Maternal Nutrition Knowledge and Children's HEI

Tables 5 and 6 give two alternative estimates for the preschoolers' and school-age children's HEI equations. Column 1 of each table reports results of the empirical HEI equation

$$HEI = \alpha_0 + \sum_{p=1}^{P} \alpha_p X_p + \beta_1 NCK + \beta_2 DHA + u, \quad (5)$$

estimated by ordinary least squares (OLS). Both NCK and DHA were included as variables capturing maternal nutrition knowledge, and X_p represents the other explanatory variables. The explanatory variables are listed in table 1. These can be grouped into four broad categories: mother's characteristics, child's characteristics, household characteristics, and survey-related controls. Of the broad groups of variables suggested by the household production model, we included all except prices and community characteristics. Both of these variables were unavailable in the CSFII/DHKS data. Instead, we included in our analysis dummy variables representing household region, urbanization, survey year, season, and whether the reported intake was for a weekend, to capture price and community effects.

The two children's characteristics included are sex and age. Several household characteristics were included to control for common family effects that may influence both the child's intakes as well as the mother's knowledge of health and nutrition. These characteristics include household income, household size, race, ethnicity, participation of a household member in the Food Stamp Program or in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), and whether anyone in the household was on a vegetarian diet.

As the household production model suggests, a key variable that may affect a mother's knowledge of health and nutrition is her education level, represented in our analysis by the number of years of schooling. By including both the mother's education and information measures in the child's HEI equation, we can examine what effect, if any, a mother's education has beyond its information-enhancing role. A mother's age may capture the effects of learning and experience that remain after controlling for her education level. There has been some concern that maternal education and information effects may reflect maternal background characteristics (Behrman, 1995). We accounted for this possibility by including the mother's height and weight in the child's HEI equation.

One key variable suggested in the household production model, but overlooked in the children's health and nutrition literature, is maternal time preference. Several studies have emphasized that health habits as well as other human capital choices may be affected by an individual's time preference (Farrell and Fuchs, 1982; Grossman and Kaestner, 1995). An individual who places a higher value on current enjoyment may place less value on healthy habits, education, and information acquisition activities than those who place a higher value on future enjoyment. In the mother-child empirical context, this means a positive effect of maternal education or maternal health knowledge on child nutrition may be due to a mother's lower time preference which places a higher value on both her and her child's future health. To estimate the "true" education or information acquisition effect, one must control for maternal time preference. In this study, we used the mother's smoking status as such an indicator (Evans and Montgomery, 1994).

The standard errors reported in parentheses have been corrected for heteroskedasticity by White's procedure. Statistical significance of coefficient estimates were judged by two-sided t-tests at the 10-percent probability level.

The DHA coefficient indicates that maternal awareness of diet-health relationships significantly increases preschoolers', but not school-age children's, diet quality. On the other hand, the NCK coefficient is insignificant for preschoolers and significant in the equation for school-age children.

These OLS results highlight an important empirical question concerning the difference in the impact of our DHA and NCK variables. Given that both variables are measuring the same underlying information level, such differences could be due to measurement errors specific to each variable as well as the high correlation between NCK and DHA. In this case, it may be possible to improve the accuracy of estimated information effects by using a latent variable representation for maternal nutrition knowledge (Griliches, 1986). In this approach, the relationship between a set of error-ridden variables and the 'true' underlying variable they are attempting to measure is specified explicitly using measurement equations. In our case, these may be written as

(6)
$$NCK = \lambda_{10} + \lambda_{11}K + e_1$$
$$DHA = \lambda_{20} + \lambda_{21}K + e_2$$

where K is the true nutrition knowledge level underlying NCK and DHA, the λ's are unknown parameters, and e's are random measurement errors that are uncorrelated with each other and with K.

As noted earlier, a major focus of previous research has been to what extent information acts as a mechanism underlying the link between maternal and household characteristics and children's nutrition and health outcomes (Strauss and Thomas, 1996; Thomas, Strauss, and Henriques, 1991). To address this question and also to account for the possible effects of unobserved individual and family influences, we estimated a system of equations that treat children's HEI and mother's nutrition knowledge as jointly determined. A modified HEI equation can be written as

(7)
$$HEI = \alpha_0 + \sum_{p=1}^{P} \alpha_p X_p + \beta K + u,$$

where

(8)
$$K = \gamma_0 + \sum_{q=1}^{Q} \gamma_q Z_q + v.$$

Equation 6 was estimated along with equations 7 and 8 by maximum likelihood using the LISREL framework (Joreskog and Sorbom, 1989) for our samples of preschoolers and school-age children (see Appendix in Variyam and others, 1998, for the estimation procedure). Z_q includes all X_p variables in the HEI equation except child characteristics and the seasonal and weekend dummies. Z_q also includes four additional variables for identification. These variables indicate whether the mother has received dietary advice from a physician or a dietitian, the hours per day she spends watching television, the male head of household's education level, and whether the DHKS was conducted in person or by telephone. We expected these variables to capture sources of variations in maternal nutrition knowledge that are unrelated to children's diet quality. In tables 5 and 6, column 2, we report the HEI equation estimates, and in table 7 we report estimates for the maternal nutrition knowledge equations.

A parameter restriction is required to identify the scale of the latent "nutrition knowledge" variable K (Bollen, 1989, p. 239). We normalize the coefficient of K in the NCK measurement (equation 6) to one (i.e., λ_{11} = 1) so that NCK and K have the same scale; a unit change in K causes a unit change in NCK. The coefficient for DHA, λ_{21}, is free. All variables are expressed as deviations from their means, so the intercept coefficients in equations 6-8 are zero.

Table 5—HEI equation estimates for children ages 2-5

Explanatory variable	Ordinary least squares	Latent variable model
Mother's nutrition knowledge:		
Nutrient content knowledge	.262	—
	(.283)	—
Diet-health awareness	.925*	—
	(.365)	—
Nutrition knowledge level	—	2.716*
		(1.369)
Mother's characteristics:		
Education	-.462	-.726*
	(.342)	(.420)
Age	.323*	.221
	(.151)	(.172)
Height	.645*	.586*
	(.269)	(.282)
Weight	-.147*	-.074
	(.085)	(.117)
Weight squared ($\times10^{-3}$)	.413*	.218
	(.232)	(.321)
Smoker	-4.874*	-4.318*
	(1.519)	(1.655)
Child's characteristics:		
Child's age	-.892	-.904
	(.619)	(.617)
Female child	.962	1.029
	(1.241)	(1.296)

See notes at end of table.

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For preschoolers, the maternal information effect is positive and much larger with the endogenous latent variable model than in the OLS model (table 5). Given the estimates of λ's and β, we can infer the relationship between DHA or NCK, and the HEI. For example, the ratio β/λ_{21} gives the change in HEI score due to a change in maternal nutrition knowledge (K) that corresponds to an additional correct answer recorded on DHA. This ratio is estimated to be 3.757 (2.716/0.723). Therefore, a mother gaining information to answer an additional DHA question correctly would increase her preschooler's diet quality by about 3.75 points on the HEI scale according to the latent variable model. The comparable effect estimated by OLS is 0.93. The HEI equation under the latent variable model also has a higher R^2 of 0.28 than the HEI equation estimated by OLS which has an R^2 of 0.27.

A mother's nutrition knowledge, however, has a negative but statistically insignificant effect in the school-age child's HEI equation. If maternal influence on children's diet quality declines with age, especially after children start school, the statistical insignificance of maternal knowledge is not surprising. However, the negative sign and the relatively large size of the knowledge coefficient is troubling. We attempted many different specifications, including adding other identifying variables to the mother's knowledge equation but were unsuccessful in obtaining meaningful results. The central problem appears to be the lack of any variables that can sufficiently capture the variation in the mother's knowledge equation. The four variables we used successfully in the preschooler's equation: dietary advice, hours of television watching, male head years of education, and whether the survey was conducted in-person or by telephone were all statistically insignificant in the school-age children's equation. This statistical insignificance implies that we cannot adequately model and explain the variation in the nutrition knowledge equation. Thus, we feel that the coefficients in the equations for school-age children should be interpreted very carefully. Additional modeling research is clearly necessary, but perhaps this

Table 5—HEI equation estimates for children ages 2-5—Continued

Explanatory variable	Ordinary least squares	Latent variable model
Household characteristics:		
Log income	1.232	0.073
	(1.038)	(1.349)
Household size	.373	.072
	(.482)	(.538)
Black	-4.083*	-2.467
	(2.179)	(2.427)
Other race	2.068	5.722
	(4.910)	(5.578)
Hispanic	-1.379	1.898
	(2.349)	(3.323)
Food stamp participant	1.778	1.667
	(1.916)	(2.030)
WIC participant	.669	1.272
	(1.896)	(2.020)
Vegetarian diet	5.181*	4.231*
	(1.623)	(2.168)
Midwest	-1.556	-2.506
	(1.966)	(2.111)
South	-.593	-1.391
	(1.921)	(2.076)
West	-.621	-3.060
	(2.287)	(2.808)
Suburb	1.248	1.532
	(1.518)	(1.629)
Nonmetro	.537	-.193
	(1.726)	(1.966)
R^2	.270	.282

Note: Asymptotic standard errors are given in parentheses below the estimates. An asterisk indicates significance of the estimate at the 10-percent or lower level on a two-sided t-test. All models also include 13 dummy variables representing region and urbanization of the household, survey year, survey season, and whether any of the recorded 3-day intake was on a weekend; see table 1.

Source: Calculated by the Economic Research Service, USDA, using data from 1989-90 CSFII-DHKS.

dilemma will not be solved until more data become available. For the remainder of this section, we will focus on the preschooler model.

The latent variable model yields better results than the OLS model for preschoolers because the OLS model ignores the effects of other maternal and household characteristics that are transmitted through knowledge while the latent variable model accounts for such indirect effects. For example, both maternal education and household income have positive effects on maternal nutrition knowledge (table 7, column 1), confirming their role in increasing access to and use of information (Ippolito and Mathios, 1990). Comparing column 1 and column 2 estimates in table 5, one can see that after the knowledge-enhancing role of maternal education is taken into account, its remaining effect on preschoolers' diet quality is negative. This negative educational effect is different from the Thomas, Strauss, and Henriques (1991) finding that maternal education level may not influence Brazilian children's height. A possible explanation is that, in the United States, education enhances nutrition knowledge, but it may also increase the demand for convenience foods and food-away-from home, both of which may be of lower dietary quality (Lin, Guthrie, and Blaylock, 1996).

Height is a key variable used in many previous studies to control for maternal background effects (Behrman, 1995). In conformity with previous results, we find that maternal height is significantly related to diet quality

Table 6 —HEI equation estimates for children, ages 6-17

Explanatory variable	Ordinary least squares	Latent variable model
Mother's nutrition knowledge:		
Nutrient content knowledge	1.126*	—
	(.211)	
Diet-health awareness	.011	—
	(.229)	
Nutrition knowledge level	—	-3.587
		(2.685)
Mother's characteristics:		
Education	.087	1.339*
	(.230)	(.788)
Age	.022	.121
	(.083)	(.123)
Height	.295*	.432
	(.164)	(.265)
Weight	.071	-.023
	(.070)	(.060)
Weight squared ($\times 10^{-3}$)	-.257*	.047
	(.151)	(.314)
Smoker	-6.016*	-7.183*
	(1.101)	(1.670)
Child's characteristics:		
Child's age	-.035	-.042
	(.152)	(.155)
Female child	-2.971*	-3.000*
	(.905)	(.905)

See notes at end of table. — Continued

(Barrera, 1990; Haughton and Haughton, 1997; Thomas and Strauss, 1992). However, maternal height has no information-related effect, suggesting that it is capturing maternal background and endowment effects that do not influence information acquisition.[2]

Excepting Haughton and Haughton (1997), few other studies have used maternal weight as an explanatory variable. While Haughton and Haughton (1997) find a positive relationship between child nutrition and maternal weight, we find that maternal weight has an inverse relationship with children's diet quality through its influence on maternal nutrition knowledge. One explanation is that obesity may be discouraging mothers from investing further in acquiring and processing information. This conclusion is supported by the fact that the adverse influence is greater at higher weight levels. These opposite findings are clearly related to the fact that in developing countries, weight is a positive indicator of health because under-consumption of foods and nutrients related to weight is the major problem, at least in the populations studied. In industrialized countries, overweight or obesity is a negative indicator of health because the major nutrition problem is over-consumption of fat- and calorie-rich foods. Therefore, both results confirm the underlying relationship that maternal health endowment is positively related to children's nutritional outcomes.

Maternal smoking has a substantial negative effect on children's diet quality. The diets of children whose mothers smoke score approximately five HEI points lower than children whose mothers are nonsmokers. The effect is estimated rather precisely with a relatively low standard error. The sizable effect of maternal smoking status is also not related to information. This finding poses a challenge to nutrition educators because standard nutri-

[2]A quadratic term for maternal height was tried and found to be not significant.

Table 6—HEI equation estimates for children, ages 6-17—Continued

Explanatory variable	Ordinary least squares	Latent variable model
Household characteristics:		
Log income	0.827	1.852
	(.773)	(1.159)
Household size	.493*	1.124
	(.292)	(.556)
Black	-1.604	-9.326*
	(1.528)	(4.760)
Other race	-8.170*	-14.896*
	(3.962)	(6.881)
Hispanic	3.427*	-4.116
	(1.759)	(4.924)
Food stamp participant	.420	-.043
	(1.552)	(2.019)
WIC participant	-3.224*	-5.650*
	(1.787)	(3.117)
Vegetarian diet	2.768	4.403
	(2.183)	(3.203)
Midwest	-2.084	-.789
	(1.418)	(2.073)
South	.016	-.212
	(1.363)	(1.962)
West	-.417	2.793
	(1.552)	(2.817)
Suburb	-4.237*	-3.248*
	(1.106)	(1.624)
Nonmetro	-2.892*	.362
	(1.265)	(2.503)
R^2	.238	.220

Note: Asymptotic standard errors are given in parentheses below the estimates. An asterisk indicates significance of the estimate at the 10-percent or lower level on a two-sided t-test. All models also include 13 dummy variables representing region and urbanization of the household, survey year, survey season, and whether any of the recorded 3-day intake was on a weekend; see table 1.

Source: Calculated by the Economic Research Service, USDA, using data from 1989-90 CSFII-DHKS.

tion information programs are not likely to lower the dietary risk of children with smoking mothers. This result also has important policy implications given that earlier studies have found that smokers' diets are substantially worse than nonsmokers' (McPhillips, Eaton, and Gans, 1994). Another study of diet quality found that smokers score about three to four HEI points lower than nonsmokers (Variyam, Blaylock, Smallwood, and Basiotis, 1998). The present results show that this negative effect is transmitted to children with a similar, if not a higher, magnitude. Therefore, nutrition education programs need to target smokers, particularly those who are the main meal planners of their household, and alert them to the possible negative influence of their health habits on their children's diets.

In previous studies, children's age and sex have been included to capture possible gender and age discrimination in the allocation of household resources. To the extent that children's diets are under parental control, gender or age differences were not expected in our sample and none was found. Among household characteristics, there was a large, positive effect of about five points on the HEI scale for children from households where at least one member was on a vegetarian diet. As the *Dietary Guidelines for Americans* (1995) notes, vegetarian diets are consistent with its recommendations and can meet Recommended Dietary Allowances for nutrients. This result

Table 7—Estimates for mother's nutrition knowledge equation in the children's HEI study

Explanatory variable	Ages 2-5	Ages 6-17
Mothers' characteristics:		
Education	0.129*	0.282*
	(.065)	(.042)
Age	.041	.021
	(.027)	(.015)
Height	.021	.022
	(.049)	(.037)
Weight	-.038*	-.021
	(.018)	(.014)
Weight squared ($\times 10^{-3}$)	.097*	.070
	(.052)	(.039)
Smoker	-.189	-.234
	(.280)	(.220)
Received diet advice	1.684*	-.306
	(.603)	(.284)
Hours watching TV	-.190*	-.050
	(.082)	(.049)
Household characteristics:		
Log income	.414*	.149
	(.208)	(.161)
Household size	.144*	.125*
	(.086)	(.063)
Black	-.489	-1.586
	(.409)	(.298)
Other race	-2.106*	-1.613*
	(.895)	(.811)
Hispanic	-1.632*	-1.695*
	(.426)	(.344)
Food stamp participant	.081	-.080
	(.359)	(.295)
WIC participant	-.435	-.500
	(.332)	(.407)
Vegetarian diet	.483	.351
	(.349)	(.450)
Male head's education	.064*	.020
	(.029)	(.016)
In-person survey	.380	.468*
	(.264)	(.194)
R^2	.601	.458

Note: Asymptotic standard errors are given in parentheses below the estimates. An asterisk indicates significance of the estimate at the 10-percent or lower level. Each equation also includes 7 dummy variables representing region and urbanization of the household and the survey year; see table 1.

Source: Calculated by the Economic Research Service, USDA, using data from 1989-90 CSFII-DHKS.

and the result for smoking show how strong intra-family effects are generated by the health habits of individual members of the household.[3]

Other household characteristics are generally insignificant, except race. Diets of preschoolers in Black households are found to score about four points lower on the HEI scale than diets of children from White households. Given the potential effect of such higher dietary risk for preschoolers on their future health and schooling, this finding clearly indicates that nutrition education programs should target Black households for special attention.

The effects of nutrition information sources are as expected. Time spent watching television is inversely related to knowledge, possibly because it curtails more information-intensive activities like reading.[4] The effects of having received dieting advice from a physician or a dietitian, and the education level of the male head are both positive. We calculated a χ^2 statistic to test whether excluding the four variables used to identify the knowledge equation from the children's HEI equation is valid. The exclusion of each variable from the HEI equation could not be rejected at the 10-percent level. When TV hours and in-person survey variables, which had the relatively higher χ^2 values, were included in the HEI equation, the knowledge coefficient remained fairly stable at 2.274 although its standard error increased to 1.727. The results on the whole, therefore, seem to support the endogenous latent variable specification.

[3]When we included all preschool children from households with multiple preschoolers in the estimation sample (instead of selecting one child randomly from households with multiple preschoolers), the effects of maternal height, maternal weight, and a household member being on a vegetarian diet became insignificant. This finding is likely due to the correlation of these variables with unobserved maternal and household characteristic and, therefore, justifies our procedure of selecting one child randomly from households with multiple children. The knowledge coefficient estimate in this "full" sample (N=439) was 2.394 with a standard error of 0.071. Other results were similar to those reported in table 5, column 2.

[4]To ensure that the TV variable is capturing only the information effect and not the effect of a mother's level of physical activity, a dummy variable indicating activity level was included in equations 7 and 8 of the endogenous latent variable model.