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Malnutrition Expectations and Precautionary Demand for Children: Evidence from Vietnam

Eric T. STUEN*, Nam Trung HOANG** and Van Hong Thi HOANG***

Abstract

Precautionary demand for children has long been recognized by economists as a component of household demand for children, such that households respond to the risk of children not surviving to adulthood by increasing their optimally desired family size. We examine whether such an effect exists in response to nutritional constraints. We argue that nutrition measures are suitable proxies for the expectations of parents regarding the lifetime mortality risks of their children. Using a sample of 5,966 Vietnamese households, we estimate Logit models of a birth indicator regressed on self-constructed measures of nutrient consumption and other controls. We find significant effects for calories, protein and an index of micronutrients on the likelihood that the household had a child. The micronutrient index effect is dominant, and is contingent on the health insurance status of children in the household. These findings provide initial non-experimental evidence of the relevance of nutrition on demand for children. They suggest that rising prices and disruptions to food supplies may increase population growth rates, all else equal, an indirect effect that may be moderated by agricultural and food aid policies.

Keywords: malnutrition, fertility choice, demographic transition, precautionary demand

1 Introduction

This paper provides new evidence of precautionary demand for children by households. An important aspect of the economic theory regarding household demand for children is that, in an effort to ensure a desired optimal family size, parents will respond to risk of mortality of their children with a precautionary increase in their demand for children. This theory has its roots in work by Ben-Porath and Welch (1972) and Schultz (1978) but was first formalized by Sah (1991). Our contribution is to use variables for consumption of several types of nutrients as measures of the mortality expectations of parents — to approximate such risks at the household level. As we argue below, there is much evidence linking malnutrition with mortality, so that malnutrition may influence expectations regarding

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the mortality of children and hence contribute to precautionary demand for children.

To what extent might malnutrition contribute to larger family sizes? We examine this question in the context of Vietnam, using cross-sectional survey data on Vietnamese households from 2006. Vietnam has developed very rapidly in the past twenty-five years and its incidence of malnutrition is far less acute than it once was. Under-5 child malnutrition, using low height-for-age, fell from 53% in 1990 to 37.3% in 2000 and down to 23.3% in 2010.[1] However, the rate of anemia in children under-5 persisted at 31.3%, as of 2011. Vietnam's birth rate per thousand fell from 31.4 in 1990 to 19.8 in 2000 and 15.5 in 2013. The under-5 mortality rate fell from 5.5 percent in 1990 to 3 percent in 2000 and 2.4 percent in 2013. Real per-capita income grew on average 5.8 percent per year from 1990 to 2000 and then accelerated to 6.1 percent per year from 2001 to 2009.[2] But as O'Donnell, Nicolas and van Doorslaer (2009) note, these positive trends were accompanied by rising inequality in health status and pockets of extreme poverty remain. Here we use the variation in nutrition consumption across households in Vietnam to shed light on the theory of precautionary demand for children, not to make a statement about the development of Vietnam itself. We find significant effects of malnutrition on family size despite declining malnutrition in Vietnam. Given the gains in development that Vietnam has achieved, this suggests that such effects are likely to be even stronger in the least developed areas of the world.

Institutional changes in Vietnam's economy accompanied these trends and accelerated the improvements in nutrition. The *Doi Moi* policy initiated in 1986 removed many government controls on markets, de-collectivized agricultural land, privatized many state-owned enterprises and made private health care and education legal. In 1988 the government of Vietnam initiated a program to counter vitamin A deficiency, which provided free supplementation as well as information on diet. In 1995 a nutrition program was initiated, the National Plan of Action for Nutrition, which focused on diversifying agriculture to improve the availability of macronutrients (Le and Nguyen 2002). By 2002, universal vitamin A supplementation had been achieved (Nguyen et al. 2002) and incidence of acute vitamin A deficiency rare. However, as recently as 1998, 46.5% of children ages 6 months to 5 years were anemic (Thu et al. 1999).

We use data on households from the 2006 round of the Vietnam Household Living Standards Survey (VHLSS) to examine the hypothesis that households respond to nutritional constraints by increasing their optimal family size, all else equal. After controlling for relevant characteristics of the household and of the mother of the children in the household in Logit models, we find that greater availability of certain nutrients decreased the likelihood of having a child in the year prior to the survey. These included total calories (kilocalories), protein, and a micronutrient index made up of seven nutrients. Since in Logit models the marginal effects of the variables vary depending on the levels of all covariates, we evaluate the marginal effects of increases at the median levels of all variables. We find in our main specifications that a one percent increase in calorie consumption reduces the likelihood of a birth by 0.12 percent. A 0.1 increase in the micronutrient index (similar to a one standard deviation increase) reduces the probability of a birth by 2.13 percent. When including interactions of the nutrient measures with the household's percentage of children with health insurance, the micronutrient index is the dominant factor, and its effect depends highly on the degree of health insurance coverage of households' children. The effect is strongest for households without any coverage for children: an increase in the micronutrient index of 0.1 reduces the likelihood of a birth by 3.93 percent for that group.

These results provide evidence of precautionary demand for children due to constraints on the availability of nutrition, providing further support for the economic theory of mortality risk affecting fertility choice. It is the first study in this literature, to our knowledge, to use nutrition as a proxy for expected child mortality. Our findings suggest that policies that improve the availability of nutrients may have the effect of reducing population growth. Improvement of access to health services has a complementary effect, improving the effect of nutrient availability.

2 Prior Literature

2.1 Economics of household demand for children.

Economists have modeled fertility as under the control of rational optimizing parents, starting with Leibenstein (1954) and Becker (1960). According to those, income should have a positive effect on optimal family sizes and the average "quality" of children. Mincer (1963) found that optimal family sizes should decrease as women's earnings increase, while Becker and Lewis (1973) found that they should decrease due to rising education of parents and increases in the costs of education (increasing quality of children). Another explanation for a negative relationship between income and fertility is the role of children as means of saving and insurance. In the absence of financial and insurance markets, as has been the case in many low-income countries, children may be desired for their capacity to eventually support their parents. For a seminal reference on this, see Kotlikoff and Spivak (1981).

In the interest of studying demographic transitions, in which falling death rates precede falling birth rates and there is an increase in the population growth rate, others focused on the direct effects of changing mortality conditions on fertility. In particular, optimal family sizes may depend on the expected number of survivors. This is in addition to the direct effects of mortality on fertility, through replacement. Early analyses of these effects come from Ben-Porath and Welch (1973) and Schultz (1978). Later, Sah (1991) showed that uncertainty over child survival induces hoarding behavior, or precautionary demand for children, so that optimal family size will be based on the expected surviving number of children. A drop in mortality will reduce the uncertainty over child survival, reducing fertility. Similarly, the expected return to education for each child will increase, magnifying the quantity/quality substitution effect. This effect is discussed by Galor and Weil (1999) but formally analyzed by Kalemli-Ozcan (2003). Recent work by Aksan and Chakraborty (2013) extended this effect to the context of morbidity, predicting higher fertility from hoarding behavior in high-morbidity locations as well as interactive effects of mortality and morbidity risks.

Empirical evidence for such precautionary demand is seen in a number of studies, but none have previously focused on nutrition. Rosenzweig and Schultz (1983) estimated a production function for infant mortality based on birth order (family size) and health and demographic characteristics. Using survey data on 8,119 households with births in the US, and using income and prices as instruments, they find a negative relationship between family size and mortality. Their estimates suggest that decreases in mortality account for about one-fifth of the reduction in fertility in developed countries that occurred from 1883 to 1983. Olsen and Wolpin (1983) considered the possibility that mortality itself is endogenous to parental choices over health inputs. They use a two-stage analysis in which the family fixed-effect from a first-stage regression of time-to-death on household characteristics was used as an indicator of exogenous child mortality. With survey data on 1,262 Malaysian households, they found evidence of a positive relationship between child mortality and fertility but that the effect of the exogenous component of mortality is relatively small. A third study is Angeles (2010), which studies the effect of mortality on fertility with cross-country data. Using dynamic panel-data estimation, he found that net fertility (proportion surviving childhood) responds positively to measures of mortality at ten- and twenty-year lags. The effect of mortality was stronger than that of other factors such as real per-capita GDP, education and urbanization.

2.2 Linkages between nutrition and mortality

Many studies support the idea that chronic malnourishment is a factor in mortality, and that acute deficiencies of certain micronutrients can cause cognitive and motor disabilities. Measuring chronic malnourishment with the height-for-age score (stunting) and acute malnourishment with the weight-for-age score, Heller and Drake (1979) found that both forms of malnourishment in children were associated with heightened risk of illness. This relationship goes both ways, as studies surveyed by Dasgupta and Ray (1990) find that disease, especially diarrhea, limits the retention of nutrients consumed. Therefore, the effect of nutrition on malnourishment depends not just on nutrition availability, but on other health factors such as disease prevalence, access to clean water sources and health services, a point emphasized by Cutler, Deaton and Lleras-Muney (2006). Nokes, Bosch and Bundy (1998) review studies of iron deficiency, noting that studies of infants and young children (<24 mo.) found that iron deficiency had negative effects on cognitive and motor ability that were not treatable through later supplementation. For school-aged children, they note that nine out of ten randomized treatment studies found improvements in cognitive outcomes after iron supplementation. Benton (2008) reviewed studies of the effects of micronutrient deficiencies on ability and behavior. Deficiency of Vitamin A was “associated with an increased risk of morbidity, mortality, wasting and stunting in children" (Benton 2008: 39). It can cause night blindness and in extreme cases, blindness. Impairment of vision from vitamin A deficiency can impede educational attainment. Thiamin (vitamin B1) deficiency can result in Beriberi, which can be fatal. This condition is most common in populations in which polished rice dominates the diet, as thiamin is critical for the metabolism of glucose (Lonsdale 2006). Potassium deficiency exacerbates the condition of kwashiorkor, resulting from acute protein deficiency. Effects include edema and liver failure (Waterlow 1994).

Two studies are notable for examining the effect of nutrient deficiencies on health and mortality in Vietnam. English et al. (1997) used a difference-in-difference methodology to examine the effect of increased nutrition, through increased garden production and nutrition education, on respiratory and diarrheal infections. They found significant decreases in the incidence of both types of infections for a treatment commune relative to a control commune. Thu et al. (1999) used a double-blind, placebo controlled study of supplementation of iron, zinc, retinol and vitamin C for a sample of Vietnamese children aged 6–24 months. They found a significant effect after three months of supplementation on the height-for-age scores of children with low initial height-for-age.

Chronic malnourishment also increases adult mortality and negatively affects educational attainment. Since what matters for precautionary demand is a household's expectation of their children's prospects for surviving healthily into adulthood, long-term and developmental factors may play a role as well. Elo and Preston (1992) cite several epidemiological studies in Europe and the U.S. documenting heightened risk of mortality for shorter individuals. This is primarily due to greater susceptibility to tuberculosis, Hepatitis B and cardiac diseases. Malnutrition also affects the earnings potential of individuals through the reduction of cognitive abilities, which impacts the attainment of education. Glewwe and Miguel (2008) discuss several studies which provide evidence that nutrition deficiencies cause large decreases in school enrollment and completion, as well as cognitive outcomes (Martorell, Habicht and Riviera 1995, Glewwe, Jacoby and King 2001 and Alderman, Hoddinott and Kinsey 2006).

3 Data and method for empirical analysis

We employ data on 5,966 households surveyed in the 2006 round of the Vietnam Household Living Standard Survey (VHLSS 06). This survey is administered by the General Statistical Office of Vietnam. It was completed first in 1992, followed by a second round in 1997. Since 2002 it has been administered on a biannual basis. Technical assistance for the survey design was provided by the United Nations Development Program (UNDP) and the World Bank. Although many households have been resurveyed, not every round contains all of the same questions. At present, it is not possible to create a panel dataset for the purposes of this paper. The sample we used includes only households for which the health questionnaire, VHLSS 06 section 3, was administered. This was based on whether the household had a female adult member age 17–49.

Our dependent variable is an indicator for whether the mother had one or more children under one year of age, indicating that the household experienced a birth in the previous year. This measure is constructed based on the record of children within the household. The VHLSS also provided us with detailed information on food expenditures and home food production, with which we made measures for levels of consumption of specific nutrients (within-household per-person averages, excluding the number of children under age 1). These included total kilocalories and protein as well as iron, potassium, vitamin A, vitamin B1 (thiamin), vitamin C, phosphorus, calcium and sodium. Quantities consumed of foods purchased were reported in section 5 of the VHLSS, while quantities consumed of foods produced by the household were reported in section 4B. These combined quantities were multiplied by representative nutrition content values of Vietnamese foods to determine total nutrient consumption.[3]

These nutrition variables serve as proxies for life expectancy of the children in the household. We expect to see lower fertility for households with higher nutrition, *ceteris paribus*, due to higher life expectancy (and hence lower mortality risk) diminishing the precautionary demand for children. However, for nutrients that are known to be very important to infant and maternal health such as vitamin A, this precautionary demand effect is likely to be overshadowed by the choice to boost consumption of it around the time of a pregnancy. To avoid multicollinearity, we combine all of the micronutrients except vitamin A (and excluding calories and protein as macro measures of nutrients) into a micronutrient index. The nutrient index is constructed as the geometric average of the proportion of the 99th percentile of each nutrient that is the household's consumption. Letting such proportion for nutrient j be σ_j, the index is given by:

$$Micronutrient\_index = \sqrt[7]{\prod_{j=1}^{7} \sigma_j}\ . \tag{1}$$

We control for other characteristics related to demand for children as well. These include total household income and years of education of the mother, the latter of which serves both as a control for the implicit cost of raising children and a proxy for preferences over the "quality" of children. We constructed several alternate variables for demand for education of children based on peer expectations, namely the percentage of school-age children enrolled in school or extra classes at the district level, but found that the results were not sensitive to their inclusion. We control for the mother's earning power with an indicator for whether the mother was generally in a "skilled occupation". Of four occupation indicators used, this was the only one to which the results were sensitive.[4] To control for lifecycle and family size effects on demand for additional children, we included the age of the mother, her age squared and an indicator for whether the household had three or more children. We further control directly for the household's experience with child mortality, the number of children deceased, an important factor due to the desire to replace such a loss.

Another pair of variables is intended to control for differences in the availability of health services, which might mitigate the effects of differences in nutrition on mortality. These included an indicator variable for whether the mother had health insurance and the proportion of children in the household with health insurance. For households with no children, we based this instead on whether the mother had health insurance. The former variable may affect the costs of pregnancy. Since lack of insurance indicates reduced access to health care, this may heighten the health risks from malnutrition, so we also include interactions of the nutrition variables with the child insurance percentage variable in some specifications. Sample statistics of all of the variables are presented in Table 1. Protein is measured in grams and Vitamin A in micrograms. Income is measured in hundreds of thousands of Vietnam Dong (VND).

We estimate Logit models of the following form by maximum likelihood:

$$log\ (P\ (y_i=1)\ /\ P\ (y_i=0))=\alpha_0+\boldsymbol{x\beta}+\varepsilon_{\mathrm{i}} \qquad (2)$$

where y_i equals one if household i had a birth in the year prior to the survey (2005), **x** is the vector of explanatory characteristics for household i, and $\boldsymbol{\beta}$ is the vector of slope parameters to be estimated.

Two potential criticisms of this empirical approach are (a) that nutrition and fertility are simultaneously determined, and (b) that our data on nutrition are reported for the year following a pregnancy, and so their level should not have caused the pregnancy decision. The two objections are related and we address them both here. Our view is that the theoretically important variable in

Table 1 Household Sample Statistics (n = 5966)

Variable	Mean	Minimum	25th Perc.	Median	75th Perc.	Maximum
Dependent Variable						
Birth (=1 if child born in year prior to survey)	0.21	0	0.00	0.00	0.00	1.0
Main Set of Regressors						
Kilocalories (1000 grams per person per year)	725.55	192.669	595.87	707.77	835.02	2794.908
Protein (1000 grams per person per year)	24.96	6.740	19.29	23.51	28.90	92.99
Vitamin A	217.09	0.114	82.51	156.10	274.03	3191.75
Micronutrient Index	0.37	0.057	0.28	0.35	0.44	0.985
Income (100,000 Vietnam Dong)	365.16	33	178.93	269.40	425.03	10407
Skilled craft occupation indicator	0.07	0	0.00	0.00	0.00	1.0
No. of child fatalities ever experienced	0.07	0	0.00	0.00	0.00	6.0
Rural	0.76	0	1.00	1.00	1.00	1.0
Education of mother, years	7.58	0	5.00	8.00	9.00	19.0
Age of mother, years	36.82	17	31.00	37.00	43.00	49.0
Three or more children	0.30	0	0.00	0.00	1.00	1.0
Insurance, mother	0.40	0	0.00	0.00	1.00	1.0
Share of children in HH with health ins.	0.66	0	0.00	1.00	1.00	1.0

Source: Vietnam Household Living Standards Survey 2006.

determining precautionary demand for children is the expected mortality risk that potential children would face, both while children and into adulthood. Expected malnutrition is one factor that contributes to that risk. The nutrition measures that we use serve as proxies for expected malnutrition, because households are limited in their ability and willingness to reduce malnutrition.

To what extent is the ability and willingness of parents to reduce malnutrition limited? Income of households with malnourished children may vary widely. Indeed, a paradox recently recognized by many aid organizations is that malnutrition can coexist with having enough calories, with roughly one-billion people worldwide falling in the category of under-nourished while adequately fed.[5]

For the poorest households, malnutrition is not chosen, but is rather a consequence of lack of income for food (along with lack of access to health services and information). Many studies have estimated demand elasticities of food for of impoverished households and found demand to very insensitive to prices and income. For example, Pitt (1983) calculated nutrient elasticities with respect to the prices of nine key foods, for households in rural Bangladesh from 1973–74. Accounting for substitution effects across foods, he indeed found nutrient elasticities with respect to the prices of rice, pulses, fish and mustard oil to be close to zero for households at the 10 percentile level of expenditure, indicating that these households would spend almost all extra income on food.

Other households with malnutrition may be able to reduce it but be unwilling to, given the costs and tradeoffs required. For less severely impoverished households, the price elasticity of demand for food is higher. Banerjee and Duflo (2011: 23) sum up the evidence on this as: "the poor seem to have many choices, and they don't elect to spend as much as they can on food." For this reason, we argue that poor households tend to take as given their level of nutrition. Nutrient consumption in the subsequent year would therefore be a valid proxy for the household's malnutrition expectations. Timing of measuring the nutrition level should not matter as well, if families do not consider it worthwhile to spend more on nutrition after an addition to the family.

If the assumptions above were not to hold for the households in our sample, we would expect households that experienced a birth in the previous year to *increase* their nutrient consumption per capita. That is, simultaneous choice of nutrition and fertility by households should cause nutrient consumption to be positively correlated with the likelihood of a birth. But as discussed in section 4, below, this is not what we observe, except in the case of vitamin A. That we find negative correlations between nutrition and fertility suggests that either households do not adjust consumption much because of a birth, or that the precautionary demand effect dominates such a selection effect. Vitamin A is a special case, in that it is inexpensive to obtain supplements of and is widely known to be critical to maternal and infant health.

Another potential concern is the omission of an important variable: the availability of contraception to the household. If poor households that are nutritionally constrained are also limited in access to modern contraception, they would be more likely to have unwanted children. Then some of the children that we attribute to precautionary demand may be instead due to lack of contraception. While the VHLSS does not include information on family planning and contraception availability at the household level, related sources suggest that this unlikely to be driving our results. National health clinics have provided contraception and family planning information in Vietnam since 1995, subsidizing the majority of the cost. Data from a related survey in 2002, the Vietnam Demographic and Health Survey, show that of married Vietnamese women not using contraception, only 3% gave lack of knowledge as the reason for non-use and only 0.2% cited difficulty in obtaining it (Reich 2004: 298). The rate of unmet need for contraception for the entire population was higher but still quite low: 4.3%.[6] That contraception availability is not an important factor is also supported by data for our sample from the VHLSS on the use of contraceptives; we find no significant linear relationships between contraceptive use and income or nutrition.

4 Results

The hypothesis that precautionary demand for children is affected by nutrition is confirmed by our regression results. In various specifications, total calories, protein and the index of micronutrients are seen to significantly affect the likelihood of a household in the sample having a child. However, only for the micronutrient index is the effect significant after interacting the nutrient measures with the child insurance percentage. These results are presented in Table 2.

The model estimated in column 1 includes kilocalories, protein and vitamin A, but does not include the micronutrient index or the nutrition/child-insurance-percentage interactions. Here kilocalories and protein are negative and statistically significant, so that households that consumed more of those nutrients were less likely to have had a child in the previous year. This is consistent with our hypothesis that (lack of) nutrition affects households' assessment of the mortality risk their children will face and hence precautionary demand for children. Vitamin A has a positive and significant effect however, consistent with a households increasing consumption of this critical nutrient around the time of a birth.

The signs of the control variables are as we would expect. Income raises demand for children and we see a positive effect, while mother's income, controlled for here by the skilled occupation indicator, raises the cost of having children and we see a negative effect. The effect of the mother's education is also negative, for the same reason, and also as an indicator of preferences for fewer, more highly educated, children. With the child insurance percentage variable, we see that families in which more of the children have health insurance are more likely to have a child.

The micronutrient index is added as a regressor in the model estimated in column 2. Its effect is negative and statistically significant too, yet its inclusion causes the effect of protein to be diminished. It may be that lack of micronutrients is correlated with but is a greater overall concern to parents than

Table 2 Logit Regressions of Birth Indicator on Nutrition Measures, Covariates

Variable	(1)	(2)	(3)
Kilocalories (1000s per year)	−0.0019***	−0.0018***	−0.0008
	(0.0005)	(0.0005)	(0.0010)
Protein (1000s of grams per year)	−0.0405***	−0.0164	−0.0002
	(0.0146)	(0.0165)	(0.0353)
Vitamin A	0.0008**	0.0010***	0.0010
	(0.0004)	(0.0004)	(0.0008)
Micronutrient index		−2.1475***	−5.0629***
		(0.7011)	(1.4785)
Kilocalories x child insurance percentage			−0.0012
			(0.0012)
Protein x child insurance percentage			−0.0251
			(0.0411)
Vitamin A x child insurance percentage			−0.0000
			(0.0009)
Micronutrient index x child insurance percentage			3.8636**
			(1.7152)
Income	0.0002**	0.0002**	0.0002**
	(0.0001)	(0.0001)	(0.0001)
Skilled occupation indicator, mother	−0.5405***	−0.5041***	−0.5151***
	(0.1891)	(0.1894)	(0.1898)
Child Mortality, count	0.1791	0.1752	0.1658
	(0.1444)	(0.1449)	(0.1447)
Age, mother	−0.5248***	−0.5248***	−0.5297***
	(0.0506)	(0.0506)	(0.0508)
Age squared, mother	0.0055***	0.0055***	0.0056***
	(0.0008)	(0.0008)	(0.0008)
Education (years), mother	−0.0098	−0.0048	−0.0062
	(0.0119)	(0.0120)	(0.0121)
Three or more children, indicator.	−0.3446***	−0.3684***	−0.3706***
	(0.1081)	(0.1087)	(0.1088)
Insurance indicator, mother	−0.1557	−0.1776*	−0.1655*
	(0.0970)	(0.0974)	(0.0977)
Child insurance percentage	0.3612***	0.3633***	0.4598
	(0.1223)	(0.1225)	(0.4674)
Rural	0.2258*	0.2103*	0.2189*
	(0.1177)	(0.1179)	(0.1183)
Constant	11.1656	11.1835	11.2000
	(0.8600)	(0.8602)	(0.9177)
Pseudo R-squared	0.2535	0.2554	0.2567
N	5,966	5,966	5,966

Note: Standard errors in parentheses. *$p<0.1$; **$p<0.05$; ***$p<0.01$.
Source: Vietnam Household Living Standard Survey 2006, and authors' estimations.

lack of protein.

The coefficient on kilocalories from the Logit model in column 2, −0.0018, implies that at the median level of all variables, a one percent increase in kilocalories over the median reduces the probability of a birth by approximately 0.12 percent. Food consumption increased by 50 percent in Vietnam, 1985–2000 (Le and Nguyen 2002), and if calorie consumption increased commensurately and the model's effects held linearly, this would correspond to a cumulative reduction of 6 percent in the annual likelihood that each household would have had a child.

Similarly, the coefficient on the micronutrient index, −2.15, implies that a 0.1 increase in the index (which varies from 0.05 to 0.98 and has a standard deviation of 0.13) reduces the probability of a birth by 2.13 percent. Again, there are substantial differences between households with low nutrient consumption and those with high nutrient consumption.

The third model includes interaction terms of each of the nutrient variables with the child insurance percentage. This is to examine the hypothesis that since the health effects of malnutrition are exacerbated by a lack of health care, the health insurance status of children should condition the expectations of parents over the mortality risk of their future children. The child insurance percentage variable serves as a proxy for the insurance status of potential children since it is based on the current status of siblings, or lacking any, the status of the mother. Surprisingly, only the micronutrient index had a significant interaction effect or level effect in column 3. The partial effects of the other nutrients became insignificant with the inclusion of the interaction terms. Interpreting the effect of micronutrients with the significant interaction term, we see that the effective coefficient for a household with a child insurance percentage of 1 (100%) is −1.199, while for a household with a child insurance percentage of 0 it is the full −5.0629. At the median values of all variables, the latter coefficient implies that an increase in the index of 0.1 reduces the probability of a birth by 3.93 percent, more than four times the effect of the former coefficient, which corresponds to only a 0.93 percent reduction. This suggests that for the subset of the population that is both constrained in terms of nutrition and lacks health insurance, the effects of expected malnutrition on demand for children are large.

In Table 3, the models from columns 2 and 3 of Table 2 are estimated using the rural and urban subsamples to examine whether the effects vary between the two types of households. Examining the coefficients on the nutrient variables between columns 1 and 2, we see that the effect of calories is smaller and statistically insignificant in the urban sample. The statistical insignificance appears to be due largely to the smaller urban sample size, since the standard error increased by 120%, while the coefficient estimate decreased by only 39%. The coefficient for the micronutrient index is roughly the same in columns 1 and 2 as in column 2, Table 2. Between columns 3 and 4 we see a more major difference, once the interaction terms have been included. The high magnitude of the micronutrient index coefficient in column 4, of −7.05, suggests that insurance and access to health

Table 3 Logit Regressions, Rural and Urban Sub-samples

Variable	Rural (1)	Urban (2)	Rural (3)	Urban (4)
Kilocalories (1000s per year)	−0.0018***	−0.0011	−0.0005	−0.0011
	(0.0005)	(0.0011)	(0.0012)	(0.0027)
Protein (1000s of grams per year)	−0.0202	−0.0134	−0.0072	0.0187
	(0.0187)	(0.0371)	(0.0394)	(0.0807)
Vitamin A	0.0012***	0.0004	0.0012	0.0006
	(0.0004)	(0.0007)	(0.0009)	(0.0018)
Micronutrient index	−2.0969***	−2.1376	−4.8582***	−7.0502
	(0.7559)	(1.8934)	(1.5462)	(4.9445)
Kilocalories x child insurance percentage			−0.0017	0.0002
			(0.0014)	(0.0030)
Protein x child insurance percentage			−0.0216	−0.0398
			(0.0460)	(0.0936)
Vitamin A x child insurance percentage			−0.0000	−0.0003
			(0.0010)	(0.0021)
Micronutrient index x child insurance percentage			3.7390**	5.7955
			(1.8141)	(5.4359)
Income	0.0004**	0.0001	0.0003**	0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Skilled occupation indicator	−0.3797*	−0.7292**	−0.3935*	−0.7210**
	(0.2236)	(0.3643)	(0.2243)	(0.3658)
Child Mortality, count	0.1634	0.0723	0.1534	0.0605
	(0.1526)	(0.4369)	(0.1523)	(0.4403)
Age, mother	−0.5424***	−0.5135***	−0.5464***	−0.5157***
	(0.0560)	(0.1206)	(0.0561)	(0.1218)
Age squared, mother	0.0058***	0.0051***	0.0059***	0.0051***
	(0.0008)	(0.0018)	(0.0008)	(0.0018)
Education (years), mother	−0.0298**	0.0829***	−0.0312**	0.0824***
	(0.0139)	(0.0266)	(0.0140)	(0.0266)
Three or more children, indicator.	−0.3792***	−0.4300	−0.3805***	−0.4446*
	(0.1208)	(0.2639)	(0.1210)	(0.2634)
Insurance indicator, mother	−0.1590	−0.4619**	−0.1475	−0.4775**
	(0.1121)	(0.2248)	(0.1125)	(0.2254)
Child insurance percentage	0.3695***	0.2475	0.7654	−0.8753
	(0.1345)	(0.3071)	(0.5229)	(1.1175)
Constant	11.7940	10.3691	11.5918	11.3651
	(0.9469)	(2.0418)	(1.0091)	(2.1920)
Pseudo R-squared	0.2586	0.2596	0.2602	0.2617
N	4,554	1,412	4,554	1,412

Note: Standard errors in parentheses. *$p<0.1$; **$p<0.05$; ***$p<0.01$.
Source: Vietnam Household Living Standards Survey 2006 and authors' estimations.

care conditions the effect of micronutrient deficiencies on precautionary demand for children more for urban households. Though the standard error is much higher in column 4 than column 3, so that the coefficient is not statistically significant against a traditional two-sided alternative at the 5% level, given the t-stat of −1.42 it would be significant against a one-sided alternative at the 10% level. This is at least suggestive of a larger effect for urban households lacking health insurance.

5 Conclusions and future research implications

This study provides evidence that household demand for children is impacted by nutritional limitations. This supports the economic theory of precautionary demand for children, a source of demand that stems from perceived mortality and morbidity risks. Using data on a nationally-representative cross-section of Vietnamese households from 2006, we find that households consuming fewer calories, less protein and fewer micronutrients per person were significantly more likely to have had a child in the year prior to the survey. Moreover, the effect was strongest for micronutrient deficiencies by households with little or no child health insurance. The effects did not vary substantially between rural and urban households, except that the effect of micronutrient deficiency was strongest for urban households lacking health insurance coverage.

These results shed light on the complex interrelationships between income, mortality and demand for children. Given the strong upward trend in nutrition for Vietnam nationally, 1985–2010, they help to explain the rapid reduction in birth rates over the same time period. The policy changes that expanded access to nutrition to poor and rural households likely accelerated the ongoing fertility decline caused by other factors, the economic factors of which were primarily rising incomes of women and expectations of increased educational investment in children. Fortunately, malnutrition is diminishing in Vietnam. But in the current era of rising and volatile food prices, malnutrition will continue to impact places where extreme poverty persists. Our study suggests that malnutrition matters not just for health and education outcomes, but fertility too. Future studies that use experimental or quasi-experimental designs would provide more robust support for the link between nutrition and precautionary demand for children by isolating random variation in nutrition. It will also be important to investigate the relationship between nutrition and fertility in other locations before specific policy recommendations can be derived from these results.

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Notes

1 See Le and Nguyen (2002), Figure 2.

2 Malnutrition, mortality and income data from World Bank, *World Development Indicators*, various years. http://databank.worldbank.org.

3 Nutrient measures given by: Nutrition Contents of 400 Common Vietnamese Foods and Dishes, Vietnam Medical Publishing, Ho Chi Minh City, 2001. Vietnamese: Nguồn: Sách Thành phần dinh dưỡng 400 thức ăn thông dụng – NXB Y học.

4 The four occupation categories included "leadership" (managerial or bureaucratic), "professional" (primarily medical and educational) and "clerical". The share of sampled households with a woman in the "leadership" category was only 0.006. For "professional" only 0.014.

5 Many of these organizations are mentioned in a recent article in *The Economist*, "The Nutrition Puzzle", Feb. 18th, 2012.

6 World Bank, *World Development Indicators*, 2011: http://databank.worldbank.org.

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