 12 months, was [CHILD] hungry but you just couldn't afford more food?

Appendix 2

Analysis of the 1999 Current Population Survey Food Security Supplement

Because the TCS data only have 8 of the 18 USDA questions, we construct a VLFS variable which is correlated with the USDA definition of VLFS to the maximum extent. To make this determination, we obtained the data from the April 1999 Census survey--which is closest in calendar time to the first wave of the TCS survey--and selected those households with children, living in a metropolitan area, and with household income below 185 percent of the poverty line (a variable that was available in the Census survey) to approximate the TCS sample. For each of the resulting 1,113 households in the Census data, we constructed both a USDA VLFS indicator variable equal to 1 if 8 or more of the 18 questions were answered affirmatively, but also a set of VLFS indicator variables using only the 8 Census questions that were used in the TCS survey. Specifically, using only those 8 in the Census data, we constructed VLFS indicators for whether 1 or more, 2 or more, or 3 or more of the 8 TCS questions were answered affirmatively, and we then determined which of these indicators classified families most closely into the same VLFS categories as they were placed into using the full 18 questions.[19]

Our results showed that the "error rate" was smallest for a definition using the subset of TCS questions which classified a household as having VLFS if 2 or more of the 8 questions were answered affirmatively. For that definition, 81 percent of those classified as having VLFS also had VLFS by the 8-or-more-out-of-18-question USDA definition. Further, using this same 2-or-

[19] Of course, the Census questions for children ask about all children whereas the TCS questions only ask about the focal child, so there is a necessary noncomparability in that sense.

more-out-of-8 VLFS definition, 97 percent of those classified as not having VLFS were also not VLFS by the full USDA criterion. The overall misclassification rate, or error rate, was only 4 percent. In contrast, defining VLFS as having answered 1 or more of the 8 questions affirmatively resulted in a 7 percent misclassification rate (and only 57 percent of those classified as having VLFS from this definition were also classified as having VLFS by the USDA definition) and, going higher by requiring a household to answer 3 or more of the 8 questions affirmatively to be classified as VLFS resulted in a 6 percent misclassification rate. Other definitions resulted in even larger misclassification percents.

Applying this definition--namely, VLFS=1 if 2 or more of the 8 questions are answered affirmatively--to the TCS data themselves yields a VLFS rate of 8.8 percent. The Census sample we used for the analysis above has a VLFS rate of 9.4 percent, quite close.[20]

[20] In a separate analysis, we estimated logit models on the CPS data first using the USDA definition of VLFS as the dependent variable and then using the 2-or-more-out-of-8 definition. The signs and magnitudes of the coefficients on covariates for family structure, race, income, regional location, education, ages of children, and other socioeconomic characteristics were not very different. In another analysis (Moffitt and Ribar 2016), we estimated a Rasch model on the CPS data using both VLFS definitions and determined the Rasch scores for each. The scores for a 8-or-more-out-of-18 definition were in the same range as the scores for a 2-or-more-out-of-8 definition.

Appendix Table 3A. Means Values of Child Characteristics

Characteristic	Percent Distribution
Age	
0-5	54.7
6-11	19.3
12-18	26.0
Gender	
Male	51.0
Female	49.0
Race-Ethnicity	
Hispanic	51.0
Non-Hispanic Black	44.4
Non-Hispanic White	4.6

Notes:
Wave 1 only, N=1,463.
Survey weights used in this and all other tables in the study.

Appendix Table 3B. Means Values of Caregiver Characteristics

Characteristic	Percent Distribution
Education	
Less than high school	39.6
High school	39.5
College	20.8
Employment	
Working	36.7
Not working	63.3
Married	30.1
Health Status	
Good, very good, or Excellent	74.5
Fair or poor	25.5
Disabled	16.7

Notes:
Wave 1 only, N=1,463.

Appendix Table 3C. Means Values of Household Characteristics

Characteristic	Mean Value or Percent Distribution
Log real monthly income	$1558[1]
Income below poverty line (%)	76.0
Own car (%)	48.2
Own home (%)	17.4
Has a financial asset (%)	38.6
Number of adults	1.8
Number of children (other than focal child)	
Boys 0-5	.08
Boys 6-11	.18
Boys 12-18	.77
Girls 0-5	.06
Girls 6-11	.21
Girls 12-18	.74
City of residence (%)	
Boston	32.2
Chicago	36.1
San Antonio	31.7
Financial strain index[2]	-0.1
Above median of index(%)	43.5
Family routines index[3]	2.8
Above median of index (%)	48.3
Weak Network (%)[4]	30.0
TANF	34.4
SNAP	46.1
SBP	70.8
NLSP	73.1
WIC	43.1

Notes:
Wave 1 only, N=1,463.
[1] In 1999 CPI-U-RS dollars.
[2] Composite score measuring level of financial strain from six questions (how often has to borrow to pay bills; how often has to put off buying something you need; how often can afford to do things for fun; have had difficulty paying bills in last 12 months; can afford the housing, food, and clothing you need; have generally ended up with enough money in the last 12 months)
[3] Mean of answers to four family routine questions (have a time when everyone talks or plays quietly; children go to bed at the same time each night; family eats dinner at the same time each night; at least some of the family eats breakfast together)
[4] Percent with no have access to people who will listen, help with child care, help with small favors, or will loan money.