YOUNG LIVES STUDENT PAPER

Adult Education and Child Nutrition in India and Vietnam: The Role of Family, Neighbours and Friends

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October 2005

Thesis submitted for the degree of Doctor of Philosophy, Faculty of Medicine, University of London. (Nutrition and Public Health Research Intervention Unit, Department of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine)

The data used in this paper comes from Young Lives, a longitudinal study investigating the changing nature of childhood poverty in Ethiopia, India (Andhra Pradesh), Peru and Vietnam over 15 years. For further details, visit: www.younglives.org.uk.

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Young Lives
An International Study of Childhood Poverty

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Abstract

It is well established that mothers' education has positive effects on child nutrition in developing countries. In school, girls can acquire skills which are later used to access modern health services and comprehend health messages. Less explored, however, is the effect exerted by the education of other individuals – the mothers' friends, neighbours and family – which may influence child nutrition directly or modify the effect of maternal education. Furthermore, questions remain about the mechanisms underlying the adult education–child nutrition relationship, especially the role of mothers' health and nutrition (HN) knowledge which has been debated in recent literature. Future research into the impact of adult education on child nutrition should therefore widen the focus from mothers only to others in her household, community and communication network and specifically examine the mediating role of mothers' HN knowledge.

The thesis has two main components. In the first part I analyse data collected in 2002 from the Young Lives (YL) study in Vietnam and Andhra Pradesh (AP) in India to assess the association between child height- and weight-for-age z-scores and adult education in the household and community. Adult education was measured as the level of formal schooling completed and community-level education was measured by aggregating individual-level data. Data were collected on 6019 households in 20 sites and 133 communities with children aged either 1 or 8 years old.

In the second part of the thesis I present the results of a cross-sectional study undertaken in 2004 of a sub-sample of YL mothers in AP, the Knowledge and Networks (KN) study, which was designed to explore mediators of the education effect, specifically the role of HN knowledge. Data were collected on the education, HN knowledge, general awareness, media, communication ability and communication networks of 302 mothers. I used multi-level regression modelling in Stata and MLwiN to adjust simultaneously for confounding and the hierarchical structure of the data-sets. The instrumental variable approach was used in an attempt to adjust for 'endogeneity' of knowledge.

The results in part 1 show that the education of mothers, fathers and grandmothers has independent positive effects on child nutrition. A linear effect of parental education was found, with the greatest effect observed for a higher level of education. There was a positive effect of community-level maternal literacy on child height over and above parental education in Vietnam though not in AP. However, the distribution of educated individuals in the community did not have an additional impact. There was no difference between the countries in the effect of maternal education on child nutrition, although the effect was stronger in Vietnam for paternal education and stronger in AP for grandmother education. Overall, adult education was more strongly associated with child nutrition in households and communities that were relatively wealthy and well-educated than among the poorer and less well-educated. Furthermore, grandmothers' education was more strongly associated with boys' nutrition than girls'. Drawing on findings from previous research I explore possible reasons behind the social and spatial differences in education effect and hypothesize about underlying causal mechanisms.

Part 2 revealed that a mother's HN knowledge was associated with her education, the size of her communication network and her ability to communicate. The results were compared with another type of knowledge – referred to here as 'general awareness' – which was determined by education, ability to communicate and use of telephones and newspapers. There was no evidence that HN knowledge or general awareness were endogenous variables in the causal model predicting child nutrition, although this may be explained by the weakness of the instruments used. Ordinary least squares regression results suggest that general knowledge may mediate the education effect, but that HN knowledge does not. Mothers' communication ability was identified as an important positive effect-modifier of the education effect and a potential mediator or confounder. The difficulties with the application of the instrumental variables approach are discussed in depth, along with the difficulties in disentangling the effect of mothers' identity and skills in shaping child nutrition.

In this thesis I demonstrate the important role of education among 'influential others' beyond the mother in determining child nutrition, thereby calling for a less individualistic approach to research and policy. I challenge the attention given in recent

years to the role of mothers' HN knowledge in mediating the education effect and argue instead that mothers' communication skills are more important, perhaps because they enable her to develop social networks and access support which benefit the health and well-being of herself and her family. An important issue worthy of further debate is the extent to which innate capabilities can be enhanced through education. I conclude by outlining key recommendations for future research which address both the methodological weaknesses of the present study and the remaining knowledge gaps in the literature.

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GLOSSARY OF TERMS

AP	Andhra Pradesh
CESS	Centre for Economic and Social Studies (Hyderabad)
CI	Confidence interval
DHS	Demographic health survey
DFID	Department for International Development
HAZ	Height-for-age z-score
HH	Household
HN	Health and/or nutrition
INCAP	Instituto de Nutricion de Centro America y Panama
IFPRI	International Food Policy Research Institute
IV	Instrumental variables
KAP	Knowledge attitudes and practice
KN	Knowledge and Networks study
LR	Likelihood Ratio
NHFS	National Family Health Survey
NS	Not significant (statistically)
OLS	Ordinary least squares
ORS	Oral re-hydration solution
PEM	Protein-energy malnutrition
SE	Standard error
SL	Sustainable livelihoods
TB	Tuberculosis
TV	Television
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
WAZ	Weight-for-age z-score
YL	Young Lives
2SLS	Two-stage Least Squares

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CHAPTER 1

ADULT EDUCATION AND CHILD NUTRITION: BACKGROUND, AIM AND OBJECTIVES

1.1 Introduction

The thesis is divided into two parts. In the first part I use data from the Young Lives Study to explore the relationship between adult education and child malnutrition in Vietnam and Andhra Pradesh State in South India. In the second part I examine potential underlying mechanisms for this relationship through the Knowledge and Networks study, which I conducted among a sub-sample of women participating in the Young Lives study in Andhra Pradesh.

In this chapter I provide a background to the two studies. The chapter is divided into seven sections. In Sections 2-4 I present a literature review of the evidence for child malnutrition being a serious public health problem, the relationship between adult education and child nutrition, proposed mechanisms underlying this relationship and the role of non-parental actors. In Sections 6-9 I provide a summary of the background literature, a justification for further research and the aims and objectives of the thesis.

1.2 Child malnutrition

In this section I summarise the literature concerning the consequences of child malnutrition, its causes and the role of education to combat it.

1.2.1 The consequences of malnutrition

An inadequate diet and ill-health can be detrimental to children's physical growth. While severe protein-energy malnutrition (PEM) in the form of kwashiorkor or marasmus can be fatal but is relatively rare, mild or moderate malnutrition is considerably more common and is usually measured in terms of growth failure (Schroeder and Brown 1994; WHO 1995).

Anthropometry provides a measure of malnutrition. The concepts of wasting (low weight for height), stunting (low height for age) and underweight (low weight for age) were introduced by Waterlow in the 1970s (Waterlow, Buzina et al. 1977). Since then it is broadly understood that stunting is an accumulative process related to long-term chronic malnutrition, whereas wasting is more dependent on shorter-term and acute malnutrition (WHO 1986; Bogin 1999). Underweight is the outcome of both chronic and acute malnutrition. A good review of the literature and a discussion on these anthropometric indices is provided by Cesar Victora, who draws attention to the lack of statistical association between the population prevalence of wasting and stunting worldwide, as evidence for different aetiologies between the two nutrition indicators (Victora 1992). Further discussion about the causes of malnutrition will be given in Section 1.2.3.

A number of studies in developing countries have explored the consequences of being malnourished in the preschool years (Tomkins and Watson 1989; Schroeder and Brown 1994; Pelletier, Frongillo et al. 1995; van Ginneken, Lob-Levyt et al. 1996; Scrimshaw and SanGiovanni 1997). The main consequence is an increased risk of death due to an impaired immune system which increases a child's susceptibility to infectious diseases. It has recently been estimated that more than 10 million children die each year, mostly from preventable diseases, and malnutrition, predominately mild to moderate malnutrition, accounts for more than half of these deaths (Schroeder and Brown 1994; Pelletier, Frongillo et al. 1995; Black, Morris et al. 2003). Malnutrition has also been shown to be associated with delayed mental development (Grantham-McGregor, Powell et al. 1989; Mendez and Adair 1999), poorer educational achievement (Hall, Khanh et al. 2001) and

lower physical and intellectual productivity in adult life (Strauss and Thomas 1998; UNICEF 2004). Moreover, malnutrition before birth that manifest itself as fetal growth retardation, has been shown to be related to raised blood pressure in childhood and adult life, which is a risk factor for cardiovascular disease (Law, Egger et al. 2001; Adair and Cole 2003).

In recent years many developing countries have begun to bear the 'dual burden of malnutrition', whereby a growing proportion of the population are suffering from obesity and obesity-related disorders in addition to the large proportion who remain undernourished (SCN 2004). However, in this thesis the term 'malnutrition' will refer to under-nutrition rather than over-nutrition because undernourishment is the main problem among children in India and Vietnam.

1.2.2 The scale of the problem worldwide and in Asia

The enormous personal and social costs of child malnutrition in developing countries is well recognised. The costs in terms of deaths and ill-health are so great that reports in the early 1990s estimated that eliminating malnutrition would cut child mortality by more than 50% and reduce the burden of disease in developing countries by about 20% (Tomkins and Watson 1989; FAO/WHO 1992). Despite a worldwide decrease in the percentage of poorly nourished children in developing countries since the 1980s, malnutrition remains a major public health problem in many of these countries. One out of every three children under five years old in developing countries is small for its age (Smith and Haddad 1999).

The picture remains bleak in Asia. Although the prevalence of malnutrition in Asia has decreased in the last 20 years, about half the preschool children remain underweight, which is the highest level in the world: in India there are 62 million children underweight and in Vietnam there are 5 million, both corresponding to 50 percent of the child population (Mason, Hunt et al. 1999; de Onis, Frongillo et al. 2000). In both countries there has been concern that economic advances have not been reflected in improvements

in child nutrition (Claeson, Bos et al. 2000; Glewwe, Koch et al. 2002; Thang and Popkin 2003). Within South Asia this concern has been termed 'the South Asian enigma', the enigma being that despite levels of poverty and agricultural productivity being similar to those of Sub-Saharan Africa, rates of malnutrition remain significantly and persistently higher in South Asia (Ramalingaswami, Jonsson et al. 1996). At the same time there have been recent profound changes in diet and lifestyle in Asia, a phenomenon known as the 'nutrition transition', which has led to problems of over-nutrition in the urban and wealthier sections of society (Popkin 1994; Claeson, Bos et al. 2000; Griffiths and Bentley 2001; Shetty 2002; SCN 2004).

Another type of enigma is observed in Vietnam, where child mortality figures are low by East Asian standard and yet the country has a relatively high incidence of child malnutrition (World Bank 2000). Spatial and social inequalities in malnutrition, which have been traditionally low in Vietnam, have now begun to increase, probably in response to a move away from a planned economy towards a market economy (World Bank 2000; Wagstaff, van Doorslaer et al. 2003). A recent report by the World Bank noted a strong correlation between child nutrition and improvements in household income during the 1990s, but claimed that this association was not necessarily causal. The authors instead hypothesise that higher incomes led to community-level improvements in health services through increased taxes. It is these services that determine child nutrition rather than household level resources (Glewwe, Koch et al. 2002).

While it is clear that malnutrition should be combated, the way to accomplish it is still widely debated. In order to develop strategies to tackle the problem it is essential to that our understanding of its causes is enhanced. Research into the biological and social roots of malnutrition has been going on for decades. This research will be summarised in the next sections.

1.2.3 Causes of malnutrition

Nutritional factors

Our current understanding about the causes of malnutrition comes primarily from a small number of longitudinal studies. The INCAP study in Guatemala, for example, was designed to assess the effect of improved nutrition on child growth through a food supplementation experiment, where the treatment (in the form of a nutritious drink) was provided in two villages and a placebo provided in two control villages (Martorell and Habicht 1986; Martorell 1995; Schroeder, Martorell et al. 1995). The study showed that growth failure occurs primarily in utero and in the first three years of life, and that this was the main cause of short stature in adults. Other studies have found similar findings (Huttly, Victora et al. 1991; Shrimpton, Victora et al. 2001). Many studies have attempted to disentangle the underlying mechanisms of growth retardation that operate through deficiencies in macro- or micro-nutrients (Victora 1992; Allen 1994; Branca and Ferrari 2002). On the whole, however, the most important finding of nutritional research from the last two decades has been related to the timing of malnutrition and the role of intrauterine growth retardation in determining post natal growth and future stunting. This directs the focus onto women and adolescent girls, who, when poorly nourished before or during pregnancy are likely to give birth to underweight babies. These babies are likely to grow up to become stunted adults and thereby perpetuate the life-cycle of malnutrition (ACC/SCN 1998; Mason, Hunt et al. 1999; UNICEF 2004).

Socio-economic factors

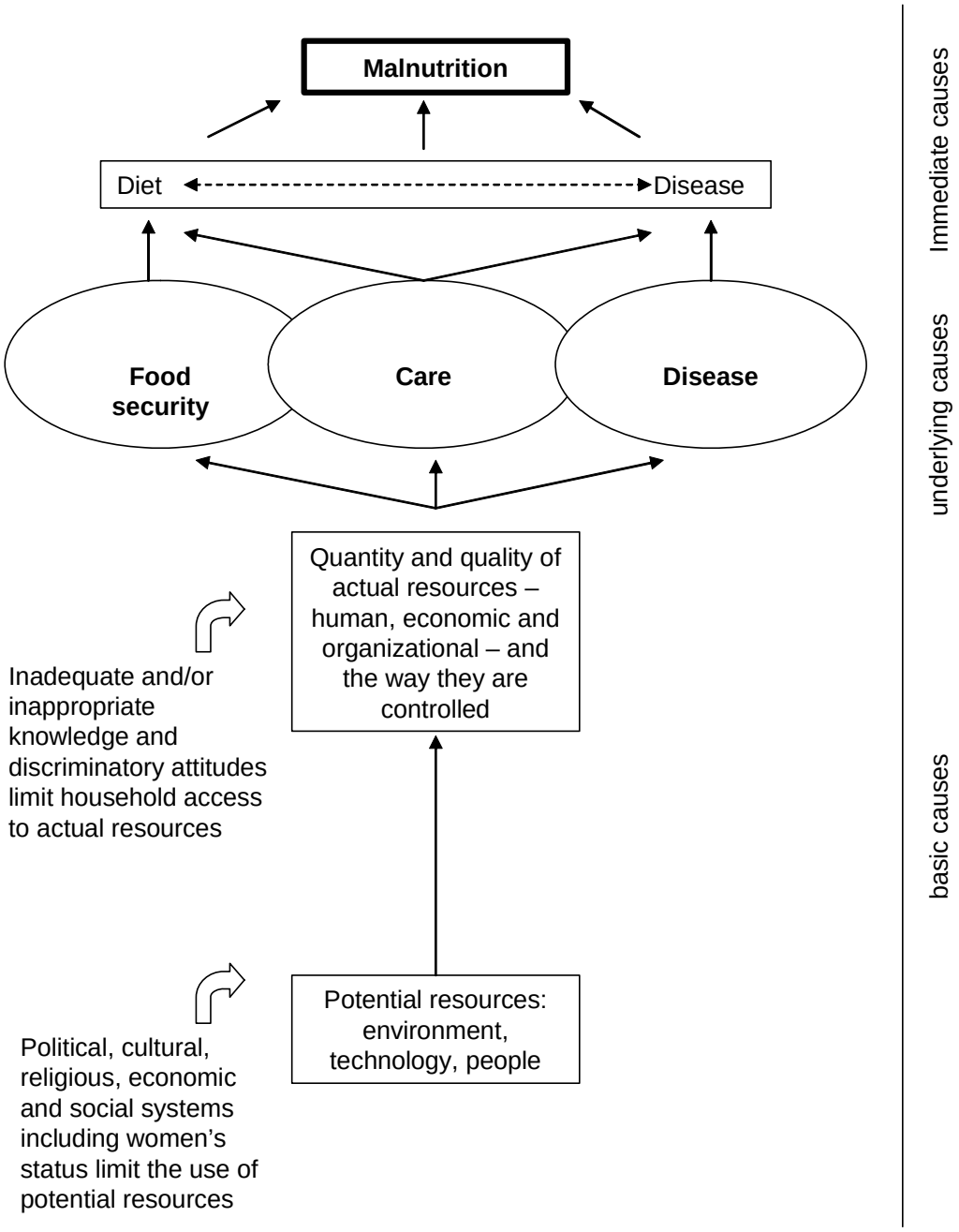
The past two decades have witnessed an increasing number of attempts to understand the myriad of factors that affect child nutritional status (Wolfe and Behrman 1982; Bhuiya, Zimicki et al. 1986; Martorell and Habicht 1986; Huttly, Victora et al. 1991; Strauss and Thomas 1995; Frongillo, de Onis et al. 1997; Strauss and Thomas 1998). These studies have revealed associations between family background and early childhood nutrition in developing countries, many of which have been reviewed by Strauss and Thomas (Strauss 1990; Strauss and Thomas 1998). What is currently known about the determinants of child malnutrition is illustrated well by UNICEF's framework provided

in Figure 1.1. It is similar in structure to the framework proposed for child survival by Mosley and Chen in 1984. The UNICEF model demonstrates the multiple and inter-related causes of malnutrition by incorporating biological and socio-economic causes at both micro and macro levels (Mosley and Chen 1984; UNICEF 2004). It shows that while the immediate causes of malnutrition are a poor diet and infectious disease (Black, Brown et al. 1984; Tomkins and Watson 1989; Pelletier 1994; Scrimshaw and SanGiovanni 1997), underlying these are inadequacies of food security (Bouis and Hunt 1999), caring practices (Engle, Bentley et al. 2000) and basic health services (Elo 1992; Caldwell 1993). At the broader societal level, the political, economic and ideological structures indirectly affect behaviour within the household. The UNICEF framework was useful in the 1990s in fostering debate on the causes and nature of malnutrition. As a result, the study of malnutrition is no longer confined to the individual, but also encompasses the compositional and contextual situation in which the person lives (Duncan, Jones et al. 1998; Griffiths, Madise et al. 2004).

Role of women

Biological causes of malnutrition operate within a cultural context that has drawn attention to the role of women in determining child malnutrition – their knowledge and abilities, their physical and mental well-being and their decision-making power in shaping children's nutrition. Education has received most attention, the literature on which will be reviewed in the next section. The strong focus on female education can possibly be explained by the relative ease with which it can be measured compared with other individual characteristics such as knowledge and behaviour, thereby facilitating the standardisation of education measures across countries. Moreover, policy intervention on education may be more easily considered and achieved than on say cognitive development. A recent report by IFPRI (International Food Policy Research Institute) estimates that the worldwide improvements in female secondary school enrolment rates between 1970 and 1995 explain almost half of the total 15.5 % reduction in child underweight in that period (Smith and Haddad 1999). This finding is particularly relevant to South Asia where the traditionally low status of women in society is now being identified as a key factor in explaining the high rates of child malnutrition.

Figure 1.1 The UNICEF model for the determinants of malnutrition (UNICEF 2004)



1.3 Education to combat malnutrition

Women's education is recognised by all the major international development agencies as crucial for developing countries. For example the UNICEF report 'State of the World's Children 2004' advocates the vital importance of improving girls' education as it benefits both boys and girls, helps lower infant and child mortality, improves nutrition and health, raises economic productivity and reduces poverty around the world (UNICEF 2004). Apart from being an important end in itself, education is viewed as a key element in the overall strategy for reducing poverty and malnutrition in the developing world (OXFAM 2001; Bruns, Mingat et al. 2003).

Basic schooling became a human right in 1948. At the 1990 'Education for All' conference in Thailand more than 150 governments promised to provide free and compulsory basic schooling so that by the year 2000 adult illiteracy rates would be halved and all children would enjoy the right to a good primary schooling. That commitment was unfortunately not kept, but it was reaffirmed at the World Education Forum in Senegal in 2000. This was the same year as the UN set the Millennium Development Goals, one of which was to 'ensure by 2015 that children everywhere will complete a full course of primary schooling' (UNDP 2003). Yet despite the worldwide recognition of the multiple benefits of education, many children remain uneducated and illiterate because the educational infrastructure and quality is inadequate or because families cannot afford the financial and opportunity costs associated with sending children to school.

The literature reviewed in this section includes the major studies of education and child health and nutrition. It focuses on education among adults, rather than children, as the synergism between child education and child nutrition lies outside the remit of this study and has been summarised elsewhere (Behrman 2000). Although there has been much interesting research in the developed world exploring the relationships between education and health [for example see (Chandola, Clarke et al. 2004; Schnittker 2004; Lleras-Muney 2005)] the review only includes studies from developing countries.

1.3.1 Findings from large-scale household surveys

In the late 1970s and early 80s, large-scale studies across the developing world showed that education was positively related to child survival and inversely related to fertility (Caldwell 1979; Caldwell 1980; World Bank 1980; Cochrane, Leslie et al. 1982). Moreover mothers' education appeared to confer greater benefits than fathers' education (Caldwell 1979; Hobcraft, McDonald et al. 1984; Ware 1984). Hobcraft, for example, used survey data from 25 countries to show that the odds of a child dying before the age of 2 years was significantly lower if the mother had 7 or more years of education, the odds ratio being below 0.6 in 18 countries, whereas the equivalent effect for fathers' education was found in 2 countries only (Hobcraft, McDonald et al. 1984). Given the recognised important biological and social role of women in determining children's health outcomes, it is currently deemed plausible that investments in female education yield greater social returns than investments in male education (Garza 2000; Schultz 2002; Charmarbagwala, Ranger et al. 2004; SCN 2004).

In the decade that followed, the analysis of massive data-sets from the World Fertility Survey and Demographic and Health Surveys confirmed the role of female education in the demographic transition, and that the effect of education operates independently of socio-economic indicators (World Bank 1980; Hobcraft, McDonald et al. 1984; Ware 1984; Cleland and van Ginneken 1989; Cleland, Bicego et al. 1992; Bicego and Boerma 1993; Basu 1994; Brockerhoff and De Rose 1994).

The strong linear relationship between maternal education and child health outcomes has been found across a number of studies (for a review see Cleland and Kaufman 1998). One study has estimated that the under-five mortality rate drops by 2-5% per year of mothers' education (Cochrane, Leslie et al. 1982).

More recent research has raised questions about the causal relations between maternal education and child health outcomes. Desai and Alva use Demographic Health survey data (DHS) from 22 developing countries to examine the effect of maternal education on

child health (Desai and Alva 1998). They found that the inclusion of a rural/urban indicator and various individual-level variables weakened the original effect of education. Hypothesising that unobserved factors operating at the community-level might also be linked with the exposure and outcome, the authors included all the communities as binary variables in the model instead of the rural/urban variable. This led to a further reduction in the effect of education. The authors therefore conclude that education acts as a proxy for socio-economic status of the family and geographical area of residence and claim that, despite the strong correlation between maternal education and child health outcomes, a causal relationship is far from established. This study will be discussed further in Section 1.4.2.

There have been additional studies showing no effect of education on child health outcomes (Black and Krishnakumar 1999; Thang and Popkin 2003). A meta-analysis by the World Bank examining the determinants of child health and nutrition using household survey data in developing countries found that, despite an overall statistically significant effect of maternal education, there were a number of studies that did not find significant educational effects (Charmarbagwala, Ranger et al. 2004). The authors speculate that learning outcomes matter more than attendance, so that low quality schooling may have no beneficial effects for child nutrition. To consider this possibility they used a literacy indicator rather than school attendance, assuming therefore that literacy is more strongly associated with quality of education than mere attendance. However, again a number of studies still did not show a significant relationship with child nutrition. The authors conclude that it is mother's health knowledge that matters, as suggested by Glewwe (Glewwe 1999). The absence of an education effect may therefore be explained by schooling not providing such knowledge directly, or if health information is provided outside of the education system it is understood equally by the less educated. The role of knowledge will be discussed further in Section 1.3.2.

Research in India and Vietnam

Large-scale household surveys in India have shown the importance of education in reducing child death and fertility (Tulasidhar 1993; Murthi, Guio et al. 1995;

Ramachandran 2003). There has also been some interesting research into the role of education to combat gender discrimination in children's diet and immunization against disease (Bhuiya and Streatfield 1991; Bourne and Walker 1991; Borooah 2004) and the role of education in explaining the spatial clustering of malnutrition and death (Das Gupta 1990; Griffiths, Matthews et al. 2002). Moreover, a comparative study of the determinants of child nutritional status from selected African and Indian regions has emphasised the importance of community- and regional-level influences in determining the effect of household-level influences on child nutritional outcomes (Griffiths, Madise et al. 2004).

A recent paper by Basu and Stephenson presents the findings of analysis of 1992/93 Indian National Family Health Survey data (NFHS), exploring and comparing various causal pathways between maternal education and child nutrition. The paper shows that even low levels of education increase child survival prospects and health-related behaviours (Basu and Stephenson 2005). Additional studies in India which have explored the relationship between maternal education, health and nutrition knowledge and child nutrition and will be reviewed in depth in Chapter 5.

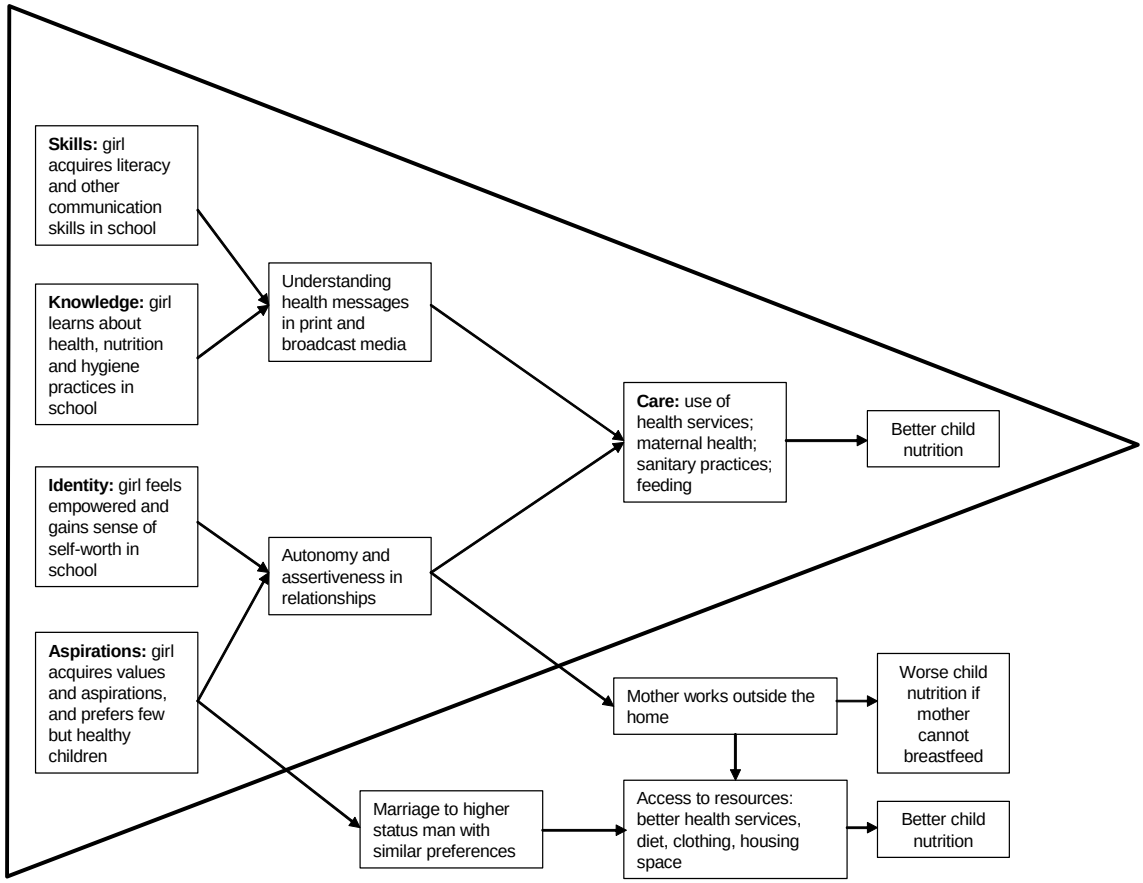
The role of education with regard to child nutrition in Vietnam has been less clear (White and Masset 2002). A recent study using two nationally representative surveys found no significant effect of maternal education on child nutrition (Thang and Popkin 2003). Similar findings were found by a recent World Bank study (Glewwe, Koch et al. 2002). The authors suggest that increased pressure for women to work outside the home has negative consequences for child-care and breastfeeding practices, which may have outweighed any potential benefit of education. The lack of effect may also be due to other factors being more important determinants of nutrition than education, such as inadequate water supply, sanitation and household livelihoods [see (Koch and Linh 2002) cited in (Young Lives 2003)].

1.3.2 Establishing causal mechanisms

As a result of the evidence reviewed here there has, in recent decades, been a massive expansion of female education in the developing world (UNESCO 2004) despite, as LeVine's review points out, the nagging issues of causal inferences that continue to divide those who interpret the evidence for policy purposes (LeVine, LeVine et al. 2001). Therefore, following the many analyses of survey data from the 1970s and 80s, there came a demand for more pragmatic investigations into the intermediate factors (Ware 1984; Cleland and Van Ginneken 1988). Authors such as LeVine and Cleland have drawn on research from many disciplines to explore the plausibility of proposed underlying mechanisms between maternal education and child health (Cleland and Van Ginneken 1988; LeVine, LeVine et al. 2001).

Figure 1.2 is a framework that summarises these proposed mechanisms, based on the model by LeVine et al. (2001). It shows the multiple and stepped causal pathways between women's education and child nutrition. In short, a girl gains skills, knowledge, identity and aspirations by going to school, all of which may aid her in caring for herself and her family, thereby improving her future child's nutritional status. She does this by understanding health messages and having the autonomy to act upon them. I have added a triangle that encloses the pathways relating to behaviour, which are more open to policy interventions than the pathways outside the triangle. The pathways less amenable to intervention include the tendency for educated women to work outside the home, thereby having less time and opportunity to care for and breastfeed their children, which may lower children nutritional status unless out-weighed by a resulting access to more material resources. A summary of evidence for the various causal pathways now follows.

Figure 1.2 The causal pathways between female education and child nutrition, adapted from LeVine et al. (2001)



Care and labour-force participation

Figure 1.2 suggest that care is an immediate determinant of malnutrition. The apparently stronger effect of maternal education than paternal education might suggest that care is important, assuming that in most societies mothers are the main caregivers of the child (Bishai 1996). Indeed, many studies have found that maternal education is strongly

associated with indicators of care, such as the use of modern health services, the type of sanitary practices used in the home, her ability to care for her own health and child feeding and immunization (Streatfield, Singarimbun et al. 1990; Joshi 1994; Bishai 1996; Raghupathy 1996; Matthews and Diamond 1997; Ruel, Levin et al. 1999; Armar-Klemesu, Ruel et al. 2000; Engle, Bentley et al. 2000; Bloom, Wypij et al. 2001). It should be noted, however, that aspects of care are often difficult to capture in routine surveys, and associations observed between care behaviour and child health outcomes may suffer from the problem of reverse causality. For example mothers of sick infants may decide to wean earlier than mothers of healthy infants because they believe the sick infant needs food additional to breast-milk to get well and grow. Therefore, although a cross-sectional study may find a strong correlation between diarrhoea and the cessation of breastfeeding, it would be impossible to distinguish the direction of the causal relationship. Longitudinal studies overcome the problem of 'reverse causality' and findings from such studies confirm that the multidimensional aspects of care play a crucial role in determining child nutrition. In the Philippines, for example, longitudinal data from 3000 children were analysed to show that mothers recognise certain unobservable threats to the health of their infants and take measures to reduce the risk of such threats (Cebu Study Team 1991). The study suggests that maternal education induces changes in behaviour, which in turn leads to changes in the prevalence of childhood diarrhoea.

Any discussion about care and education must mention the important role of labour-force participation. The picture is not a clear one. Education is often associated with employment outside the home, which may have both positive and negative effects on child nutrition (Hobcraft, McDonald et al. 1984; Smith, Ramakrishnan et al. 2002). A study in Benin, for example, found a negative association between maternal education child weight. The authors explain the results by suggesting that education improves the woman's chances for getting paid work, drawing her away from childcare in the home, which has detrimental impacts on child nutrition (Reed, Habicht et al. 1996). On the other hand, there are positive consequences of women working, mainly a higher income, so that sometimes the negative effects on care can be out-weighed by positive impacts on

household food and resources. A study by Barrera (1990) in the Philippines showed that although educated mothers weaned their children sooner than uneducated mothers, they compensated with better quality of care, so that overall their children were better nourished, as measured by their height-for-age z-score (Barrera 1990).

Skills

In the classroom children may acquire skills in literacy and numeracy that will lead to life-long benefits, assuming that the skills are maintained after leaving school. Skills in 'oral literacy', in particular 'decontextualized language' skills, are useful because this is the language often spoken in health clinics and other bureaucratic settings (this issue will be discussed in further depth in Section 5.4.5). A study in Nepal by LeVine et al. (1994) showed that women who had been to school retained academic literacy skills into adulthood at a level of proficiency that reflected the amount of education they had experienced. The skills influenced their comprehension of health messages (in print or broadcasted over the radio) and their ability to understand instructions and tell a health narrative (LeVine, LeVine et al. 2004). The theoretical model proposed by LeVine in which academic literacy skills – including a proficiency in decontextualized language – serve as a pathway between formal schooling and maternal health-related behaviours has been tested in Venezuela (Schnell-Anzola, Rowe et al. 2005), Mexico (Dexter, Levine et al. 1998) and Nepal (LeVine, LeVine et al. 2004). Other studies have also emphasised the importance of literacy as an outcome of formal education which contributes to the improvement of child nutrition (Grosse and Auffrey 1989; Lomperis 1991; LeVine, Dexter et al. 1994; Sandiford, Cassel et al. 1997; Stuebing 1997; Kovsted, Pörtner et al. 2002). It has even been argued that going to a 'low quality' school for a few years is sufficient to achieve these benefits (LeVine, LeVine et al. 2001; Basu and Stephenson 2005), an issue which will be discussed later in Section 10.3.6.

Knowledge

Studies have shown that women's knowledge of health and nutrition, including their perceptions of child growth and ability to detect growth faltering, are important determinants of child nutrition and may mediate the effect of education (Black and Krishnakumar 1999; Glewwe 1999; Christiansen and Alderman 2001; Webb and Block

2003). Thomas et al. (1991) used data from the 1986 Brazilian DHS to show that almost all the impact of maternal education on child survival and height could be explained by indicators of access to information, such as reading newspapers, watching television and listening to the radio. Glewwe used data from Morocco to show that a mother's knowledge of health is crucial for improving the linear growth of her child. He hypothesises that, although this knowledge is obtained outside the classroom, it depends on the skills in literacy taught in school (Glewwe 1999). This study and others examining the role of maternal knowledge of health and nutrition will be reviewed in depth in Chapter 5.

The possible importance of maternal knowledge in determining child nutrition suggests that adult nutrition education programmes may potentially in combating child malnutrition in poor countries with inadequate educational infrastructure or limited access to formal schooling by the very poor. Also, it may suggest that training mothers in growth monitoring will lead to improvements in child malnutrition. These issues will be discussed in greater detail at the end of the thesis in Section 10.3.

Identity, empowerment and aspirations

It has been suggested that by going to school a girl can gain a sense of identity, empowerment and aspirations for herself and her future family (Jejeebhoy 1995). Here 'identity formation' refers to the psychological process whereby she gains a subjective sense of self in relation to others in society; 'empowerment' refers to the social freedom from traditional women's roles; and 'aspirations' refers to her preferences for life-style or achieving status goals in society that may lead her to marry a man of higher status (Schultz 1984; Ware 1984). All these effects may enable her to make decisions and take actions that benefit her children. Within the household she may have greater bargaining power and control over resources and outside the household she is able to manipulate critical aspects of the modern world, such as health services (Cleland and Van Ginneken 1988; MacCormack 1988; Behrman and Wolfe 1989; Caldwell 1994; Thomas 1994; Santow 1995; Handa 1996; Haddad 1999; Bloom, Wypij et al. 2001; Smith, Ramakrishnan et al. 2002; Osmani and Sen 2003). Education, it is argued, increases a

woman's knowledge of modern health-care facilities, improves her ability to communicate with health care providers and increases her awareness and value of health, which in turn increases the demand for services (Caldwell 1979; Schultz 1984). Although many studies suggest that women's 'power' or 'status' is closely associated with their ability to care for their children, LeVine and others warn against the assumption that education goes hand in hand with 'empowerment' as conceptualized in Western thought (LeVine, LeVine et al. 2001; Malhotra, Schuler et al. 2002; Mumtaz and Salway 2005). An example can be taken from South India where a certain level of education has become essential for urban middle-class women to attract men of appropriate status to marry. Education has become a ticket into the marriage market. Once married however, women with university degrees typically stay at home and thereby do not apply their knowledge and skills outside the home. This can lead to deep frustration and in some cases psychological and physiological disorders (Liddle and Joshi 1986; Moestue 1996).

1.3.3 Differential impact of education

Studies have shown a differential impact of education between rural and urban areas, between relatively poor and wealthy households and environments, and between boys and girls. The observation of social and spatial variations in the impact of education has raised hypotheses about underlying causal mechanisms. Take the rural-urban differential as an example. On the one hand, researchers like Caldwell have shown that the benefit of education is greater in settings where modern health facilities are available. He showed that in Nigeria the benefit of maternal education to child mortality was greater in a village with a hospital than a village without such a service. Such a synergistic interaction between education and services is supported by others, for example Bicego and Boerma (1993) and Folsade (2000), who have also found an education advantage in urban areas. Bicego and Boerma show that differential use of basic health services did little to explain the education advantage and take a different view of the causal mechanisms. They suggest that it is access to broader social and economic support in urban areas that matters most, rather than physical access to health services. They also agree with Caldwell that education enhances women's ability to manipulate critical aspects of the

modern world (Caldwell 1979; Bicego and Boerma 1993; Folasade 2000). On the other hand, the opposite effect is found by Rosenzweig and Schulz in Columbia. They analysed 1973 census data to show that access to medical services in urban areas has a greater impact on the survival of children with less educated mothers, thereby narrowing the education differential (Rosenzweig and Schultz 1982).

Differences in the impact of education between boys and girls have also been explored. Bourne's study in India is relevant in this respect. Using census data from 1981 the study found that, although maternal education was associated with a reduced mortality rate for both sexes, the greatest effect was observed for girls (Bourne and Walker 1991). This finding is supported by the study by Thomas, who, using household survey data from the United States, Brazil and Ghana, showed consistently across countries that maternal education had a bigger effect on girls' height whereas paternal education, in contrast, had a bigger effect on boys' height (Thomas 1994).

Differences in the size of the education impact across household wealth categories have also been explored. Ruel's study is seminal in this respect and will be reviewed in detail in Chapter 5. It shows that maternal education has a greater impact on child nutrition among the relatively wealthy households compared to the less wealthy (Ruel, Habicht et al. 1992). Other authors have also shown that the education effect is dependent on socio-economic status. Using cross-sectional data from Benin, Reed et al. (1996) found an unexpected negative effect of education among children of highly educated mothers and speculate that in this socio-economic group maternal education has enabled women to participate in activities outside the home without simultaneously ensuring adequate childcare (Reed, Habicht et al. 1996).

1.3.4 Study methodologies

It is well-known in the field of epidemiology that it is difficult to examine causal links using observational data (Rothman 1998). Although the randomized experiment is the most powerful design to establish causality, it is ethically questionable and typically not feasible to assign education as a random element as in an experiment. For these reasons,

most of the studies examining the links between adult education and child nutrition have been observational in design. They have also tended to be cross-sectional because longitudinal studies would be impractical and expensive. An association between adult education and child nutrition in cross-sectional data does not, however, necessarily mean that education is causally linked to nutrition. There may be confounding factors which can explain the relationship, some of which may not be observable, such as hereditary traits. According to Behrman et al. (1994), most of the large-scale studies showing an important effect of maternal education have not been very informative about causal effects because they are based on analysis of cross-sectional data that does not control for inter-generationally correlated genetic endowments (Behrman, Rosenzweig et al. 1994). In an attempt to overcome this problem, the authors used data on adult Nicaraguan twin sisters to show that a failure to adjust for sisters' shared childhood endowments results in an overestimate of the impact of maternal education on child health. Others, however, have drawn attention to methodological problems with this type of analysis [for example (Bound, Jaeger et al. 1995; Bishai 1996)]. Another approach, especially popular in recent years, is to use 'instrumental variables', surrogate variables for education. This approach will be discussed in detail in Chapter 8. The main problem is identifying valid instruments, a variable that is strongly related to education but not with the unobserved factors that influence child nutrition.

1.4 The role of non-parental actors

As I have shown so far, emerging themes in recent literature have largely concerned the causal pathways between education and nutrition. In addition, however, there has been a notable rise in awareness of the role of non-parental actors, both the effect of their education and their care-giving on child nutrition. These effects may operate directly or indirectly by modifying the maternal education effect.

In this section I will review the literature that explores the effect of education among grandmothers and other carers, as well as the effect of community-level education. I also

review multi-level modelling techniques and methods used to measure 'externalities' of education. A further review of the literature will be presented in Chapter5 concerning women's 'communication networks' (Section 5.5.4).

1.4.1 Grandmothers and other carers

Earlier it was mentioned that maternal education has been shown to be more important for child nutrition than paternal education. Bishai claims that this differential can be explained by children's greater 'exposure time' to mothers compared with fathers who traditionally tend to work outside the home. If, however, employment draws mothers away from childcare, the presence of other household members who are better educated than the mother may offer the potential for an improvement in the overall quality of childcare (Bishai 1996). Research has drawn attention to the importance of both older siblings and grandparents in childcare (Das Gupta 1990; Van Esterik 1995). A study in Senegal, for example, found that grandmothers promote improved maternal and child nutrition practices (Aubel, Toure et al. 2004). Qualitative and quantitative data were collected to document and evaluate an 'action research nutrition education project' with or without grandmothers being encouraged to promote nutritional practices during pregnancy. The outcomes were compared between villages with and without the grandmother-strategy and showed significant improvements after one year in grandmothers' nutritional knowledge, their advice to younger women and these women's nutrition-related practices. The findings are complemented by the results from a study in the Gambia showing an improved risk of survival of children living with maternal grandmothers (Sear, Mace et al. 2000). The studies suggest that any exploration into the role of adult education for child nutrition must take account of other individuals in the household who may directly care for the child or influence the caring practices of mothers.

1.4.2 Community-level education and multi-level modelling methods

Community-level education

The concept of ‘mass education’ was introduced by Caldwell in 1980 (Caldwell 1980) and developed by Cleland and Jejeebhoy, who used survey data from South Asia to demonstrate that in communities where the average level of education is high, the fertility of the women with little or no education is lower than would otherwise be expected (Cleland and Jejeebhoy 1996). The term ‘education externality’ describes the spill-over effect of education, which results in an overall impact which extends beyond the individuals who went to school (Haveman and Wolfe 1984; Schultz 1993; Ashenfelter and Krueger 1994; Weir and Knight 2000; Psacharopoulos and Patrinos 2002). Kravdal (2004) claims that an expansion of education would reduce mortality, not only because more women would enter an educational category associated with lower mortality, but also because all, including those who themselves remained uneducated, would benefit from the generally higher level of education in the community (Kravdal 2004). Kravdal, who explores the role of community-level education, is critical of the paper by Desai and Alva, in particular their specification of ‘community’ as a fixed effect (the meaning of ‘fixed’ and ‘random effects will be explained in Section 2.3.4). By specifying community as a fixed effect, Kravdal argues that Desai and Alva’s model purges the effect of community-level education and other community-level variables which may lie on the causal path way between maternal education and child nutrition (Kravdal 2004).

Kravdal has published three studies of community-level education on fertility and health outcomes, taking account of parental education and other confounding factors, one in Zimbabwe, one in Sub-Saharan Africa and one in India (Kravdal 2000; Kravdal 2002; Kravdal 2004). The first study found no effect of district-level education and literacy on a woman's birth rate above and beyond that of her own education when urbanization was controlled for. A possible reason for the lack of effect may be the small sample size of communities in the study. His next study used DHS data from 22 Sub-Saharan countries and showed, in contrast to his first study, that the average educational level in a village or a community of a similar size has a statistically significant depressing effect on a woman's birth rate, adjusting for urbanization and her own education. However, there were no differences observed between female and male community-level education. Finally, his third study examined the role of female and male community-level education

for child nutrition and mortality in India. He used data from the NFHS conducted in 1998-99 to show that the average education of women in a census enumeration area has a strong impact on child mortality, in addition to the effect of the mother's own education.

Similar work has been undertaken by a few others. A study by Alderman, Hentschel and Sabates (2002) assesses the impact on child nutrition of community-level education among Peruvian women, adjusting for household-level education and income. They created an aggregate measure of education by summing the variable of interest over the sample cluster (community) and then subtracting the observation for the household and dividing this difference by the number of households in the cluster. The results showed that formal education among female members of the community had a significant effect above and beyond household education, but only in rural areas. Similar findings for female community-level education have been shown in Ethiopia for child school enrolment (Weir 2000) and in India for women's contraceptive use (McNay, Arokiasamy et al. 2003; Moursund and Kravdal 2003).

Overall these findings imply that investments in education made by one household may contribute to the health of other households in the community. Although the causal pathways are yet unknown, it is plausible that the effect operates through improvements in infrastructure such as sanitation or the sharing of knowledge. The latter possibility will be explored in the second half of this thesis.

The distribution of educated individuals

In recent years there has also been interest in the role of the distribution of education in relation to economic growth, the argument being that equitable distribution of human capital is a necessary condition for productivity. Economists say that the average level of educational attainment alone may not be sufficient to reflect the characteristics of a country's human capital, and that there is therefore a need to look beyond averages and examine the dispersion of education (Vinod, Wang et al. 2001; Valenti 2002). A recent study has explored the role of income distribution for child stunting in Ecuador. The study found that, after controlling for confounders, economic inequality at the provincial

level had a statistically significant depressing effect on stunting, whereas no effect was found at municipal or local levels (Larrea and Kawachi 2005). One may conclude from this that scale of the measurement of community-level variables is an important consideration (see Section 4.4.2 for further details).

Multi-level modelling methods

Many of the studies mentioned above have used multi-level methods to examine the role of community-level education on individual-level child nutrition. Since the early 1990s there has been a resurgence of interest in the role of place in shaping people's health experiences, perhaps as a backlash to the fear of the 'ecological fallacy' and an over-individualistic approach to determinants of health (Macintyre and Ellaway 2000). The development of multi-level modelling techniques (Goldstein 1991; Diez-Roux 2000) has facilitated the identification of community-level effects on health, leading to a surge of research on the impact of community-level factors on health outcomes (Jones, Moon et al. 1991; Diez-Roux 1998; Pickett and Pearl 2001; Griffiths, Madise et al. 2004).

Multi-level modelling techniques are appropriate for most survey data which are hierarchical in nature, for example where individuals are clustered within communities or regions. The assumption is that individuals are more likely to be similar to individuals within the same community than individuals in other communities (in terms of measurable and non-measurable characteristics) meaning that independence between observations cannot be assumed. This was shown by Skoufias who used national household survey data from Romania to show that when the unobserved heterogeneity at the cluster level (village) was accounted for, maternal education did not have a significant effect on children's health. He therefore warns against an over-reliance on simple correlations that do not take the intra-cluster correlation into account (Skoufias 1998). Although multi-level modelling is becoming increasingly popular in epidemiology for methodological and conceptual reasons, a useful review by Macintyre et al. summarises some important weaknesses of recent work (Macintyre, Ellaway et al. 2002).

1.4.3 Methods used to measure the externalities of education

Kravdal argues that only a multi-level analysis of education can capture the total effect of education, which goes beyond the individuals who went to school (Kravdal 2004). Until recently these spill-over benefits (or 'externalities') from educated individuals to uneducated individuals were often ignored in statistics because they are difficult to measure. Although the pioneering work by Caldwell more than two decades ago led him to draw conclusions about the externalities of education on fertility (Caldwell 1980; Caldwell and McDonald 1982), it is only lately, with the development of more sophisticated statistical methods, that it has been possible to quantify these effects. In recent years several studies have attempted to estimate the size of education externalities using a range of statistical methods (Schultz 1993; Acemoglu and Angrist 1999; Psacharopoulos and Patrinos 2002). The method by Basu and Foster (1998) is based on capturing the added impact on nutrition associated with the distribution of educated individuals within a community. They study literacy rather than formal education because they believe that the education externalities is primarily explained by literates helping illiterates to read and write. Their aim was to develop a new measure of literacy that takes account of the benefits gained when literates share knowledge and skills with illiterates (Basu and Foster 1998). I will review their methodology here because their work relates to the distribution of educated persons between households, an issue which will which will be examined in Chapter4. They did not propose a multi-level methodology, but I will apply their theory using both single- and multi-level methods.

In order to capture the fact that the 'proximate literates' (illiterates who live with at least one literate person) have an advantage over isolated illiterates (those who live only with other illiterates), Basu and Foster assign a positive externality – α – a fixed number between 0 and 1 – to the former. This means that each proximate literate counts for α literates, while isolated illiterates count for 0 literates. The current standard way of calculating population literacy is by simple prevalence. For example, if 1=literate, 0=illiterate and society $\mathbf{x}$ is composed of three households with the following literacy profiles (0,0) (1,1,0,0) (1,0,0,1,1), then the society literacy profile would be defined as the vector obtained by concatenating the household profiles: x*=(0,0,1,1,0,0,1,0,0,1,1) and

the literacy rate is 45%. Notice how the household structure goes unaccounted for. Basu and Foster proposed a method that distinguishes proximate literates from and isolated illiterates: if, for example, a household's literacy profile is x^h=(1,1,0,0) they suggest that the 'household's effective literacy profile' would be given by x^h =(1,1, α, α). Using this method on the example above, the 'societal effective literacy profile' would be x*=(0,0,1,1, α, α,1, α, α,1,1). The authors assume that the externality is fixed and independent of the number of literates or illiterates, or in other words, there is no rivalry in consumption: The proximate literate benefits from the externality as long as he/she lives with one literate person in the household. Additional literates and illiterates in the household have no effect on the magnitude of the externality. Basu and Foster did not empirically estimate α or suggests ways to do it, although others have done so using empirical data and suggested ways in which the Basu and Foster theory could be improved (Gibson 2001; Valenti 2002).

The work by Gibson (2001), which has been inspired by Basu and Foster, is particularly relevant to the current study because he estimates the size of α through the use of nutrition indicators. He uses data from the 1996 Papua New Guinea Household Survey which defines literacy according to a respondent's answer to the question: 'Can you read a newspaper?'. With the use of single-level analysis at both the household and community level he examines the effect of proximate literacy in the community on child nutrition and compares this effect with that standard literacy measure. The resulting ratio of regression coefficients provides an estimate of the effect of literacy mediated through proximate literates (α). In Papua New Guinea the 'effective literacy level' was 0.76, suggesting that the effect of proximate literacy on nutrition is 76% of effect size of standard literacy.

Gibson raises the important issue of aggregation. He remarks that the phenomenon being studied – the spill-over benefits from literates to illiterates – is assumed to take place mainly within households – whereas the literacy rates are calculated at the community or state level. He draws attention to the practicalities of aggregating at the household-level due to the lack of variability in the number of literates and illiterates, which might lead to

co-linearity between indicators of literacy and proximate literacy at the household level (Gibson 2001). Gibson attempts to resolve the problem of aggregation by estimating the models at both the household-level and community-level and comparing the results. A more sophisticated and statistically sound method would be to use a multi-level modelling technique.

1.5 Summary of background literature

So far in this chapter I have attempted to summarise the vast literature concerning adult education and child nutrition while drawing out the key topical and methodological themes that have been debated in recent years. In the first section I have demonstrated the enormous individual and social costs of child malnutrition. In the second section I reviewed the major studies of education and health from the last three decades, the majority of which suggested that female education plays a crucial role in combating child malnutrition. The numerous pathways by which female education benefits child nutrition have been summarised and discussed, along with the methodological difficulties of determining causality. The role of education of non-parental actors has been identified as an emerging key theme, such as grandmothers and other community members. Multi-level modelling methods, which have recently been used to capture the effect of community-level education over and above parental education, have been reviewed along with the methods proposed by Basu and Foster (1998) and Gibson (2001) for measuring education externalities by estimated the additional impact of education distribution.

1.6 Needs for further research

Given the enormous social and economic significance of child malnutrition, and the recognised role that education plays in combating it, considerable interest exists in better understanding this relationship. There are a number of research gaps which have been identified in Sections 1.2-1.4 and which form the basis of this thesis:

1. Most studies of adult education and child nutrition have focused on parents only. Few have examined the effect of education among other household- or community members, although research suggests that these 'others' may play an important role in determining child nutrition – either directly through childcare or indirectly through influencing mothers' care behaviour.
2. There is a need to examine the modification of the education effect by characteristics of the community, household and the child, for examples differences between rural and urban areas, between relatively wealthy and poor households and between boys and girls.
3. In recent years a small number of studies have identified mothers' health and nutrition knowledge as an intermediary variable between maternal education and child health. This will remain important so long as formal education is limited in many parts of the developing world and while targeted education programmes are a possibility.
4. It is becoming increasingly recognised in the anthropological and demographical literature that women do not make decisions in isolation, but do so in conjunction with others. Although women's communication networks have been widely studied for their role in determining fertility behaviour, little has been done in relation to maternal health and nutrition knowledge or child nutrition outcomes. Yet these studies indicate that these factors may have an important role to play.
5. Recent advances in multi-level modelling techniques have enabled the examination of community-level effects over and above individual-level effects. A small number of studies have suggested that community-level education may determine child nutrition over and above household-level education. Further research is necessary to explore this question, and to examine whether or not the distribution of educated people within the community is important for child nutrition.
6. It has been argued that women's innate traits (for example intelligence or the genetic predisposition to be small) may explain much of the association between their education, health and nutrition knowledge and child nutrition. Further research is needed to disentangle the role of mothers' skills and identity.

7. Epidemiologists have recently recognised the role of econometric methods for statistical analysis, especially the 'instrumental variable' approach, which can be used to overcome 'endogeneity bias'. This is a recognised problem in investigating the relationships between education, knowledge and nutrition. There is a need for further studies to explore the application of this method in epidemiology and to discuss its strengths and weaknesses in addressing epidemiological questions.

1.7 Aim and objectives of the thesis

The overall aim of the thesis is:

- To examine the relationship between adult education and child nutrition in Vietnam and Andhra Pradesh

The thesis is divided into two parts. In the first part I use data from the Young Lives Study to explore the relationship between adult education and child malnutrition in Vietnam and Andhra Pradesh State in South India (objectives 1–3 in chapters 2-4). In the second part I examine potential underlying mechanisms for this relationship through the Knowledge and Networks study (Objectives 1, 4-7 in chapters 6-9).

The objectives are given below:

1. To examine the effect of adult education within the household on child nutrition (Chapter3)
2. To estimate, using multi-level methods, the effect of community-level education and education distribution on child nutrition, over and above individual-level factors (Chapter4)
3. To systematically examine the literature concerning the determinants of maternal health and nutrition knowledge in India, and the role of maternal health and nutrition knowledge in mediating the relationship between maternal education and child nutrition worldwide (Chapter5)
4. To examine the role of mothers' education, their use of media, the characteristics of their communication networks and their communication ability as determinants of their health and nutrition knowledge (Chapter7)

5. To examine the role of maternal health and nutrition knowledge in mediating the education effect on child nutrition, using both conventional and econometric methods (Chapter8)
6. To examine the role of mothers' communication in mediating, modifying or confounding the effect of maternal education on child nutrition (Chapter9)

CHAPTER 2

METHODOLOGY OF THE YOUNG LIVES STUDY

In this chapter I describe the methods used for the secondary analysis of data from the Young Lives (YL) study in Vietnam and Andhra Pradesh state in South India. The chapter is split into three sections. In the first section I summarise the YL study setting, sampling methods, questionnaires and fieldwork. In the second section I describe the measurement of adult education and child nutrition. Finally, in the third section I discuss the data analysis, including the application of the conceptual framework and statistical methods.

2.1 The Young Lives Study

The full list of objectives has been given in Chapter1 Section 1.7. Data from the YL study will be analysed to address the following two:

1. To examine the effect of adult education within the household on child nutrition
2. To estimate, using multi-level methods, the effect of community-level education and education distribution on child nutrition, over and above individual-level factors

More specific objectives will be outlined at the beginning of chapters 3 and 4. The YL data are suitable for meeting the objectives because they have been collected in different countries and in rural and urban areas within each country. This sampling design permits the examination of education effects in multiple settings. The benefit and challenge of comparative analysis is that it enables the identification of common patterns while

maintaining an objective eye to the possibility of real variation. This has important implications for the generalisability of findings. Moreover, the data-set provides education data for all household members, which is quite a rare feature of household surveys and thereby facilitates the comparison of education effect between various household members. The data are hierarchical in structure, which enables the examination of community-level effects over and above individual-level effects. Further explanation of the YL study and how education and nutrition were measured is given below.

2.1.1 Study setting

YL is a study investigating childhood poverty in four countries – Peru, Vietnam, Ethiopia and Andhra Pradesh State (AP) of South India – through the follow-up of cohorts of children over time. It is a collaboration between academic institutions and non-governmental Organizations including the London School of Hygiene and Tropical Medicine and Save the Children UK. It is funded by the UK's Department for International Development (DFID). Further information on the specific aims and rationale for the study and on its design can be found on the YL website: http://www.younglives.org.uk.

The data from AP and Vietnam will be used for analysis in this study because they provide contrasting socio-economic and cultural contexts within Asia and because the required data were available at the time. Data from Ethiopia, for example, were not cleaned or deemed ready for use when analysis was planned. Another reason for using data from Vietnam and AP was that these country teams expressed a particular interest in education issues and were thus supportive of more in-depth exploration of the data, which enabled me to conduct the Knowledge and Networks Study in AP in 2004 that forms the basis of the second part of this thesis.

2.1.2 Sampling

In each country approximately 3000 children were sampled from 20 sites. This includes 2000 children aged 6 to 17.9 months at enrolment and who will hereon be referred to as '1-year olds'. The sample also includes 1000 children aged 7.5 to 8.5 years known as '8-year olds'. A multi-stage sampling protocol was developed that was common to all YL countries. Sentinel sites, hereon referred to simply as 'sites', were selected semi-purposively. Within each site the equivalent of random sampling was used to select households. In both AP and Vietnam advisory panels of experts were set up to discuss key factors determining the selection of sites, which was done in an objective way to provide the best possible coverage of the state or country, taking account of recognised variations between 'poor' and 'non-poor' areas. The YL mandate required an over-sampling of the 'poor' and coverage of both urban and rural areas. In Vietnam the 20 sites were chosen, first by selecting 5 provinces out of a total of 61, and then by selecting 4 sites within each province. In AP a similar procedure was used. While one site was chosen from the urban slums of the state capital Hyderabad the remaining 19 sites were selected from 4 'poor' and 2 'non-poor' districts geographically spread between AP's three regions. Country-specific differences, such as the poverty ranking of sites that contributed to their selection, have been documented in the Preliminary National Reports (Young Lives 2003a; Young Lives 2003b).

Households were selected within a sample of 'communities', which are administrative units located within a site. In Vietnam the communities (known as 'communes') were purposively selected according to their representation of regional or provincial features, the commitment expressed by the local government to YL and the practical feasibility of data collection. In AP the selection of communities (a village or a cluster of hamlets) was undertaken semi-randomly by dividing each site into 4 contiguous geographical areas and randomly selecting one community from each area. Although both countries sampled households within 20 sites, the number of communities within

which these household were located was greater in AP than in Vietnam. Table 2.1 provides the sample sizes of communities and sites for each country.

Within communities children and their households were selected using a method equivalent to random sampling. In both countries a door-to-door screening survey was conducted. A list of eligible children was formed and simple random sampling was applied to select 100 1-year olds and 50 8-year olds in each site. Refusals by caregivers to take part in the study was less than 2% and replacement sampling was used. More information on study design and sampling methods has been published as a YL working paper (Wilson and Huttly 2004). It should be noted that although the YL sample is not nationally representative, I will refer to the study countries – AP and Vietnam – by their country names for ease of interpretation.

Table 2.1 Sample sizes of 1- and 8-year olds per site and community each country

	Vietnam	AP
Sites	20	20
Communities	31	102
Sample of infants per site (mean, range)	100 (100-100)	99 (82-102)
Sample of 8-year olds per site (mean, range)	50 (50-50)	50 (47-53)
Sample of infants per community (mean, range)	65 (27-100)	20 (0-56)
Sample of 8-year olds per community (mean, range)	32 (8-50)	10 (2-30)
Total sample size of all children	3000	3019

2.1.3 Survey tools and fieldwork

The YL study involved collecting data around a set of child welfare indicators and their determinants using a number of different survey tools. Further information on the development of the questionnaires and its justification is documented elsewhere (Young Lives 2002). The present analysis uses data from the questionnaire administered by the field investigator to the 'main caregiver' of 1- and 8-year old children. The main caregiver will be referred to simply as 'caregiver' from now on. It

took the field investigator approximately 1.5 hours to administer the questionnaire. Questionnaires were translated from English into the local language and the interviews were conducted in the local language with the guidance of a comprehensive field-manual. Anthropometric status was measured for both the 1- and 8-year old children either before or after the interview had taken place (see Section 2.2.12). Informed consent was obtained from the respondent before the data collection began. All survey instruments were field-tested to highlight ambiguities in the meaning of questions that led to revisions in questionnaires, training modules and manuals.

In AP data were collected between September and December 2002. In Vietnam data were collected in July 2002 from four sites, and between September and November 2002 from the remaining sites. Almost all field investigators were male in AP, while the reverse was true in Vietnam. The field investigators and supervisors received 2-3 weeks of training. Trainers used a comprehensive training manual developed by the YL project, which was further adapted according to the needs in each country. Completed questionnaires were checked on site and errors were corrected by repeat visits to the household. Further details about the fieldwork has been given elsewhere (Attawell 2003; Galab, Gopinath et al. 2003; Tuan, Lan et al. 2004).

2.2 Measurement of nutrition and education

The way in which the YL study measured child nutrition and adult education is given below.

2.2.1 Nutrition

Anthropometric indices were used as indicators of child nutrition. The recumbent length of each 1-year old child and the standing height of each 8-year old were measured using a locally constructed length board with a moveable head-panel to a precision of 0.1 cm. Children wore light clothes and no shoes. Weight was measured using a Seca scale to the

precision of 0.1 kg. If the child was unable to stand on the scale, both the mother and child were weighed together and the weight of the mother was automatically subtracted from the combined weight. Height and weight were measured twice by the same person and if they differed a third measurement was taken as the final measurement. All equipment was checked and calibrated before fieldwork began. Field investigators had been specifically trained to take anthropometric measurements. In order to construct anthropometric indices, data on child age and sex were collected. The respondent was asked to report the child's date of birth. If the exact day was not known the month and year were entered. The field investigator also asked for an official documentation (such as a birth certificate) to check that the reported age matched. If such documentation was not available and the respondent did not know the date of birth, field investigators prompted by relating the time of the birth to local events or seasons. The age of each child was calculated later by subtracting the date of birth from the date of visit. Z-scores of height-for-age and weight-for-age were calculated by comparing a child's height and weight with the median height and weight of a large sample of well-nourished children of the same age and sex, known as a 'growth reference'. The difference is expressed in standard deviation (SD) units known as 'z-scores'(WHO 1986; Beaton, Kelly et al. 1990). The growth reference used is recommended for international use by the WHO and was published in 1977 by the United States National Center for Health Statistics (NCHS) (Hamill, Drizd et al. 1979). Z-scores of height-for-age and weight-for-age were estimated to two decimal places. Z-scores below -6SD and above 6SD were excluded from the analysis (Sullivan and Gorstein 1990). Children are classified as 'stunted' if they have height-for-age z-scores below -2SD and 'underweight' if they have weight-for-age z-scores below -2SD (WHO 1986; WHO 1995). In this thesis, I will use the terms 'height' and 'weight', or 'height-for-age' and 'weight-for-age', as abbreviations for height-for-age z-scores and weight-for-age z-scores respectively.

2.2.2 Education

Education data were collected during the interview by filling out a 'household roster'. The respondent was asked to supply information about each household member,

including education, name, sex and relationship to the child. Names were recorded in full and age in completed years. If the respondent didn't know the age of a household member the field investigator would first ask if anyone else in the household knew, then ask for documentation with age or date of birth stated, or failing that estimate the date of birth though a comparison with other household members whose date of birth was already known. Education was measured by asking the respondent what level of formal schooling each household member had completed. If the respondent did not know the answer the field investigator would ask if there was anyone else in the household who knew, and failing that enter 9 NK (no knowledge). There were small differences in the definitions used for 'levels of education' between AP and Vietnam. Table 2.2 shows how the data was recoded into the 4 main categories: 'none', 'primary', 'secondary' or 'higher'. This coding system does not differentiate between those who have never attended school and those who attended but did not complete grade 5 (primary). This issue will be discussed further in Section 3.5.2.

Adult education variables were created by using data on level of completed education (none, primary, secondary or higher), sex (male or female) and relationship to child (parent, grandparent and so on). Table 2.3 describes all the variables used in the analysis, including the education variables. 'Adults' are defined as anyone aged 12 years and above.

Table 2.2 The categories used for levels of education in AP and Vietnam and how the categories were recoded for joint analysis

AP coding			Vietnam Coding			Joint
	Age	Grade		Age	Grade	
Not enrolled						
None	<6	0	None	<6	0	None
Primary	6-11	1-5	Primary	6-11	1-5	Primary
Middle	11-14	6-8	Secondary	11-15	6-9	Secondary
High School	14-16	9-10	Higher	15+	9+	Higher
Vocational College	16+	10+				
College/university						

2.3 Data analysis and management

2.3.1 Main variables

The main outcome and exposure variables are given below. I do not use weight-for-height as an outcome of child nutrition, because this is an indicator of 'wasting' (thinness) that tends to occur as a result of short-term food deprivation or ill-health. Because I hypothesise that education is only likely to affect malnutrition over the longer term, I will use height-for-age and weight-for-age only, because these are indicators of chronic malnutrition. Further information is given in Table 2.3 about the exposure and outcome indicators. The creation of the community-level education and education distribution variables will be described in detail in Chapter 4 rather than here because it is informed by the preliminary analysis of data. It should be noted that the effect of other household members, such as grandfathers, was not explored due to the small sample size of households with all family members present.

The main exposure variables:

- Maternal education
- Paternal education
- Grandmother education
- Community-level presence/education
- Education distribution

The main outcome variables:

- Child height-for-age z-scores
- Child weight-for-age z-scores

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Table 2.3 Variables used in the analysis: their name, level (1=.household 2=community), what they indicate and their measurement and units

a) Main exposure and outcome variables

Variable	Level	Indicator	Measurement and units
Child height-for-age	1	Low height-for-age: indicator of chronic malnutrition.	Continuous (-6 to 6 z-scores)
Child weight-for-age	1	Low weight-for-age: indicator of both chronic and acute malnutrition.	Continuous (-6 to 6 z-scores)
Maternal education	1	The level of education completed by the mother living in the household.	Ordered categorical: 'none' (0=reference) 'primary'(1) 'secondary'(2), 'higher'(3)
Paternal education	1	The level of education completed by the child's father living in the household.	Same as maternal education
Grandmother presence/ education	1	Two variables used: 1) Level of education completed by the child's grandmother living in the household. If two grandmothers are present the education of the most educated grandmother is used. 2) Categorical variable to assess the role of education versus presence of grandmothers in the household.	Same as maternal education Categorical: 0=no grandmother present in household 1=grandmother uneducated 2= grandmother educated (at least primary)

b) Other explanatory variables – individual level

Variable	Level	Indicator	Measurement and units
Child sex	1	Child sex is an independent risk factor of nutrition z-scores	Binary: 1=male 0=female
Age of child	1	Child age is an independent risk factor of nutrition z-scores	Continuous: months
Age of mother	1	Maternal age is an independent risk factor of nutrition z-scores	Continuous: years
Age-group	1	Child age	Binary: 1=1 yr olds 0=8 yr olds
Housing quality score	1	Household wealth	- Continuous: score 0-1 (1=highest quality). Indicator has two components: rooms per capita (capped at 1.5) and type of floor, roof and wall scaled 0-1. - Categorical: 0 ('poor'), 0.01-0.19, 0.20 – 0.39, 0.40 – 0.59, 0.60-0.79 and 0.80-1 ('wealthy')
Own land	1	The ownership of land. This is a natural asset: the stock of natural (environmental) resources accessible to the household, such as land, air and water. More applicable in rural areas than urban.	Binary: 1=yes 0=no
Number of Adults / Number of Children	1	Human asset: Indicator divided into well-bodied adults (household labour supply) and children, to denote providers and consumers.	Continuous: number. Well-bodied adults defined as age≥12 years without long-term disability. Children are aged <12 years.
Sectors	1	Number of different economic sectors that the household is involved with. This is a financial asset: the liquidity of holdings in the household and its access to credit and sources of income.	Continuous: number
Country	2	Indicator of household setting	Binary: 1=AP 0=Vietnam
Urbanity	2	Indicator of household setting	Binary: 1=urban 0=rural

c) Other explanatory variables – community-level

Variable	Level	Indicator	Measurement and units
Com-level education*	2	Two variables are used: 1) Community-level maternal literacy: percentage of literate mothers in the YL sample 2) Community-level higher education - percentage adults who have completed 'higher' education in the YL sample per community	Continuous: percentage (in figures) or proportion (in models)
Education distribution*	1/2	Two variables used: 1) Individual-level maternal proximate literacy - defined as being both illiterate (answers 'with difficulty' or 'not at all' to literacy question – see above) but living with at least one adult who has completed higher education. The effect of proximate literacy on nutrition is compared with illiteracy. 2) Community-level education distribution - an indicator of community-level education which accounts for the distribution of educated people in the community. It is calculated as the percentage of literate mothers plus the percentage of 'proximate literate' mothers within the YL sample	Continuous: percentage (in figures) or proportion (in models)
Com-level wealth	2	Mean housing quality score in YL sample per community	Continuous: score 0-1
Com-level ownership of land	2	Proportion owning land in YL sample per community	Continuous: proportion (0-1)
Com-level number of children	2	Mean number of children per household in YL sample per community	Continuous: number.
Com-level number of adults	2	Mean number of adults per household in YL sample per community	Continuous: number.
Com-level child sex	2	Mean proportion of male children in YL sample per community	Continuous: proportion (0-1)
Com-level child age	2	Mean child age of YL sample per community	Continuous: number.
Com-level age of caregiver	2	Mean age of caregiver of YL sample per community	Continuous: number.
Com-level sectors	2	Mean number of economic sectors household involved with, in YL sample per community	Continuous: number.

* Detailed explanation of the creation of these indicators is given in Chapter4

2.3.2 Conceptual framework and choice of confounders

The conceptual framework used to illustrate the relationship between maternal education and child nutrition is given in Figure 2.1. It is based on UNICEF's model for the determinants of malnutrition which incorporates biological and socio-economic causes at both micro and macro levels (UNICEF 1998) and DFID's model for Sustainable Livelihoods (SL). The SL model suggests that the livelihood strategies adopted by people to meet particular livelihood objectives or outcomes are a direct response to changing resource endowments and access to assets. Livelihood outcomes refer to indicators and dimensions of well-being such as levels of income, vulnerability and food -security, or – as in the YL study – child poverty measures such as nutritional status (DFID 2001). The SL model describes five types of household productive 'assets': human, social, physical, natural and financial. The availability of these assets affects both a household's livelihood strategy and its ability to withstand shocks.

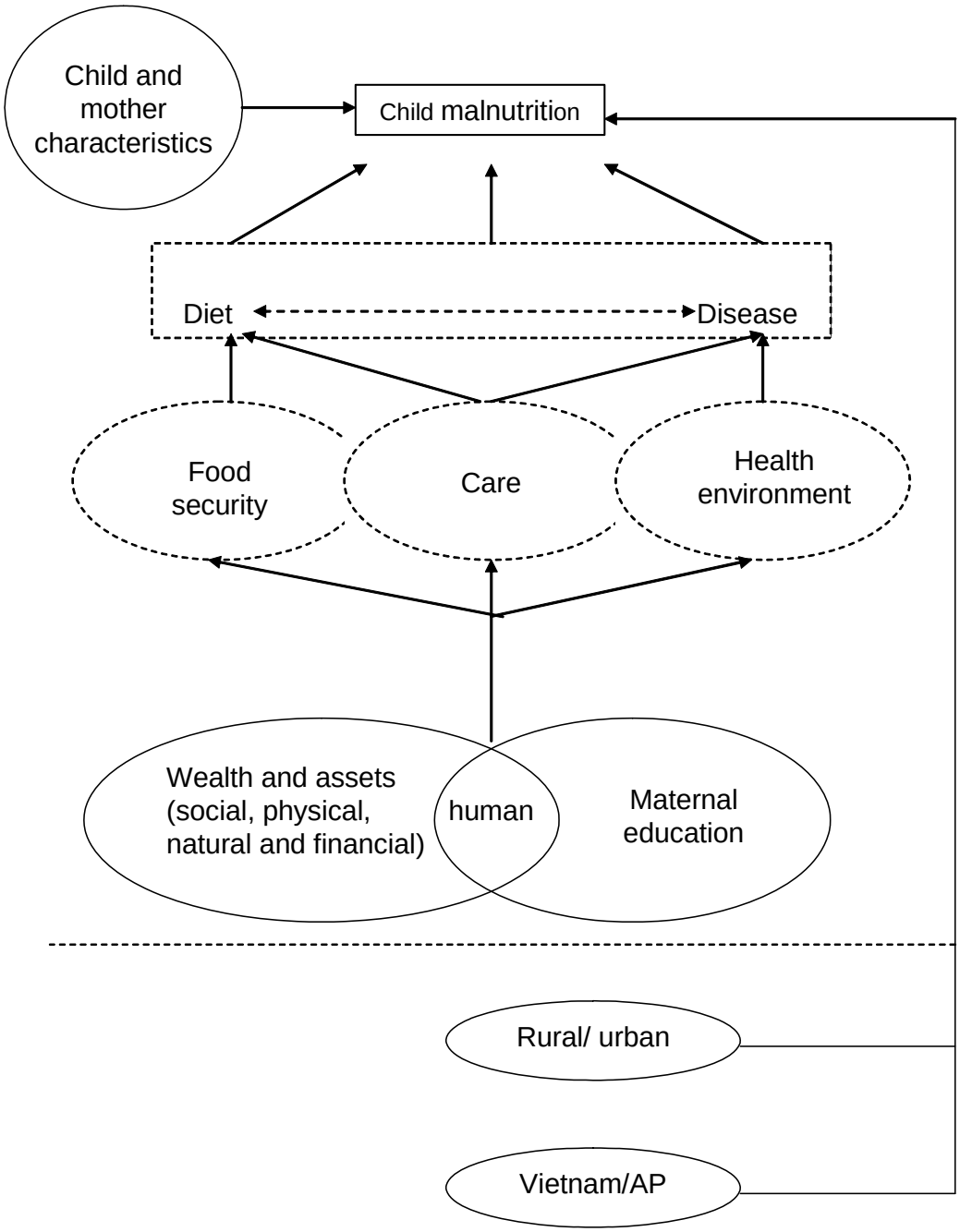
The conceptual framework in Figure 2.1 shows that maternal education forms part of households' 'human' assets which encompass skills, knowledge, ability to work and health. The framework shows that assets affect food security, care and the health environment, which in turn affect a child's diet and disease status that are direct determinants of nutrition. The framework is used to guide the analysis and the interpretation of results. The components outlined with a dotted line are not directly measured in the present study, but nevertheless feature strongly in its interpretation. The consequences of not measuring these factors will be discussed in Section 10.3.1. It is recognised that the relative importance of each asset type in predicting child nutrition is likely to vary by country and between rural and urban areas. Bias will therefore be limited by including in a multi-variable regression model several indicators of assets and adjusting for the effects of urbanity and country, so that the variables jointly capture the household asset base.

Confounding occurs when effect estimates of the main exposure variable is biased upwards or downwards due to a third variable that is independently associated with both the exposure and outcome. Potential confounders were identified in three steps:

- A list of potential confounders was created using the conceptual framework
- The availability of data on these factors was assessed
- The number of potential confounders was reduced to a manageable figure, so that each component of the conceptual framework was represented by at least one suitable variable

Table 2.3 includes the variables 'child age' and 'child sex' because they are known to be independent risk factors of malnutrition. Furthermore, the table distinguishes between factors measured at level 1 and 2. Level 1 factors are those measured for the household or the household members, thereby providing unique values for each child. Level 2 factors are those measured for the community, thereby providing a common value for all observations within a community.

Figure 2.1 The conceptual framework used to examine the effect of maternal education on child malnutrition



2.3.3 Statistical analysis

Descriptive analysis

I examine the frequency distributions of main explanatory and outcome variables, and the crude association between these variables and other potentially confounding factors. The tests used include chi-squared tests, Students' T-test and F-test to assess the statistical significance of differences between proportions, 2 means or more than 2 means respectively. Statistical significance is given at the 5% level.

Multi-variable analysis

The next stage of statistical analysis involves conducting linear regression to examine the relationship between exposure and outcome indicators while simultaneously adjusting for the effect of confounders and independent risk factors. The regression model includes all variables identified as potential confounders or independent risk factors regardless of whether their association with malnutrition was statistically significant or not after adjustment for the effect of other factors in the model. These variables are included, first because of their theoretical role in determining child nutrition (see Figure 1.1 for the determinants of malnutrition) and second because they are likely to be associated with other variables in the model so that excluding them would alter the confounding structure and thereby impact upon the parameter estimates of other variables.

Test for trend

Ordered categorical variables were used for education to enable easy identification of the level of education (primary, secondary and so on) with the greatest effect on child nutrition. An overall P-value was calculated by conducting an LR test between a model that included the variable of interest and a model that did not. A test for trend was undertaken by applying the LR test between a model where the categorical variable is specified as continuous and a model excluding this variable altogether.

Confounding

One can attempt to adjust for confounding by including the potential confounding factor into the model (see Section 2.3.2 for method of selecting potential confounders). Within this thesis the degree and direction of confounding sometimes forms an explicit objective of the analysis, e.g. assessing the confounding effect of paternal education on the effect on nutrition of maternal education. In this case the degree of confounding is assessed by comparing the effect estimate of the maternal education in two models, one including and one excluding paternal education, the potential confounding factor of interest. The direction of confounding is also determined: a reduction in the effect estimate would suggest that positive confounding is taking place, whereas an increase in effect would imply negative confounding.

Effect-modification

Effect-modification occurs when the strength of a relationship between an exposure and outcome variable is modified by another variable. A comparison is made between two models, one that includes and one that excludes the dummy interaction term, using the likelihood ratio test (LR) where the difference of likelihood follows a chi-squared distribution with degrees of freedom equal to the number of new parameters. A statistically significant result, which is usually taken in the literature as having a P-value below 0.10, indicates that the models are different and hence that effect-modification is present. Another way of assessing effect-modification is by assessing the statistical significance of the dummy interaction term itself. The direction of the effect-modification is explored by using categorical variables and interpreting the parameter estimates for each dummy. It should be noted that investigations into effect-modification by age-group requires that the variable for 'age-group' (1- or 8-year olds) is added to the original model in addition to child age (in months).

2.3.4 Multi-level regression modelling

The purpose of multi-level modelling

The YL data, like many kinds of observational data collected in the human and biological sciences, have a hierarchical or clustered structure. This is because data for each household and child are collected within communities, which themselves are located within sites and within countries. This structure is not accidental, rather it is the outcome of the sampling design and the way in which people organise themselves socially and spatially. Once groupings are established – be it communities, sites or countries – they will tend to become differentiated from each other, and this differentiation implies the group and its members both influence and are influenced by group membership (Diez-Roux 1998; Duncan, Jones et al. 1998). For example, the characteristics of children within a community tend to be more similar than the characteristics of children living in different communities. Multi-level modelling tools and special purpose software enables us to account for the hierarchical structure of the data (Goldstein 1991; Rabash, Browne et al. 2000). The use of multi-level methods to analyse YL data will be explained in full following a description of essential terminology.

Fixed and random variables and effects

I will briefly describe the terms 'random' and 'fixed' which are used frequently in the hierarchical linear modelling literature. A 'fixed variable' is one that is assumed to be measured without error. It is also assumed that the values of a fixed variable in one study are the same as the values of the fixed variable in another study. Their individual levels all have specific values, for example 'sex' which is always male or female. 'Random variables', meanwhile, are assumed to be values that are drawn from a larger population of values. Random variables are typically measured with some degree of error. The individual level value is of less interest because they represent a random sample of all possible values of that variable. An example of a random variable is the level of attendance in schools sampled within a district. While attendance is likely to be measured with some degree of error for each school, together the measurements are considered to be representative of attendance rates within a wider population of schools in the district.

'Fixed effects' and 'random effects' are terms used to describe the specification of a regression model. The results of a 'fixed effect' – for example the effect of male sex on morbidity – can be generalized to other studies with similar values of the independent variable. This type of model is likely to produce smaller standard errors and be more powerful than a model with 'random effects'. A 'random effect' model refers to a statistical model which assumes that an independent variable is random. This type of model is typically used if the levels of the independent variable are thought to be a small subset of the possible values which one wishes to generalize to. Random effects models are sometimes referred to as 'Model II' or 'variance component models' and models with both fixed and random effects are called 'mixed models'. Using the earlier example concerning the level of attendance in school, 'school' may be specified as a random effect in a model which assumes that the attendance rate measured in each school is a sample from a larger universe of school attendance rates.

Multi-level regression analysis using YL data

Single-level analysis of the YL would be inappropriate because it would not take into account the within-community or within-site correlation of both measurable and non-measurable characteristics, thereby leading to an underestimation of the standard errors of model parameters. Because only one child is observed per household, an appropriate model for YL data is three-level, where level 1 refers to measurements of the individual child and the child's household, level 2 the community and level 3 the site. The communities and sites are thought of as 'random variables' whose values are drawn from a larger underlying population of values for communities and sites respectively. Therefore the variation between all the communities and sites in the sample are used to make inferences about the variation in the underlying population. The rest of the variables in the analysis are 'fixed', which means that the variables are assumed to have been measured without error. Within-country correlation can be accounted for by incorporating the country variable into the model as a fixed effect, because the number of countries is only two.

In a multi-level regression model, level-1 intercepts and slopes may vary randomly across groups. Their variances are known as 'random coefficients'. This means that the intercept and x-y relationship can be thought of as a random sample of a greater universe of intercepts and slopes. However, it is possible to 'fix' the slopes as I will do in this study, thereby assuming that the x-y relationship is the same across groups but that the intercepts vary between communities and sites. This assumes that community- and site-effects (intercepts) are random, but that the linear effect (slope) of the education variable is common for all communities and sites. Community and site lines are thus parallel but intersect the y-axis at different values. A 'variance components model' is a model that breaks down the variance explained at each level, and can be expressed like this:

$$y_{ijk} = \beta_0 + v_{0k} + \mu_{0jk} + e_{0ijk}$$

$$v_{0k} \sim N(0, \sigma^2_{v0})$$
$$\mu_{0jk} \sim N(0, \sigma^2_{u0})$$
$$e_{0ijk} \sim N(0, \sigma^2_{e})$$

In this model v (the site effects) and μ (the community effects) are assumed to be random variables coming from a normal distribution with variance σ^2_{v0} and $\sigma^2_{\mu 0}$ respectively. The variance between individuals within the groups is denoted as $e_{0ijk.}$ Multi-level regression analysis of YL data is undertaken with MLwiN 2.0 software using the IGLS estimation procedure (Iterative Generalised Least Squares). The fixed effect estimates are exported from MLwiN as text files and stored in EXCEL spreadsheets. Random effects estimates are only reported for the variance components analysis, which will be described below.

In addition to accounting for the hierarchical structure of the data, multi-level modelling is useful because it enables the study of effects of collective or group characteristics (such as community-level education and education distribution) on individual-level outcomes whilst simultaneously adjusting for potential confounders at any level. The creation of community-level variables is explained briefly in Table 2.3 and in more detail in Chapter 4.

2.3.5 Data management

Double data entry was undertaken using Microsoft Access 2000 within each of the countries. The data were cleaned, first within each country by a member of the YL team who applied a standard YL data cleaning programme, then by myself through a series of consistency checks. Cases with missing ID codes or values for nutrition or education variables were dropped from the analysis. Cases with missing values for other variables included in a regression model would be excluded from that particular part of the analysis. All changes to the data-set have been documented.

2.3.6 Statistical software

Raw data files were converted from Microsoft Access into Stata 8.2 (StataCorp 2003) format using StataTransfer 7 (http://www.stattransfer.com). Stata was be used for data management purposes and all statistical analyses, except for multi-level modelling for which MLwiN 2.0 (Rabash, Browne et al. 2000) was used. In Stata the 'stata2MLwiN' command was used to read the Stata data file and create a MLwiN programme that creates a corresponding MLwiN data file complete with variable names and value labels.

CHAPTER 3

HOUSEHOLD EDUCATION AND CHILD NUTRITION

The chapter is divided into five sections. In the first section I describe the patterns of nutrition and education in Vietnam and Andhra Pradesh, in the second section the association between maternal education and child nutrition. In the third and fourth sections I examine the role of paternal education and grandmother education respectively, providing a summary and discussion of the results in the fifth and final section.

3.1 Introduction

3.1.1 Background

As shown in Chapter1, most studies of adult education for child nutrition have focused on the mother and/or the father. Few have explored the role of other adults, such as the grandparents and few have examined whether the effect of maternal education is confounded or modified by the education of others. In this chapter I explore the independent effects of maternal, paternal and grandmother education on child nutrition. I also examine the role of paternal and grandmother education in modifying the effect of maternal education.

The analytical framework used to guide the analysis of this chapter is given in Figure 3.1. It illustrates the hypothesis that child nutrition is determined by the education of the mother as well as other household members. The underlying mechanisms through which education affects nutrition are not examined here. However, it is hypothesised that

maternal education benefits child nutrition through care behaviour, and that the education of other household members might benefit child nutrition through care (plausible for grandmothers) or decisions made about the allocation of resources (plausible for fathers/ heads of households). The potential confounders given in the framework are drawn from the conceptual framework for the determinants of malnutrition presented and discussed in Chapter1 (Figure 1.1). In this chapter, the exploration into the role that these factors play in the maternal education–child nutrition relationship led me to investigate, additionally, their potential as effect-modifiers.

3.1.2 Objectives

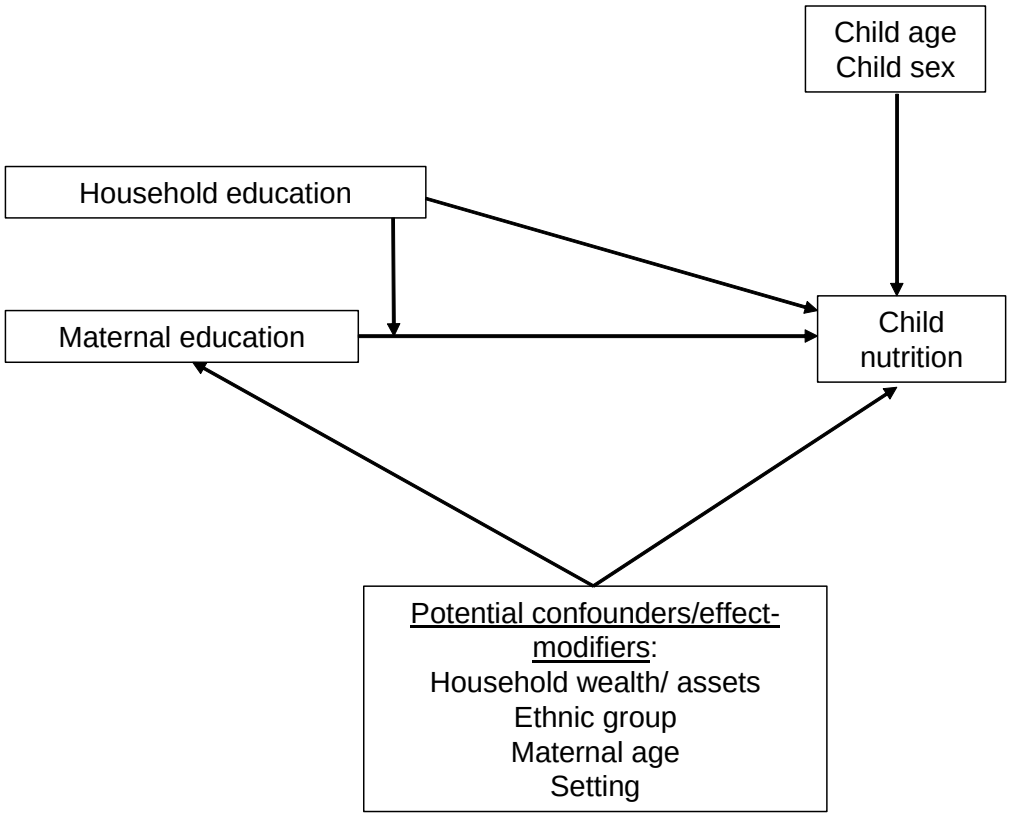
The overall objective of this chapter is:

- To examine the effect of adult education within the household on child nutrition

The specific objectives are:

- To describe patterns of adult education and child nutrition in Vietnam and Andhra Pradesh
- To examine the effect of maternal education on child nutrition, specifically exploring the role of effect-modification by country, urbanity, child age-group, child sex and household wealth
- To examine the corresponding effect of fathers' and grandmothers' education, and their role in confounding and modifying the effect of maternal education

Figure 3.1 Analytical framework: illustration of hypotheses related to the relationship between child malnutrition and education of adult household members



3.2 Patterns of nutrition and education

Data are analysed for 5692 children comprising 1-year olds (1946 from Vietnam and 1899 from AP) and 8-year olds (963 from Vietnam and 884 from AP). This follows the exclusion of cases with missing values for any of the variables selected for use in the analysis (N=327), many of whom are children whose ages are outside the desirable range (see Section 2.1.2 for child age requirements) (N=134) and/or with z-scores for height-for-age, weight-for-age or weight-for-height flagged as 'extreme' by the Anthro software (N=61). Cases whose caregivers were not their biological mothers were also omitted

from the analysis (N=93). Only four observations had missing values for maternal education. (see Section 2.3.5 for explanation about data cleaning). Since the number of subjects with missing values is low (5.4% of original sample), it was decided to conduct the analyses only on those with complete data for any variables in the analysis in order to facilitate comparisons of results from different models. The data-sets used for examining paternal and grandmother education are smaller because these family members do not always live in the household, and the sample sizes will be given in the forthcoming results chapters.

3.2.1 Nutrition

Distributions of z-scores

Figure 3.2 illustrates the shape of the distributions of height- and weight-for-age z-scores for each age-group (1-year olds and 8-year olds) in each country (Vietnam and AP). The figure suggests that the shape of the distribution is normal and that the majority of children's z-scores are well below the median value of the NCHS reference population, which suggests that they are more malnourished than the reference population. Vietnamese children are on average less malnourished than Indian children ($P<0.001$). The mean height-for-age z-scores in Vietnam and AP is -1.16 (95% CI -1.20 - -1.12) and -1.36 (95% CI -1.41 - -1.31) respectively, and the mean weight-for-age z-scores are -1.37 (95% CI -1.40 - -1.33) and -1.78 (95% CI -1.81 - -1.73) respectively. This equates to a prevalence of stunting and underweight of 19% and 24% in Vietnam and 28% and 43% in AP.

The between-country differences correspond with what has been shown elsewhere, with Vietnamese children being better nourished on average than Indian children (de Onis, Monteiro et al. 1993). The estimated prevalence of malnutrition is slightly lower than that estimated by the WHO in the Asia Region: 42% are underweight and 47% are stunting (de Onis, Monteiro et al. 1993), but this is probably mainly because the WHO sample was nationally representative and included children aged between 0-5 years, whereas the YL sample is not nationally representative and children fall into two distinct age-groups

(see Table 2.1 for sample sizes). As will be shown below, child age is an important determinant of z-score and differing ages of children in the YL sample compared with those used in previous studies is likely to explain the difference in results between this study and previous studies.

Crude associations between nutrition and other variables

The relationships between child z-scores and other variables used in the analysis are summarised in Table 3.1. The table gives the mean height- and weight-for-age z-scores by category of each variable used in the analysis, by country. It shows that patterns are similar for height-for-age and weight-for-age z-scores. Maternal education is strongly and positively associated with child nutritional status (P<0.001). Other factors strongly associated with nutritional status are the age of the child (with older children being more malnourished than the younger ones), the sex of the child (with boys being more malnourished than girls), housing quality score (with the wealthier households having better nourished children than the poorer), land ownership (with children in landowning households being more malnourished than children in the landless households), the number of children in the household under 12 years (with many children in the household associated with more malnutrition) and urbanity (with rural children being more malnourished than the urban ones). Further patterns by age, sex, location and country will be explored below. The association between maternal education and child nutrition will be detailed in Section 3.2.2.

Age differences in nutrition

Figure 3.3 shows the average height- and weight-for-age z-score by age in months in Vietnam and AP. There is a pattern of deteriorating z-scores in the first 18 months of life, followed by a levelling out of z-scores for the older, 8-year old, children. This means that, on average, 8-year olds are more malnourished than 1-year olds, with mean height-for-age z-scores of -1.16 (95% CI -1.19 - - 1.12) and -1.47 (95% CI -1.52 - -1.42) for 1- and 8-year olds respectively (P<0.001) and mean weight-for-age z-scores of -1.54 (95% CI -1.57 - -1.50) and -1.63 (95% CI -1.67 - -1.59) respectively (P=0.007). The patterns of

child stunting and underweight presented here are similar to those shown in previous studies (Shrimpton, Victora et al. 2001).

Sex differences in nutrition

Further analysis revealed that boys are more malnourished than girls in each country. The mean height-for-age z-scores for girls and boys are -1.18 (95% CI -1.22 - -1.14) and -1.33 (95% CI -1.37 - -1.29) respectively, and the mean weight-for-age z-scores are -1.51 (95% CI -1.54 - -1.47) and -1.62 (95% CI -1.66 - -1.59) respectively. This pattern of sex differences in z-scores has been found elsewhere (Moestue, de Pee et al. 2003).

Urban-rural differences in nutrition

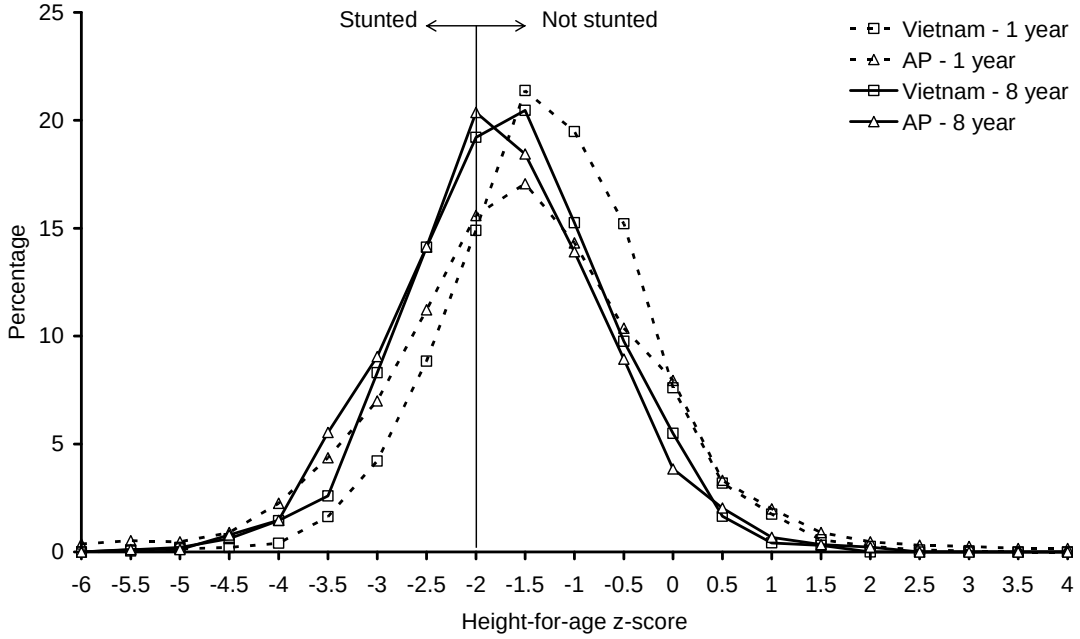
Moreover, urban children are on average less malnourished than rural children in each country with mean height-for-age z-scores of -1.39 (95% CI -1.38 - -1.32) and -0.94 (95% CI -1.00 - -0.89) respectively and mean weight-for-age z-scores of -1.65 (95% CI -1.69 - -1.62) and -1.28 (95% CI -1.34 - - 1.22) respectively.

Country differences in nutrition

Figure 3.3 also shows that Vietnamese children have on average better height and weight than Indian children of similar age, both in early and late childhood. The mean difference between Vietnamese and Indian children is 0.41 weight-for-age z-scores and 0.19 height-for-age z-scores. The difference is greatest for weight, especially in early childhood as illustrated in Figure 3.3. Among the older children the between-country differences are smaller, although statistically significant for both nutrition indicators ($P=0.03$ and $P<0.001$ for height-for-age and weight-for-age z-scores).

Figure 3.2 The distribution of height-for-age (a) and weight-for-age (b) z-scores among 1- and 8- year old children in Vietnam and AP

a) Height-for-age



b) Weight-for-age

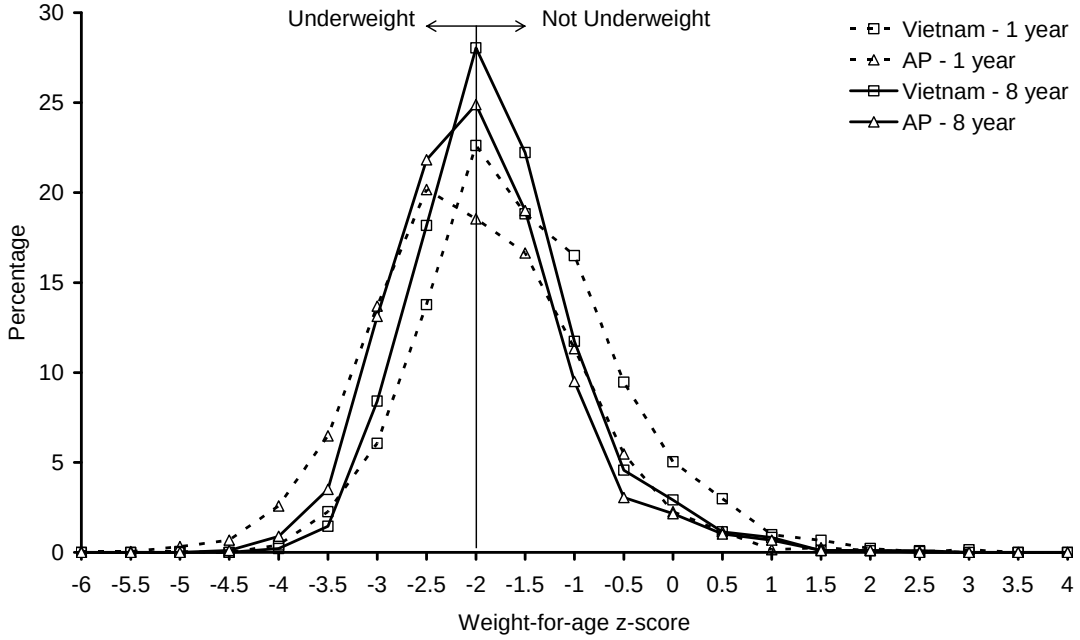
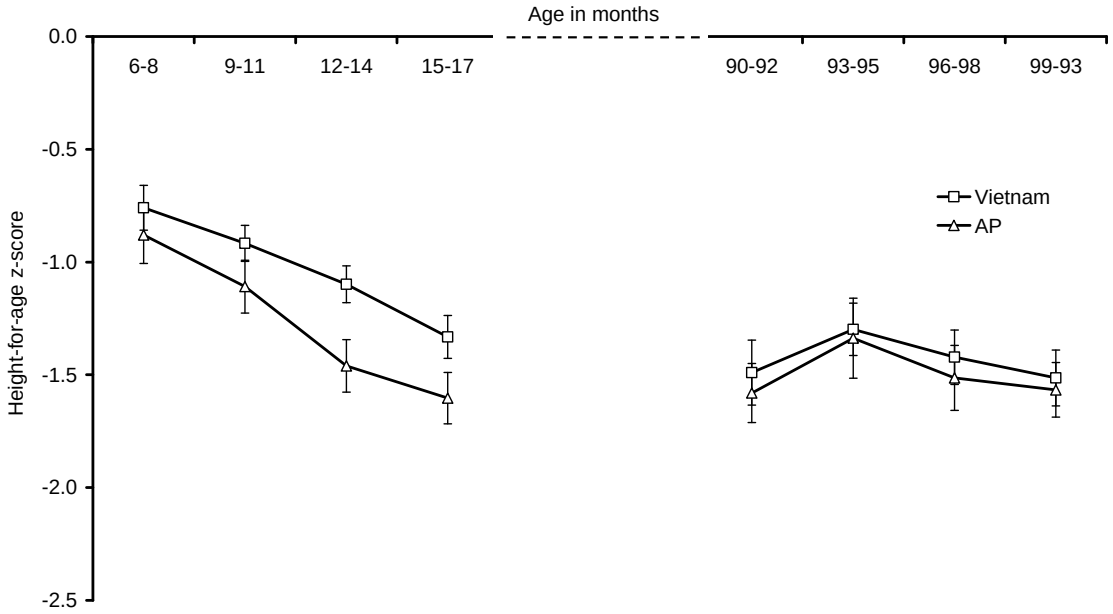


Figure 3.3 The average height-for-age (a) and weight-for-age (b) z-score by 3-month categories of child age, in Vietnam and AP

a) Height-for-age



b) Weight-for-age

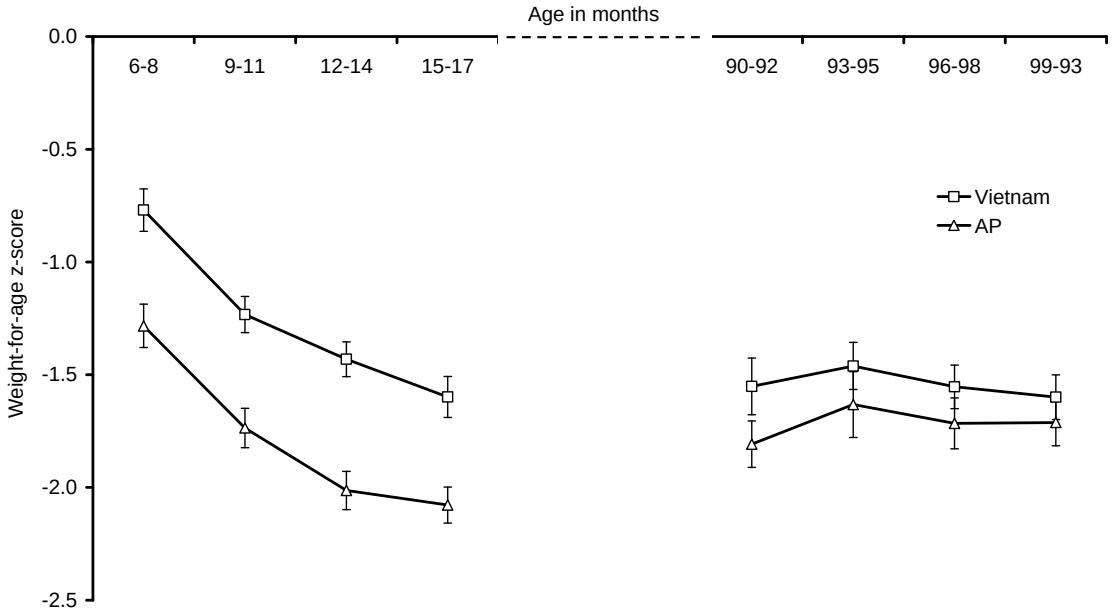


Table 3.1 Mean height-for-age z-scores (a) and weight-for-age z-scores (b) per category of variables used in the analysis by country

a) Height-for-age

		Vietnam (N=2909)				AP (N=2783)			
		N	Mean	SE	P	N	Mean	SE	P
Maternal education	None	825	-1.47	0.04		1767	-1.50	0.03	
	Primary	1054	-1.15	0.03		278	-1.26	0.07	
	Secondary	674	-1.05	0.04		312	-1.25	0.08	
	Higher	356	-0.68	0.05	<0.001	426	-0.91	0.06	<0.001
Age of child (mo)	6-8	375	-0.76	0.05		428	-0.88	0.06	
	9-11	560	-0.92	0.04		474	-1.11	0.06	
	12-14	582	-1.10	0.04		475	-1.46	0.06	
	15-17	429	-1.33	0.05		522	-1.60	0.06	
	90-92	190	-1.49	0.07		247	-1.58	0.07	
	93-95	273	-1.30	0.06		133	-1.34	0.09	
	96-98	280	-1.42	0.06		215	-1.51	0.07	
	99-101	220	-1.51	0.06	<0.001	289	-1.57	0.06	<0.001
Sex of child	Female	1426	-1.08	0.03		1325	-1.29	0.03	
	Male	1483	-1.24	0.03	<0.001	1458	-1.42	0.03	0.007
Age of mother (yr)	-19	81	-1.54	0.12		211	-1.60	0.09	
	20-24	674	-1.10	0.04		989	-1.30	0.04	
	25-29	778	-1.12	0.04		881	-1.30	0.04	
	30-34	726	-1.16	0.04		399	-1.41	0.06	
	35-39	412	-1.14	0.05		216	-1.46	0.08	
	40-	238	-1.37	0.07	0.014	87	-1.51	0.13	0.848
Housing quality score	0-0.19	626	-1.41	0.05		796	-1.55	0.05	
	0.2-0.39	397	-1.27	0.05		673	-1.33	0.05	
	0.4-0.59	524	-1.22	0.04		598	-1.33	0.05	
	0.6-0.79	377	-1.08	0.05		376	-1.26	0.06	
	0.8-1	985	-0.96	0.03	<0.001	340	-1.12	0.06	<0.001
Land ownership	No	745	-0.90	0.04		1216	-1.28	0.03	
	Yes	2164	-1.25	0.02	<0.001	1567	-1.42	0.03	0.003
No. adults in household	1 or 2	1545	-1.15	0.03		1185	-1.39	0.03	
	3 or 4	900	-1.22	0.03		964	-1.37	0.04	
	5 or 6	345	-1.18	0.06		435	-1.32	0.07	
	6-	119	-0.79	0.10	0.054	185	-1.22	0.09	0.039
No. children in household	0	1164	-1.03	0.03		1144	-1.26	0.04	
	1	1246	-1.15	0.03		968	-1.33	0.04	
	2	378	-1.39	0.05		493	-1.51	0.05	
	3-	121	-1.80	0.10	<0.001	178	-1.75	0.09	<0.001
No. economic sectors	0	878	-1.40	0.04		1893	-1.35	0.03	
	1-	2031	-1.06	0.02	<0.001	890	-1.38	0.04	0.431
Urbanity	Rural	2341	-1.26	0.02		2053	-1.45	0.03	
	Urban	568	-0.75	0.04	<0.001	730	-1.10	0.04	<0.001

b) Weight-for-age

		Vietnam (N=2909)				AP (N=2783)			
		N	Mean	SE	P	N	Mean	SE	P
Maternal education	None	825	-1.57	0.03		1767	-1.90	0.02	
	Primary	1054	-1.40	0.03		278	-1.74	0.06	
	Secondary	674	-1.32	0.04		312	-1.64	0.06	
	Higher	356	-0.91	0.06	<0.001	426	-1.38	0.05	<0.001
Age of child (mo)	6-8	375	-0.77	0.05		428	-1.28	0.05	
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	15-17	429	-1.60	0.05		522	-2.08	0.04	
	90-92	190	-1.55	0.06		247	-1.81	0.05	
	93-95	273	-1.46	0.05		133	-1.63	0.07	
	96-98	280	-1.55	0.05		215	-1.72	0.06	
	99-101	220	-1.60	0.05	<0.001	289	-1.71	0.05	0.390
Sex of child	Female	1426	-1.33	0.02		1325	-1.70	0.02	
	Male	1483	-1.41	0.03	0.028	1458	-1.84	0.03	0.001
Age of mother (yr)	-19	81	-1.50	0.11		211	-1.97	0.07	
	20-24	674	-1.28	0.04		989	-1.79	0.03	
	25-29	778	-1.35	0.04		881	-1.72	0.03	
	30-34	726	-1.38	0.03		399	-1.73	0.05	
	35-39	412	-1.42	0.04		216	-1.81	0.06	
	40-	238	-1.50	0.06	0.002	87	-1.79	0.09	0.036
Housing quality score	0-0.19	626	-1.47	0.04		796	-1.94	0.03	
	0.2-0.39	397	-1.48	0.05		673	-1.83	0.04	
	0.4-0.59	524	-1.42	0.04		598	-1.76	0.04	
	0.6-0.79	377	-1.33	0.05		376	-1.63	0.05	
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No. adults in household	1 or 2	1545	-1.38	0.02		1185	-1.80	0.03	
	3 or 4	900	-1.42	0.03		964	-1.78	0.03	
	5 or 6	345	-1.31	0.05		435	-1.74	0.05	
	6-	119	-1.02	0.09	<0.001	185	-1.68	0.07	0.051
No. children in household	0	1164	-1.26	0.03		1144	-1.71	0.03	
	1	1246	-1.39	0.03		968	-1.77	0.03	
	2	378	-1.55	0.05		493	-1.84	0.04	
	3-	121	-1.65	0.08	<0.001	178	-2.02	0.07	<0.001
No. economic sectors	0	878	-1.49	0.03		1893	-1.77	0.02	
	1-	2031	-1.31	0.02	<0.001	890	-1.80	0.03	0.377
Urbanity	Rural	2341	-1.46	0.02		2053	-1.87	0.02	
	Urban	568	-0.99	0.04	<0.001	730	-1.51	0.04	<0.001

3.2.2 Education

Figure 3.4 illustrates the distribution of maternal, paternal and grandmother education in each country. It is apparent from the figure that adults have a higher level of schooling in Vietnam than in AP ($P<0.001$), which corresponds with previous literature (UNESCO 2004). For example, 72% of mothers have at least primary education in Vietnam compared to only 37% in AP. The patterns of education are similar for both mothers and fathers, except that, on average, fathers have a higher level of education in both countries. Grandmothers are largely uneducated in either country.

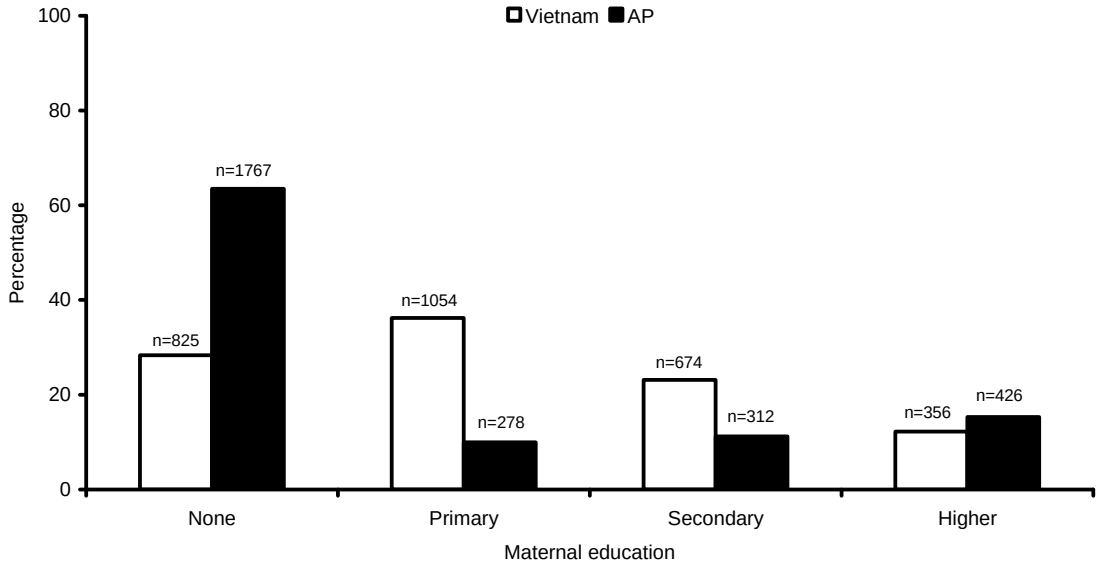
Table 3.2 shows a strong positive correlation between the education of mothers, fathers and grandmothers. The Pearson's correlation coefficient was strongest for maternal and paternal education (0.62 $P<0.001$) and somewhat weaker for maternal and grandmother education (0.37 $P<0.001$) and paternal and grandmother education (0.31 $P<0.001$). For example, among mothers with secondary school education, more than 90% have husbands with at least the same level of education.

The social and spatial patterns of education were examined. The results show that the education of various household members is similarly associated with urbanity (with urban people being more educated than rural) and household wealth (with wealthier households being more educated than the less wealthy). Detailed results are presented for maternal education in Table 3.2.

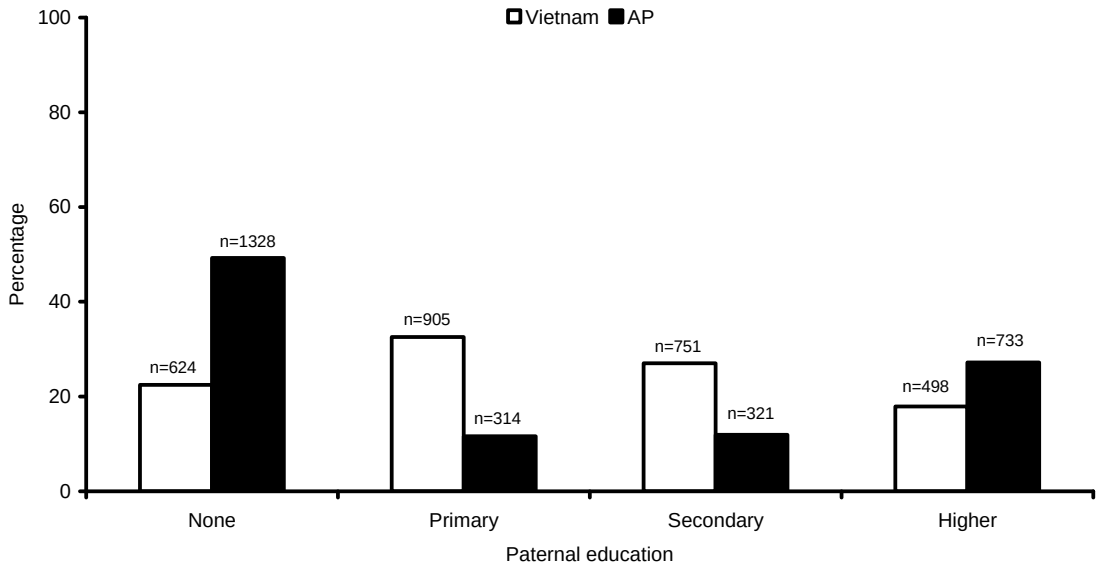
Table 3.2 can be compared with Table 3.1 to show that a number of variables are independently associated with both the exposure (maternal education) and outcome (child height-for-age and weight-for-age z-score), which suggests that they are potential confounders and that their effect will need to be controlled in the analysis. This will be explained further in the following section.

Figure 3.4 The level of education completed by mothers (a) fathers (b) and grandmothers (c) in Vietnam and AP

a) Maternal education



b) Paternal education



c) Grandmother education

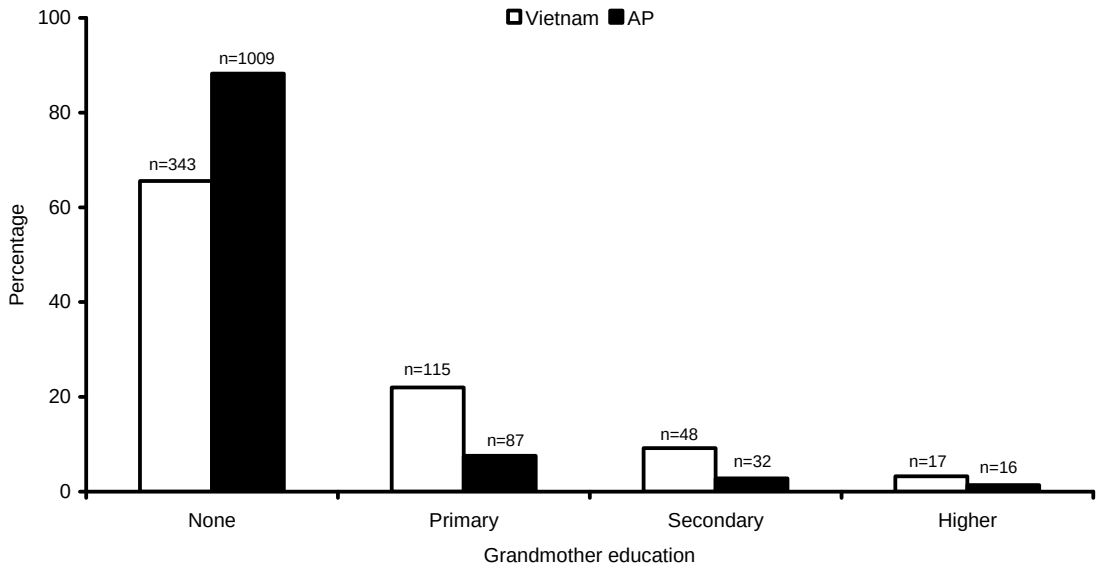


Table 3.2 The pattern of maternal education in Vietnam and AP

a) Vietnam

	None (N=825)		Primary (N=1054)		Secondary (N=674)		Higher (N=356)		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	P
Age of mother (yrs)	29.87	0.27	28.28	0.19	30.30	0.23	31.61	0.31	<0.001
Economic sectors (No.)	1.83	0.03	2.09	0.03	2.07	0.03	2.13	0.05	<0.001
Housing quality score (0-1)	0.34	0.01	0.55	0.01	0.65	0.01	0.73	0.01	<0.001
Adults in household (No.)	3.26	0.06	2.97	0.05	2.97	0.05	3.07	0.08	<0.001
Children in household (No.)	1.12	0.04	0.73	0.02	0.76	0.03	0.56	0.03	<0.001
	%		%		%		%		
Father >= primary	45.23		83.96		94.79		99.12		<0.001
Grandmother >= primary	14.84		34.76		44.8		64.29		<0.001
Male child	51.76		50.57		52.97		46.63		0.366
Own land	77.33		74.57		78.78		58.71		<0.001
Urban	9.33		16.7		22.55		45.79		<0.001

b) AP

	None (N=1767)		Primary (N=278)		Secondary (N=312)		Higher (N=426)		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	P
Age of mother (yrs)	26.49	0.15	24.83	0.30	24.34	0.26	25.38	0.25	<0.001
Economic sectors (No.)	1.37	0.01	1.37	0.04	1.35	0.04	1.38	0.03	0.949
Housing quality score (0-1)	0.33	0.01	0.45	0.02	0.51	0.02	0.63	0.01	<0.001
Adults in household (No.)	3.35	0.04	3.28	0.10	3.44	0.12	3.69	0.10	0.005
Children in household (No.)	1.03	0.03	0.82	0.05	0.81	0.05	0.62	0.04	<0.001
	%		%		%		%		
Father >= primary educ.	31.51		68.77		82.26		94.67		<0.001
Grandmother >= primary educ.	2.23		9.65		20.71		36.7		<0.001
Male child	52.35		50.72		52.88		53.29		0.743
Own land	63.78		51.08		48.08		34.74		<0.001
Urban	13.02		30.58		40.71		67.61		<0.001

3.3 The effect of maternal education on child nutrition

The effect of maternal education on child nutrition was examined in three steps: first by examining the crude effect, second by examining the confounder-adjusted effect, and finally by examining effect-modification by household wealth, urbanity, child sex, child age-group and country.

3.3.1 Crude association

Although the crude association between maternal education and child nutrition has already been examined by conducting cross-tabulations (Table 3.1), I will also examine the crude association using single-variable linear regression analysis, whereby the sole explanatory variable is maternal education and the outcomes are child height-for-age and weight-for-age z-scores. The regression results are presented in Table 3.3 as Model A. It is apparent from the table that the association is positive and statistically highly significant for both nutrition indicators ($P<0.001$), suggesting that the more educated the mother, the better nourished the child is likely to be. For example, a child whose mother has completed primary education would on average have height-for-age z-scores 0.17 greater than children whose mother has not (95% CI 0.09 – 0.25 $P<0.001$). Meanwhile the improvement in z-score associated with higher education was 0.48 height-for-age z-scores (95% CI 0.38 – 0.58 $P<0.001$). The results are similar for weight-for-age. It is likely, however, that this relationship is confounded by other factors.

3.3.2 Adjusted association

Adjusting for confounders

Multiple regression analysis was undertaken to adjust for the effect of known confounders (see Section 2.3.1 for a description of how the conceptual framework was used to identify these factors and the preliminary analysis undertaken to inform the choice of variables to be included in the model). The results are presented in Table 3.3 as Model B. This model contains variables that are considered to be potential confounders

of the education-nutrition relationship, but excludes independent risk factors of nutrition. It is apparent from the table, by comparing Model A and Model B, that the effect of maternal education diminishes somewhat after the adjustment for the potential confounders, although it remains statistically significant for both height-for-age and weight-for-age z-scores. The relationship appears to be linear in nature and the test for trend was statistically highly significant for both height- and weight-for-age ($P<0.001$), with the effect on education increasing with level of education completed.

Adjusting for both confounders and risk factors

The next step in the analysis was to conduct multivariate analysis that adjusts for both confounders and independent risk factors, which are child age and child sex. The results are given in Model C in Table 3.3 and show that child age and child sex are strongly associated with nutrition. Adjustment for age and sex makes little difference to the coefficients for maternal education, which confirms their classification as independent risk factors rather than confounders.

Table 3.3 Regression output: the crude and adjusted association between maternal education and child height-for-age z-scores (a) and weight-for-age z-scores (b) (N=5692)

a) Height-for-age z-scores

		Model A				Model B				Model C			
		Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2
Constant		-1.41	0.05	0.000		-1.34	0.12	0.000		-1.52	0.12	0.000	
Maternal	Prim.	0.17	0.04	0.000		0.11	0.04	0.013		0.10	0.04	0.022	
Education	Sec.	0.22	0.05	0.000		0.15	0.05	0.001		0.15	0.05	0.002	
	High	0.48	0.05	0.000	<0.001	0.38	0.05	0.000	<0.001	0.35	0.05	0.000	<0.001
Confounders:													
Age of mother (yrs)						-0.01	0.00	0.006		0.01	0.00	0.002	
Housing quality score (0-1)						0.26	0.06	0.000		0.28	0.06	0.000	
Land ownership (0=no 1=yes)						0.04	0.04	0.326		0.04	0.04	0.343	
Adults in household (No.)						0.02	0.01	0.047		0.01	0.01	0.261	
Children in household (No.)						-0.07	0.02	0.000		-0.06	0.02	0.000	
Economic sectors (No.)						0.02	0.02	0.395		0.02	0.02	0.281	
Urbanity (0=rural 1=urban)						0.22	0.11	0.038		0.21	0.11	0.050	
Country (0=Vietnam 1=AP)						-0.15	0.09	0.107		-0.09	0.09	0.321	
Independent risk factors:													
Age of child (mo)										0.00	0.00	0.000	
Sex of child (0=female 1=male)										-0.14	0.03	0.000	

P_1: P-value for categorical variable; P2: P-value for linear variable

b) Weight-for-age z-scores

		Model A				Model B				Model C			
		Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2
Constant		-1.70	0.05	0.000		-1.57	0.09	0.000		-1.58	0.09	0.000	
Maternal	Prim.	0.13	0.03	0.000		0.08	0.04	0.030		0.07	0.04	0.039	
education	Sec.	0.20	0.04	0.000		0.14	0.04	0.000		0.14	0.04	0.000	
	High	0.41	0.04	0.000	<0.001	0.35	0.04	0.000	<0.001	0.33	0.04	0.000	<0.001
Confounders:													
Age of mother (yrs)						0.00	0.00	0.060		0.00	0.00	0.812	
Housing quality score						0.14	0.05	0.008		0.15	0.05	0.005	
Land ownership (0=no 1=yes)						0.05	0.03	0.164		0.04	0.03	0.178	
Adults in household (No.)						0.02	0.01	0.015		0.02	0.01	0.034	
Children in household (No.)						-0.04	0.01	0.002		-0.04	0.01	0.003	
Economic sectors (No.)						0.01	0.02	0.524		0.01	0.02	0.484	
Urbanity (0=rural 1=urban)						0.27	0.07	0.000		0.27	0.07	0.000	
Country (0=Vietnam 1=AP)						-0.39	0.06	0.000		-0.37	0.06	0.000	
Independent risk factors:													
Age of child (mo)										0.00	0.00	0.000	
Sex of child (0=female 1=male)										-0.11	0.02	0.000	

P_1: P-value for categorical variable; P2: P-value for linear variable

3.3.3 Effect-modification and stratified results

It is worth questioning whether the main effect of maternal education observed so far is an adequate representation, because, as discussed in Section 1.3.3, previous literature has shown a differential impact of education between countries, rural and urban areas, age-groups, sex and by household wealth. Therefore, to explore this possibility, the LR test was used to test the difference between Model C in Table 3.3 and an equivalent model with an interaction term (see Section 2.3.3 for more information on examination of effect-modification). Table 3.4 presents the stratified regression output for the statistically significant relationships.

Child age-group

The LR test results suggest that differences in the effect of education exist between 1- and 8-year olds in terms of weight-for-age (P<0.001) but not height-for-age (P=0.849), with the effect on weight being greater for the 1-year olds. For example, as shown in Table 3.4 (a), there is a clear impact of mothers' primary and secondary education on the weight of 1-year olds (0.09 95% CI 0.00 - 0.17 P=0.043 and 0.19 (95% CI 0.09 - 0.28 P<0.001 respectively), while no detectible impact was found for older children (0.04 95% CI -0.07 - -0.15 P=0.474 and 0.07 (95% CI -0.05 – 0.19 P=0.229 respectively). The results contradict previous research showing a stronger effect of maternal education on health in later childhood than in infancy (Cleland and Van Ginneken 1988; Victora, Huttly et al. 1992). Possible reasons for this will be discussed in the last section of this chapter.

Child sex

The LR test suggests that there is no difference between boys and girls in the effect of education in terms of weight-for-age (P=0.122) and height-for-age (P=0.475). The results have therefore not been stratified.

Country

Effect-modification by country was examined and the results of the LR test are statistically non-significant for height- and weight-for-age z-score (P=0.637 and P=0.532 respectively). These findings suggest that there is no difference between Vietnam and AP in the size of effect of maternal education. In order to assess whether the education effect may vary more within than between countries, the next step was to examine differences between rural and urban areas.

Urbanity

A statistical interaction between maternal education and urbanity was examined using the same method. The LR test was statistically significant for weight-for-age (P<0.001) and height-for-age (P=0.079). The results suggest that rural-urban differences exist in the education effect on nutrition and that within-country differences are more pronounced than between-country differences. An examination of the stratified data showed that maternal education has a greater benefit for children in urban than rural areas, and that this difference is most clearly seen for secondary and higher levels of education. Table 3.4 (b) shows, for example, that the change in weight-for-age z-score associated with the completion of higher education is only 0.24 SD (95% CI 0.13 – 0.30 P<0.001) in rural areas compared with 0.44 SD (95% CI 0.29 – 0.60 P<0.001) in urban areas. The findings presented in Table 3.4 (c) are similar for height-for-age.

Household wealth

Housing quality score was used as an indicator of household wealth. A statistical interaction between maternal education and housing quality score was examined and found to be statistically significant for weight-for-age (P=0.006) and height-for-age (P=0.094), with the education effect being greater in wealthier households. Table 3.4 (d) and (e) show that maternal education has a smaller impact on nutrition in low-wealth households (for both height and weight of children) than middle or high-wealth households. For example, the effect of higher education on height-for-age in the low-wealth group is 0.14 (95% CI -0.15 - 0.42 P=0.356) compared with 0.31 (95% CI 0.14 - 0.48 P<0.001) in the high-wealth group. The difference was less strong for primary or

secondary education. These results are very similar to those shown above for urbanity, probably due to the strong correlation between household wealth and urbanity (P<0.001). For this reason, both interaction terms were entered into the model simultaneously to show that the effect-modification of wealth operates independently of urbanity (P=0.026).

Overall the results suggest that un-stratified regression output in Model C (Table 3.3) is not a sufficient reflection of the relationship between maternal education and child nutrition, as the above analyses show that the education effect differs according to wealth, rural-urban areas and age group.

Table 3.4 Regression output: the association between maternal education and child height- and weight-for-age z-scores by age-group, urbanity and housing quality score

a) Age-group differences: Weight-for-age

		1-year olds (N=3845)				8-year olds (N=1847)			
		Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2
Constant		-0.53	0.13	0.000		-1.81	0.55	0.001	
Maternal	Prim.	0.09	0.04	0.043		0.04	0.05	0.474	
education[1]	Sec.	0.19	0.05	0.000		0.07	0.06	0.229	
	High.	0.33	0.05	0.000	<0.001	0.38	0.07	0.000	<0.001
Age of mother (yrs)		0.00	0.00	0.839		0.00	0.00	0.327	
Hous. qual. score (0-1)		0.24	0.06	0.000		0.04	0.08	0.658	
Own land (1=yes 0=no)		0.06	0.04	0.121		0.00	0.05	0.964	
Adults in HH (No.)		0.02	0.01	0.071		0.00	0.01	0.940	
Children in HH (No.)		-0.07	0.02	0.000		-0.06	0.02	0.009	
Economic sectors (No.)		0.01	0.02	0.567		0.03	0.03	0.184	
Urbanity (1=urb 0=rur)		0.26	0.08	0.001		0.27	0.08	0.001	
Country (1=AP 0=Viet)		-0.46	0.07	0.000		-0.11	0.07	0.088	
Age of child (mo)		-0.09	0.00	0.000		0.00	0.01	0.897	
Sex of child (1=M 0=F)		-0.07	0.03	0.021		-0.18	0.04	0.000	

P_1: P-value for categorical variable; P2: P-value for continuous variable; 1='none' is reference category

b) Rural-urban differences: Weight-for-age

		Rural (N=4394)				Urban (N=1298)			
		Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2
Constant		-1.50	0.10	0.000		-1.73	0.25	0.000	
Maternal	Prim.	0.08	0.04	0.034		0.05	0.09	0.596	
education[1]	Sec.	0.11	0.04	0.019		0.25	0.09	0.003	
	High.	0.24	0.06	0.000	<0.001	0.44	0.08	0.000	<0.001
Age of mother (yrs)			0.00	0.648		0.01	0.01	0.155	
Hous. qual. score (0-1)			0.06	0.029		0.40	0.16	0.015	
Own land (1=yes 0=no)			0.04	0.935		0.20	0.07	0.006	
Adults in HH (No.)			0.01	0.118		0.03	0.02	0.064	
Children in HH (No.)			0.02	0.017		-0.06	0.03	0.084	
Economic sectors (No)			0.02	0.179		-0.04	0.04	0.380	
Country (1=AP 0=Viet.)			0.06	0.000		-0.42	0.13	0.001	
Age of child (mo)			0.00	0.000		0.00	0.00	0.338	
Sex of child (1=M 0=F)			0.03	0.000		-0.11	0.05	0.034	

P_1: P-value for categorical variable; P2: P-value for continuous variable; 1='none' is reference category

c) Rural-urban differences: Height-for-age

		Rural (N=4394)				Urban (N=1298)			
		Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2
Constant		-1.49	0.14	0.000		-1.56	0.25	0.000	
Maternal	Prim.	0.10	0.05	0.029		0.06	0.09	0.532	
education[1]	Sec.	0.14	0.05	0.010		0.16	0.09	0.072	
	High.	0.25	0.07	0.000	<0.001	0.43	0.08	0.000	<0.001
Age of mother (yrs)		0.01	0.00	0.026		0.01	0.01	0.019	
Hous. qual. score (0-1)		0.26	0.07	0.000		0.55	0.17	0.001	
Own land (1=yes 0=no)		0.01	0.05	0.818		0.12	0.08	0.113	
Adults in HH (No.)		0.00	0.01	0.684		0.04	0.02	0.034	
Children in HH (No.)		-0.05	0.02	0.014		-0.10	0.03	0.002	
Economic sectors (No)		0.04	0.02	0.080		-0.05	0.04	0.234	
Country (1=AP 0=Viet.)		-0.05	0.11	0.622		-0.19	0.12	0.113	
Age of child (mo)		0.00	0.00	0.000		0.00	0.00	0.000	
Sex of child (1=M 0=F)		-0.14	0.03	0.000		-0.16	0.06	0.003	

P_1: P-value for categorical variable; P2: P-value for continuous variable; 1='none' is reference category

d) Wealth differences: Weight-for-age

		Low wealth (N=1883)				Middle wealth (N=1902)				High wealth (N=1907)			
		Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2
Constant		-1.57	0.15	0.000		-2.27	0.49	0.000		-1.56	0.18	0.000	
Maternal	Primary	0.11	0.06	0.064		0.04	0.06	0.572		0.08	0.06	0.214	
education[1]	Secondary	0.16	0.08	0.046		0.12	0.07	0.076		0.14	0.06	0.036	
	Higher	0.10	0.12	0.408	0.104	0.37	0.07	0.000	<0.001	0.29	0.07	0.000	<0.001
Age of mother (yrs)		0.00	0.00	0.835		0.00	0.00	0.309		0.00	0.00	0.308	
Housing qual. score (0-1)		0.21	0.22	0.353		1.01	0.55	0.065		-0.04	0.20	0.839	
Own land (1=yes 0=no)		0.01	0.05	0.853		0.07	0.06	0.234		0.03	0.06	0.598	
Adults in HH (No.)		0.00	0.01	0.789		0.04	0.01	0.006		0.02	0.01	0.123	
Children in HH (No.)		-0.02	0.02	0.277		-0.04	0.03	0.126		-0.06	0.02	0.008	
Economic sectors (No.)		0.01	0.03	0.734		0.02	0.03	0.519		0.00	0.03	0.912	
Urbanity (1=urb. 0=rur.)		0.19	0.14	0.179		0.37	0.08	0.000		0.13	0.08	0.105	
Country (1=AP 0=Viet.)		-0.37	0.09	0.000		-0.36	0.08	0.000		-0.31	0.07	0.000	
Age of child (mo)		0.00	0.00	0.449		0.00	0.00	0.006		0.00	0.00	0.013	
Sex of child (1=M 0=F)		-0.11	0.04	0.008		-0.12	0.04	0.004		-0.11	0.04	0.012	

P_1: P-value for categorical variable; P2: P-value for continuous variable; 1='none' is reference category

e) Wealth differences: Height-for-age

		Low wealth (N=1883)				Middle wealth (N=1902)				High wealth (N=1907)			
		Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2
Constant		-1.52	0.20	0.000		-2.19	0.52	0.000		-1.67	0.22	0.000	
Maternal education[1]	Primary	0.13	0.08	0.083		0.03	0.07	0.673		0.10	0.07	0.167	
	Secondary	0.12	0.10	0.220		0.12	0.07	0.101		0.17	0.08	0.034	
	Higher	0.14	0.15	0.356	0.025	0.37	0.07	0.000	<0.001	0.31	0.09	0.000	<0.001
Age of mother (yrs)		0.01	0.00	0.137		0.00	0.00	0.602		0.02	0.01	0.003	
Housing qual. score (0-1)		0.97	0.28	0.001		1.29	0.58	0.027		0.00	0.24	0.985	
Own land (1=yes 0=no)		0.06	0.07	0.405		-0.02	0.06	0.765		0.09	0.07	0.219	
Adults in HH (No.)		-0.02	0.02	0.197		0.04	0.01	0.005		0.03	0.02	0.114	
Children in HH (No.)		-0.03	0.03	0.219		-0.06	0.03	0.039		-0.08	0.03	0.009	
Economic sectors (No.)		0.04	0.04	0.348		0.01	0.03	0.808		0.02	0.04	0.620	
Urbanity (1=urb. 0=rur.)		0.12	0.22	0.571		0.34	0.09	0.000		0.13	0.12	0.281	
Country (1=AP 0=Viet.)		-0.08	0.16	0.621		-0.28	0.08	0.001		-0.02	0.10	0.807	
Age of child (mo)		0.00	0.00	0.000		0.00	0.00	0.000		0.00	0.00	0.000	
Sex of child (1=M 0=F)		-0.18	0.05	0.000		-0.17	0.04	0.000		-0.10	0.05	0.056	

P_1: P-value for categorical variable; P2: P-value for continuous variable; 1='none' is reference category

3.4 Paternal and grandmother education

In this section I explore the role of paternal and grandmother education. First I examine their independent effect on child nutrition, then I assess whether this effect differs by wealth, country, age-group, sex and wealth, and finally I explore their role in confounding and modifying the relationship between maternal education and child nutrition.

3.4.1 Paternal education

Independent effect on child nutrition

The independent effect of paternal education on child nutrition was examined adjusting for maternal education and other confounders and independent risk factors, and the results are given in Table 3.5. The results suggest that paternal education is a significant predictor of height-for-age and weight-for-age ($P<0.001$) independently of maternal education and other confounding factors. The tests for trend suggests that the effect us linear in nature, as shown for maternal education in the previous section, with the greatest effect observed for the completion of higher education, and the effect of primary education being small and statistically non-significant.

Effect-modification

In the previous section it was shown that maternal education has a stronger effect on nutrition in urban areas than in rural ones. This type of effect-modification by urbanity was explored for paternal education by adding an interaction term to the original model (shown in Table 3.5) and conducting an LR test between the new and original model. The results are similar to those for maternal education, with the education effect being greater in urban areas and weaker in rural areas for both height- and weight-for-age z-scores ($P=0.029$ and $P=0.044$ respectively). Furthermore, adjusting for paternal education and its interaction with the rural/urban variable does not alter the results for effect-modification shown previously for maternal education, which remains borderline significant ($P=0.086$) for height-for-age and $P=0.015$ for weight-for-age), so that overall the education of both parents appears to have a stronger effect in urban than rural areas.

Table 3.5 Regression output: the association between paternal education and child height- and weight-for-age z-scores (N=5474)

	Height-for-age				Weight-for-age			
	Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2
Constant	-1.49	0.12	0.000		-1.57	0.10	0.000	
Maternal education[1]								
Primary	0.06	0.04	0.159		0.05	0.04	0.206	
Secondary	0.06	0.05	0.248		0.08	0.04	0.070	
Higher	0.23	0.06	0.000	<0.001	0.24	0.05	0.000	<0.001
Paternal education[1]								
Primary	0.02	0.04	0.628		0.02	0.04	0.630	
Secondary	0.13	0.05	0.008		0.06	0.04	0.120	
Higher	0.22	0.05	0.000	<0.001	0.17	0.04	0.000	<0.001
Age of child (mo)	0.00	0.00	0.000		0.00	0.00	0.001	
Sex of child (1=M 0=F)	-0.14	0.03	0.000		-0.11	0.02	0.000	
Age of caregiver (yr)	0.01	0.00	0.007		0.00	0.00	0.944	
Hous. qual. score (0-1)	0.25	0.07	0.000		0.12	0.05	0.025	
Own land (1=yes 0=no)	0.03	0.04	0.408		0.06	0.03	0.101	
Adults in HH (No.)	0.01	0.01	0.565		0.01	0.01	0.105	
Children in HH (No.)	-0.06	0.02	0.001		-0.04	0.01	0.004	
Economic sectors (No.)	0.02	0.02	0.382		0.01	0.02	0.567	
Urbanity (1=urb. 0=rur.)	0.19	0.11	0.074		0.27	0.07	0.000	
Country (1=AP 0=Viet.)	-0.11	0.09	0.241		-0.39	0.06	0.000	

P_1: P-value for categorical variable; P2: P-value for continuous variable; 1='none' is reference category

In the previous section it was shown that there was no difference between Vietnam and AP in the effect of maternal education on child nutrition. However, for paternal education, a between-country difference was found for height but not weight (P=0.017 and P=0.682 respectively), with the effect on height being greater in Vietnam than in AP. Adjusting for paternal education does not alter the results shown previously for maternal education, so there is still no observable difference in the effect of maternal education between countries.

I have also shown that maternal education has a greater impact on the weight of 1-year olds than 8-year olds, although no difference was observed in the impact on height. Paternal education has a similar differential effect on weight (P<0.001), and again no impact was observed for height (P=0.391). Adjusting for the effect of paternal education did not alter the original results for maternal education, so that overall parental education appears to have a stronger impact on weight for 1-year olds than 8-year olds.

As observed for maternal education, there was no difference between boys and girls in the effect of paternal education in terms of weight-for-age (P=0.892) or height-for-age (P=0.896).

In the previous section it was shown that maternal education has a greater impact on the height and weight of children in wealthy households than in poorer households. Evidence of similar effect-modification by wealth on the education of fathers was found for child height (P=0.037) but the interaction was borderline for weight (P=0.111). When the effect of maternal education was re-examined adjusting for paternal education, it was no longer significant for height (P=0.187) but remained significant for weight (P=0.008). Overall therefore, wealthier children appear to be more affected by their parents' education than poorer children.

The role of paternal education in confounding and modifying the maternal education effect

There is evidence that paternal education confounds the relationship between maternal education and child nutrition. A comparison between the models for height-for-age and weight-for-age shown in Table 3.5 with the equivalent models excluding the paternal education variables (results not shown) reveal a change in coefficient for the maternal education variable. For both nutrition indicators, the effect of maternal education is smaller once adjustment is made for paternal education. For example, the effect of primary education changes from 0.09 (95% CI 0.25 – 0.46 P=0.032) to 0.06 (95% CI -0.02 – 0.15 P=0.159) height-for-age z-scores with the adjustment for paternal education, and the equivalent change for secondary education was even greater, from (0.14 (95% CI 0.04 – 0.23 P=0.004) to 0.06 (95% CI -0.04 – 0.16 P=0.248). These results suggest that an analysis that ignores the effect of fathers' education may overestimate the effect of mothers' education.

It is possible that the overall effect estimate for maternal education presented in Table 3.3 is inappropriate because the size of the effect may vary depending on paternal education. Effect-modification by paternal education on the relationship between maternal education and child nutrition was therefore investigated. The results were statistically significant for weight (P=0.017) but borderline non-significant for height

(P=0.121), suggesting that the effect of maternal education on weight is likely to be greater if the father is also educated. This may suggest that the relationship between highly educated parents is conducive to promoting 'healthy' behaviour, for example through women's increased freedom to make decisions and act upon them, or the sharing of knowledge which may have an impact on children's health. It is also possible that, despite the adjustment for household wealth and assets in the model, the paternal education variable is capturing the residual effect of socio-economic status.

3.4.2 Grandmother education

Independent effect on child nutrition

The effect of grandmothers' presence in the household and their education on child nutrition was examined, adjusting for maternal education and other confounders and independent risk factors. The results are given in Tables 3.6 (a) and (b). The first table (a) presents the regression output for a model of all households which includes a categorical variable, where the reference category '0' refers to grandmothers being absent in the household, '1' represents households with uneducated grandmothers and '2' represents households with educated grandmothers (at least primary school). The reference category was defined as the absence of grandmothers in order to enable the assessment of effect of grandmothers' their presence in the household irrespective of their education. The definition of an educated grandmother was set at the completion of at least primary school because only a small number of grandmothers had completed secondary and higher education (N=82 and N=33 respectively).

The frequency distribution of this variable indicated that grandmothers were more commonly present in the households in AP than in Vietnam, but tended to be less educated. The numbers of 'educated' grandmothers in AP and Vietnam were 135 and 179 respectively, while the numbers of uneducated grandmothers present in the household were 977 and 342. This corresponds to 12% and 34% of grandmothers being educated in AP and Vietnam respectively.

Table 3.6 (a) shows that the presence of a grandmother in the household is not associated with height-for-age or weight-for-age z-score. However, grandmothers'

education has a positive effect on both height-for-age (0.14 95% CI 0.00 - 0.27 P=0.053) and weight-for-age (0.20 95% CI 0.08 - 0.32 P<0.001) adjusting for parental education and other confounders. To explore the role of grandmother education further, a categorical variable for grandmother education was applied to a model using only the sub-group of households with grandmothers present. Grandmothers' education was categorised into three groups: 'none', 'primary' and 'secondary and above'. A separate category for higher education was dropped because of the small sample size of grandmothers in this category. The results are given in Table 3.6 (b).

Table 3.6 (b) shows that there is a statistically significant effect of grandmother education on child nutrition. Primary education is positively associated with both height-for-age (0.21 95% CI 0.02 - 0.40 P=0.027) and weight-for-age z-scores (0.20 95% CI 0.15 - 0.05 P=0.011). However, although grandmothers' secondary or higher education was positively associated with weight (0.24 95% CI 0.04 - 0.46 P=0.022), the effect is statistically insignificant for height (0.15 95% CI -0.10 - 0.40 P=0.238). The findings suggest that there is a linear relationship between the level of schooling completed by grandmothers and child z-score, although the linearity is less clear than that shown for the relationship between parental education and child nutrition.

The present study does not attempt to measure the education effect of grandmothers who do not live in the same household as the child. One might assume, however, that the effect of their education on nutrition will be weaker because the geographical separation of dwellings would render them less likely to play a large role in childcare.

Effect modification

Given the differential impact shown for paternal education, it is plausible that the main effects of grandmothers' presence and education are misleading. The effect size of grandmother education is, like parental education, expected to vary in size by country, urbanity, household wealth, and child age-group and sex. Analysis was undertaken to explore effect-modification by these factors using a binary variable for grandmothers being 'uneducated/not present' or 'educated' (having completed at least primary). The merging of 'uneducated' and 'not present' grandmothers is justified by

the results presented in Table 3.6 (a) which showed no difference in the two groups in their effect on nutrition.

The patterns of effect-modification by urbanity, wealth and age group were similar to parental education. There is a stronger effect of grandmother education in urban areas than rural for both height- (P=0.028) and weight-for-age (P=0.027). Household wealth positively modifies the effect of grandmother education for both height- (P=0.074) and weight-for-age z-score (P=0.012). However, there is no difference in effect between 1- and 8-year old children for weight- (P=0.273) and height-for-age z-score (P=0.741).

The results suggest that there is evidence of effect-modification by country, with the LR test being statistically significant for both height- (P=0.030) and weight-for-age z-score (P=0.067). The effect of grandmother education is stronger in AP than in Vietnam. This contrasts with the results shown for parental education, which is stronger in Vietnam than in AP.

Analysis was undertaken to assess whether the sex of the child modified the effect of grandmother education on child nutrition. The results suggest that it does, and that the effect is greater among boys in terms of weight (P<0.001) although not in terms of height (P=0.427). Given that gender disparities in health are recognised as a problem in South India, and therefore possibly more evident in AP than in Vietnam, the regression results were stratified by country and sex (Table 3.7). In AP, the mean difference between boys having an educated grandmother in the household and boys who do not is 0.64 height-for-age z-scores (95% CI 0.29 – 0.99 P<0.001) and 0.52 weight-for-age z-scores (95% CI 0.25 – 0.78 P<0.001). The difference is smaller for girls (0.07 95% CI -0.24 – 0.36 P=0.671 for height-for-age and 0.29 95% CI 0.07 – 0.52 P=0.010 for weight-for-age). Meanwhile, in Vietnam, the effect of having an educated grandmother is statistically non-significant for both sexes and for both nutrition indicators. The implications of these findings will be discussed further in the final section of this chapter.

The role of grandmother education in confounding and modifying the maternal education effect

The effect of maternal education on child nutrition has been shown to be a strong positive determinant of child growth. It is possible, however, that the maternal education effect can, at least in part, be explained by the effect of the grandmother's education. An investigation into the potential confounding role of grandmother education suggested that this was not the case. Although the maternal education effect diminishes somewhat with the inclusion of grandmother education in the model (Table 3.6b), the difference was small for both height-for-age and weight-for-age. For example, the coefficient for maternal primary and secondary education changed from 0.26 and 0.19 respectively to 0.25 and 0.17 once adjustment was made for grandmothers' education. The results suggest that grandmother education does not confound the relationship between maternal education and child nutrition. This contrasts with the results for paternal education, which was shown to confound the relationship between maternal education and child nutrition.

Potential modification of the effect of maternal education by grandmother education was examined, and found to be statistically non-significant for both height-for-age (P=0.751) or weight-for-age (P=0.527). This suggests that the maternal education effect is not dependent on the educational level of the grandmother.

Table 3.6 Regression output: the effect of grandmothers' presence and education on child height- and weight-for-age z-scores in all households (a) and in households with grandmothers (b)

a) All households (N=5464)

		Height-for-age				Weight-for-age			
		Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2
Constant		-1.494	0.123	0.000		-1.568	0.097	0.000	
Mat	Primary	0.060	0.044	0.172		0.045	0.038	0.232	
educ. [1]	Secondary	0.055	0.051	0.282		0.071	0.043	0.097	
	Higher	0.224	0.060	0.000	0.001	0.230	0.051	0.000	<0.001
Pat	Primary	0.021	0.044	0.639		0.016	0.038	0.669	
educ.[1]	Secondary	0.130	0.048	0.007		0.064	0.041	0.119	
	Higher	0.213	0.051	0.000	<0.001	0.162	0.043	0.000	<0.001
Gran	Present & uned.	-0.056	0.044	0.197		-0.031	0.037	0.408	
	Present & ed	0.131	0.070	0.063	0.461	0.194	0.060	0.001	0.043
Age of child (mo)		-0.004	0.000	0.000		-0.001	0.000	0.001	
Sex of child (1=M 0=F)		-0.138	0.029	0.000		-0.105	0.025	0.000	
Age of caregiver (yr)		0.008	0.003	0.008		0.001	0.003	0.745	
Hous. qual. score (0-1)		0.242	0.065	0.000		0.115	0.055	0.036	
Own land (1=yes 0=no)		0.036	0.040	0.374		0.057	0.034	0.095	
Adults in HH (No.)		0.008	0.011	0.488		0.010	0.009	0.304	
Children in HH (No.)		-0.055	0.017	0.001		-0.041	0.014	0.005	
No. economic sectors		0.017	0.021	0.410		0.010	0.018	0.574	
Urbanity (1=urb 0=rur)		0.188	0.108	0.082		0.261	0.072	0.000	
Country (1=AP 0=Viet)		-0.097	0.094	0.301		-0.376	0.061	0.000	

b) Among households with grandmothers present (N=1633)

		Height-for-age				Weight-for-age			
		Coeff	SE	P_1	P_2	Coeff	SE	P_1	P_2
Constant		-1.942	0.246	0.000		-1.908	0.195	0.000	
Mat	Primary	0.237	0.091	0.010		0.215	0.075	0.004	
educ. [1]	Secondary	0.160	0.099	0.106		0.187	0.081	0.021	
	Higher	0.286	0.114	0.012	0.024	0.299	0.094	0.001	0.003
Pat	Primary	-0.034	0.089	0.703		-0.039	0.073	0.594	
educ.[1]	Secondary	0.141	0.097	0.148		0.110	0.080	0.168	
	Higher	0.144	0.096	0.133	0.074	0.149	0.078	0.057	0.032
Gran	Present & uned.	0.211	0.095	0.027		0.200	0.078	0.011	
	Present & ed	0.151	0.128	0.238	0.058	0.240	0.105	0.022	0.056
Age of child (mo)		-0.005	0.001	0.000		-0.002	0.001	0.063	
Sex of child (1=M 0=F)		-0.158	0.057	0.006		-0.139	0.047	0.003	
Age of caregiver (yr)		0.015	0.007	0.026		0.011	0.006	0.055	
Hous. qual. score (0-1)		0.368	0.124	0.003		0.166	0.099	0.094	
Own land (1=yes 0=no)		0.090	0.082	0.272		0.058	0.067	0.393	
Adults in HH (No.)		0.017	0.017	0.302		0.014	0.014	0.312	
Children in HH (No.)		-0.110	0.031	0.000		-0.063	0.026	0.014	
No. economic sectors		0.023	0.040	0.564		-0.003	0.032	0.936	
Urbanity (1=urb 0=rur)		0.243	0.153	0.111		0.228	0.104	0.028	
Country (1=AP 0=Viet)		0.042	0.131	0.747		-0.310	0.086	0.000	

P_1: P-value for categorical variable; P_2: P-value for linear variable; 1='none' is reference category

Table 3.7 Regression output: the effect of having an educated grandmother in the household on child height-for-age z-scores (a) and weight-for-age z-score (b) by child sex and country.

a) Height-for-age

		Vietnam boys (N=1412)			Vietnam girls (N=1352)			AP boys (N=1279)			AP girls (N=1279)		
		Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant		-1.411	0.181	0.000	-1.415	0.177	0.000	-2.000	0.224	0.000	-1.759	0.208	0.000
Mat	Prim.	0.067	0.070	0.341	0.031	0.070	0.660	0.082	0.124	0.507	0.082	0.113	0.467
educ. [1]	Sec.	0.072	0.086	0.402	0.089	0.086	0.301	-0.126	0.121	0.298	0.206	0.116	0.076
	High.	0.298	0.111	0.007	0.086	0.106	0.418	0.186	0.130	0.155	0.321	0.127	0.011
Pat	Prim.	0.093	0.076	0.223	0.139	0.073	0.058	0.107	0.113	0.342	-0.212	0.107	0.048
educ.[1]	Sec.	0.280	0.086	0.001	0.150	0.084	0.075	0.168	0.120	0.161	0.126	0.109	0.246
	High.	0.415	0.103	0.000	0.397	0.101	0.000	0.128	0.106	0.225	0.105	0.100	0.294
Age of mother (yrs)		-0.005	0.001	0.000	-0.005	0.001	0.000	-0.004	0.001	0.001	-0.004	0.001	0.000
Hous. qual. score (0-1)		0.001	0.005	0.760	0.002	0.004	0.616	0.018	0.008	0.017	0.019	0.007	0.008
Own land (1=yes 0=no)		0.133	0.119	0.261	0.287	0.114	0.012	0.253	0.142	0.075	0.185	0.135	0.170
Adults in HH(No.)		-0.008	0.074	0.916	-0.004	0.076	0.963	0.029	0.086	0.737	0.044	0.079	0.575
Children in HH. (No.)		-0.017	0.018	0.341	0.010	0.018	0.559	0.003	0.021	0.875	0.018	0.018	0.322
Economic sectors (No.)		-0.059	0.031	0.059	-0.057	0.031	0.063	-0.044	0.036	0.227	-0.101	0.035	0.004
Urbanity (1=urb. 0=rur.)		0.034	0.031	0.279	0.035	0.029	0.232	0.012	0.061	0.845	-0.052	0.056	0.354
Age of child (mo)		0.227	0.182	0.213	0.360	0.175	0.040	0.140	0.168	0.402	0.115	0.143	0.423
Gran present & educ[2]		0.127	0.106	0.228	-0.134	0.109	0.221	0.638	0.177	0.000	0.065	0.153	0.671

P_1: P-value for categorical variable; P2: P-value for linear variable, 1='none' is reference category

b) Weight-for-age

		Vietnam boys (N=1412)			Vietnam girls (N=1352)			AP boys (N=1279)			AP girls (N=1279)		
		Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant		-1.359	0.173	0.000	-1.438	0.159	0.000	-2.215	0.165	0.000	-2.293	0.153	0.000
Mat	Prim.	0.092	0.070	0.192	0.003	0.067	0.968	0.052	0.095	0.584	0.056	0.085	0.509
educ. [1]	Sec.	0.111	0.085	0.195	0.072	0.082	0.377	0.029	0.093	0.757	0.151	0.087	0.082
	High.	0.496	0.111	0.000	0.154	0.101	0.127	0.201	0.100	0.043	0.151	0.094	0.109
Pat	Prim.	0.067	0.076	0.380	0.064	0.070	0.360	0.003	0.087	0.973	-0.029	0.080	0.717
educ.[1]	Sec.	0.208	0.086	0.016	0.046	0.080	0.569	-0.003	0.091	0.971	0.130	0.081	0.110
	High.	0.232	0.103	0.024	0.209	0.097	0.031	0.107	0.081	0.185	0.207	0.075	0.005
Age of mother (yrs)		-0.003	0.001	0.000	-0.002	0.001	0.001	0.000	0.001	0.794	0.001	0.001	0.397
Hous. qual. score (0-1)		-0.004	0.005	0.458	-0.006	0.004	0.160	0.006	0.006	0.339	0.014	0.005	0.012
Own land (1=yes 0=no)		-0.151	0.115	0.191	0.112	0.104	0.280	0.173	0.106	0.104	0.208	0.099	0.036
Adults in HH(No.)		0.003	0.073	0.970	0.004	0.071	0.956	0.054	0.066	0.411	0.083	0.059	0.157
Children in HH. (No.)		-0.004	0.018	0.815	0.028	0.017	0.098	0.012	0.016	0.442	0.009	0.014	0.501
Economic sectors (No.)		-0.047	0.031	0.133	-0.048	0.029	0.097	-0.072	0.028	0.010	-0.051	0.026	0.053
Urbanity (1=urb. 0=rur.)		0.007	0.031	0.825	0.045	0.028	0.100	0.002	0.046	0.974	-0.054	0.042	0.200
Age of child (mo)		0.349	0.147	0.017	0.385	0.116	0.001	0.196	0.095	0.039	0.169	0.089	0.057
Gran present & educ[2]		0.117	0.106	0.268	-0.040	0.105	0.704	0.517	0.136	0.000	0.293	0.114	0.010

P_1: P-value for categorical variable; P2: P-value for linear variable, 1='none' is reference category

3.5 Summary and discussion

3.5.1 Summary of findings

In this chapter I have shown that the education of mothers, fathers and grandmothers have positive and independent impacts on child nutrition. The effect of parental education increases with level of schooling completed, but this linearity was not observed for grandmothers. The effect of grandmothers' higher education is smaller than primary or secondary, probably due to the small number of grandmothers educated to that degree.

The strength of the education effects varies spatially and socially. Some common patterns were found for different household members. The effect of all adults' education on child nutrition is stronger in urban than rural areas, and among the relatively wealthy compared with the relatively poor households. There is no difference between countries in the effect of maternal education, although the paternal education effect was stronger in Vietnam and the grandmother education effect was stronger in India. There are no differences in effect shown between children of different age-groups or between child sexes for paternal education. There is, however, a difference between boys and girls with respect to the effect of grandmother education. Grandmother education has a stronger positive effect on nutrition among boys than girls.

3.5.2 Implications of main findings

While many of the findings in this chapter have already been commented upon, it is worthwhile dwelling further on some of the key observations.

One of the most interesting patterns that has emerged is the stronger effect of education observed in urban than rural areas, a finding supported by previous studies (Bicego and Boerma 1993) but not by others (Rosenzweig and Schultz 1982). The results lend support to the idea that education and health services complement each other, so that better educated women are more able to take advantage of health services in urban areas. The

findings also lend support to the view of Caldwell that education enhances women's ability to manipulate critical aspects of the modern world such as bureaucratic institutions that dominate urban life (Caldwell and McDonald 1982; Rosenzweig and Schultz 1982), although causal pathways have not been directly explored so it is only possible to speculate at this stage. The idea that a certain level of service provision or resources complement education in its impact on child nutrition is supported by the results in this chapter showing a positive effect-modification by household wealth. This finding has also been shown in other studies (Bairagi 1980; Ruel, Habicht et al. 1992; Griffiths and Bentley 2001) and suggests that basic needs and sanitation must be satisfied before maternal education (Reed, Habicht et al. 1996) or nutrition education programmes (Piwoz and Viteri 1985; Wandel and G. 1988) can have a positive effect on child nutritional status.

Cross-country comparisons have here shown that paternal education has a stronger effect in Vietnam than in AP, whereas the opposite pattern is observed for grandmothers. There is no difference between countries in the effect of maternal education. It is possible that the particularly strong role of grandmothers in AP can be explained by their important role in childcare in this country, although further research would be necessary to substantiate this claim. The reasons for the stronger effect of paternal education in Vietnam is not known. However, one may speculate that differences lie in the quality of education available, as well as in the availability of health services, or perhaps methodologically, as the analysis may have failed to control for confounding equally between the two countries. Similar arguments can be applied to explain the urban-rural education differential.

The substantial differences between and within countries in the effect of education has implications for the generalisability of findings. It suggests the importance of adult education for child nutrition, and the mechanisms through which it operates, are likely to vary spatially, between social strata and from one generation to the next. An overall estimate of effect would be inadequate because it masks important heterogeneity. Furthermore, any discussion about generalisability of findings should mention that the

YL study – which over-sampled the 'poor' – was not designed to be nationally representative. Any extrapolation of findings to the wider country population would necessitate weighted estimates to be calculated.

A sex difference for the impact of education was only found for grandmothers, with a stronger benefit observed for boys than girls. This is a plausible finding, given the traditionally favoured role of boys in preference to girls in Asian culture, which has been shown to affect food allocation and medical care (D'Souza and Chen 1980; Fauveau, Koenig et al. 1991). The fact that the effect of maternal or paternal education is not dependent on the sex of the child might suggest that the traditional preference for sons has weakened.

The effect of adult education on the growth of 8-year olds is of interest because there have been few studies that have previously studied the education effect on children over five years of age, and because malnutrition in older children has been linked with slower mental development, later enrolment and lower achievement in school (Hall, Khanh et al. 2001; SCN 2002). However, because the data are cross-sectional in nature, it is not possible to ascertain how the association has come about, that is if it represents a 'current effect' or a 'lagged effect'. It is most likely that the education effect is a result of an accumulative process operating throughout the early childhood years.

The linearity of association between parental education and child nutrition corresponds with previous studies (Cleland and Kaufman 1998). In general the effect of parental education increases with the level of schooling completed, although for mothers in particular the difference in the effect of primary and secondary education was actually quite small. This contradicts the findings by Caldwell in Nigeria showing that the step from primary to secondary schooling was more important than that from no education to primary (Caldwell and McDonald 1982). Caution, however, is needed when drawing conclusions from the present study due to the inability to distinguish between mothers who attended primary school for less than 5 years and those who never went to school at all, because all are classed as uneducated (see Section 2.2.2). This means that the

importance of attending school for a few years is missed altogether, an effect which has been shown to be vital for the acquisition of skills (LeVine, Dexter et al. 1994; LeVine, Levine et al. 1994; Basu and Stephenson 2005). The implications of this weakness in the education indicator will be discussed further in Chapter 10.

The discussion should be concluded on another cautionary note. Interpretation of results from cross-country comparisons must be undertaken with care for two main reasons: one, because the meaning of 'education' is different in Vietnam and AP, and two, that the countries have different confounding structures which means that the probability of detecting an effect may differ. The Organizational structure of the formal schooling system differs between the countries, along with the skills, knowledge, financial costs and status gains associated with each level of education. It can therefore not be assumed that the education variable used in this analysis measures the same thing in AP and Vietnam. The same argument can be applied to comparative analysis of urban-rural areas or between grandmother and parental education because educational content and methods change over both time and space. It has been recognised by others too, that the level of schooling as an indicator of education is a practically useful but a conceptually dubious proxy for the processes that take place and the outcomes that result (UNESCO 2004). Meanwhile, each country is likely to have unique confounding structures so that confounders may have been ignored in the analysis or not fully captured using the variables available in the data-set. This methodological issue will be discussed further in Section 10.2.

3.5.3 Next steps

The results presented here cannot be considered a complete assessment of the total impact of education because the study accounts for household-level impacts only, while the education of people outside the household may have an impact as well. The potential importance of community-level education will be explored further in the next chapter. Secondly, as previously discussed in Section 1.3.2, a better understanding of the pathways by which adult education affects child health is needed. One potential pathway

between maternal education and child growth is, according to recent studies, mothers' acquisition of health and nutritional knowledge (Ruel, Habicht et al. 1992; Glewwe 1999; Kovsted, Pörtner et al. 2002). The research presented in the second half of this thesis will therefore further explore potential underlying mechanisms, including mothers' knowledge and communication.

CHAPTER 4

COMMUNITY-LEVEL EDUCATION AND EDUCATION DISTRIBUTION

In this chapter I explore the effect of community-level education and education distribution on child nutrition. The chapter is split into three sections. In the first I examine the effect of community-level education on child nutrition. In the second section I examine the role of the distribution of education within the community. Finally, in the third section I summarise and discuss the results.

4.1 Introduction

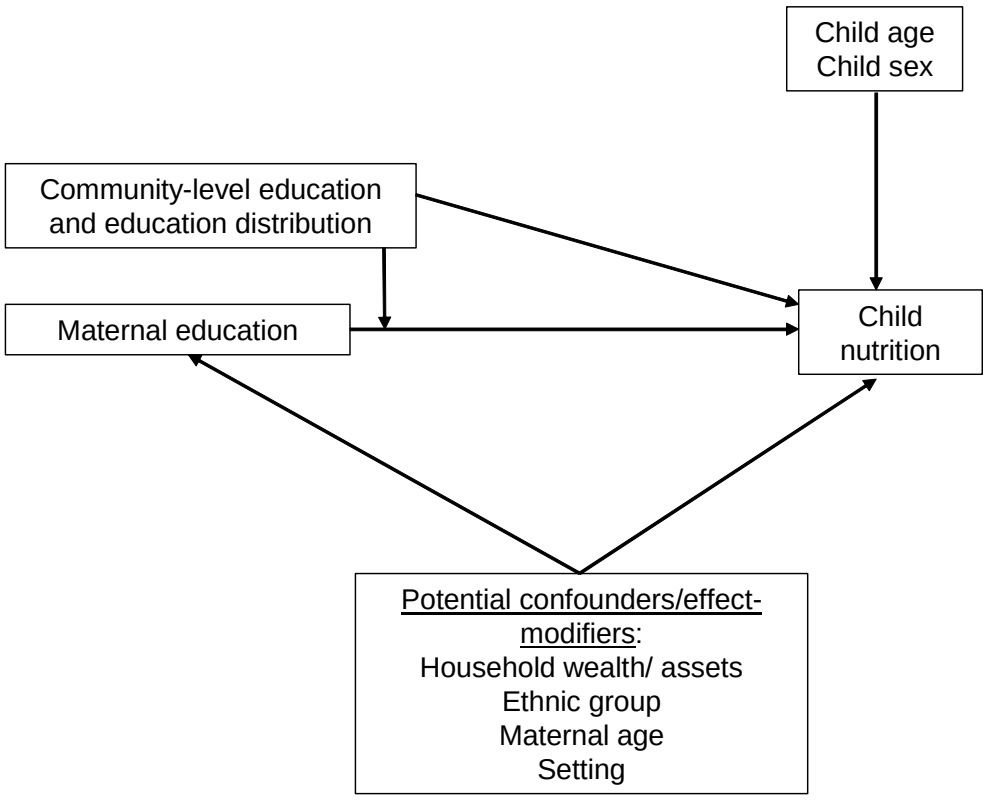
4.1.1 Background

In epidemiology there is growing recognition of the role of community-level factors in determining child health and nutrition. However, only a handful of studies have examined the effect of community-level education on child nutrition using multi-level modelling techniques to adjust for household-level education and other confounders. There has also been little research into the importance of the distribution of educated individuals within the community and no known study has used multi-level methods to explore this question (see Section 1.4.2).

The analytical framework in Figure 4.1 illustrates the hypothesis that child nutrition is determined by community-level education and the distribution of educated individuals within the community, independent of household education. The underlying mechanisms through which community-level education and education distribution affects nutrition are not examined. In this chapter I will use maternal and paternal education to represent

household-level education because the number of households with grandmothers present was small. I have developed two indicators of community-level education, and two indicators of education distribution; the measurement and rational of which will be explained in this chapter.

Figure 4.1 Analytical framework: illustration of hypotheses related to the relationship between child malnutrition and education of community members, and the distribution of educated individuals within the community



4.1.2 Objectives

The overall objective of this chapter is:

- To estimate, using multi-level methods, the effect of community-level education and education distribution on child nutrition, over and above individual-level factors.

Specific objectives are:

- To explain and justify the measurement of community-level education and education distribution
- To explore effect-modification by urbanity, country, child age-group, child sex and household wealth of the relationship between child nutrition and community education and education distribution
- To determine whether community-level education and education distribution modifies the effect of parental education
- To assess whether an indicator of community-level education, which accounts for the distribution of educated individuals, can explain more variation in child nutrition than the conventional indicator which does not account for the distribution of educated individuals

4.2 Community-level education

4.2.1 Justification for examining community-level education

A small number of studies suggest that community-level education impacts upon child nutrition above and beyond household-level education. Moreover, in the previous chapter I showed that the educational status of fathers and grandmothers is associated with child nutrition, adjusting for maternal education. Children's growth, it seems, is jointly determined by the educational status of several people, and not the mother alone.

It is likely that these 'influential others' either care for the children or make decisions that have a direct impact upon them. The results prompt the following question: 'are there any other people who live outside the household whose education is also important for child nutrition?' This is a likely scenario, given that people organise themselves spatially and socially and come to depend on the society in which they live both emotionally and financially. This proposition is supported by Kravdal (Kravdal 2002; Kravdal 2004). An analysis that ignores the education of people outside the household unit may therefore be considered an incomplete assessment of the total impact of education.

4.2.2 The measurement of community-level education

Community-level education is defined in two ways, and the two variables created will both come under the umbrella term 'community-level education'. Both indicators are aggregate measures of the YL sample, the first based solely on mothers and the second based on all adult household members.

- Community-level maternal literacy:

  The proportion of literate mothers in the community, sampled by YL.

  This measure is based on the hypothesis that the externality of education is spread mainly through literacy mechanisms (Basu, Narayan et al. 2001). Literacy is assessed by asking 'Can you read and understand a letter or newspaper easily, with difficulty, or not at all, in any language?'. Answers were coded 'easily', 'with difficulty' or 'not at all'. Women who answered 'easily' were categorized as literate.

- Community-level higher education:

  The proportion of all adults in the sample with higher education.

  This measure is based on the results in Chapter 3 indicating that the strongest association between education and nutrition is for the higher level of education. The sample size of adults used to create this indicator is greater than the above indicator, because it includes all adults and not only mothers.

The explanatory variables (community-level maternal literacy and community-level higher education variables) are both calculated at the 'community' level (level 2), whereas the outcomes variables (child height- and weight-for-age z-scores) are measured for each individual (level 1). The effect of community-level education was therefore assessed using the three-level model, which also accounts for clustering at the 'site' level (see Section 2.2.4 for further details). Adjustment was made for parental education and other potential confounders. Observations with missing values for any of the explanatory variables used in analysis were excluded from the analysis.

The number of communities used in the analysis was 31 from Vietnam and 100 from AP. The mean number of mothers per community was 90 (range: 44-145) and 27 (range 1-76) in each country respectively. No minimum sample size for community was set, with the rationale being that any cut-off would be considered arbitrary. This means that some communities have very small sample sizes, especially in AP, where 8 communities had sample sizes below 10. This issue will be discussed further in Section 4.2.7, which repeats the analysis for a sample of communities that excludes those with less than 20 households (9% of the sample of households).

4.2.3 Crude association

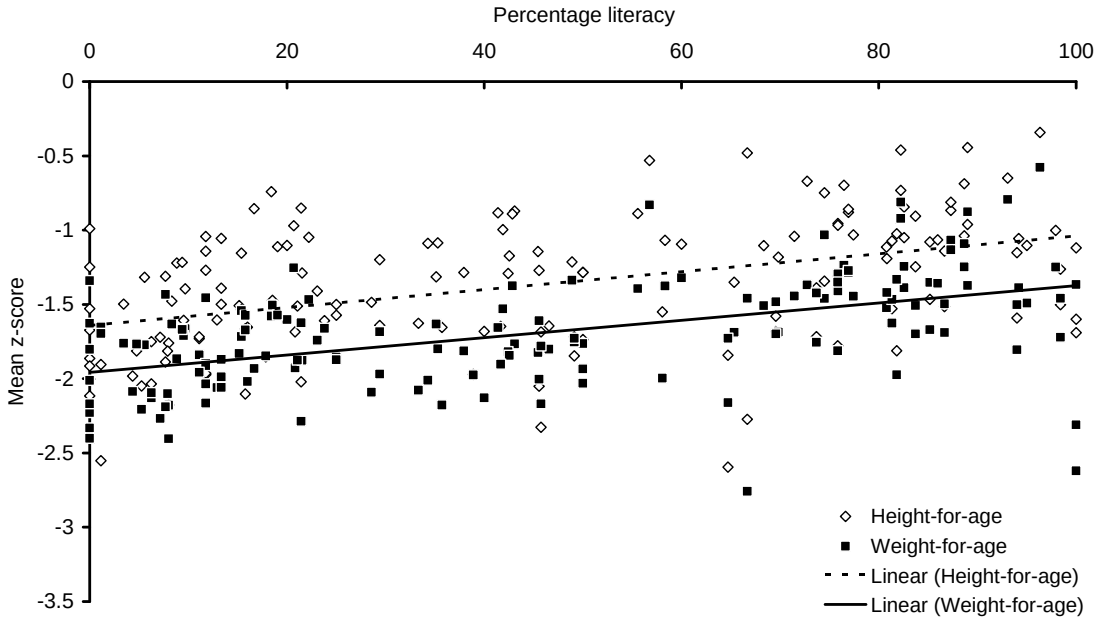
The average height- and weight-for-age z-score was plotted by community-level maternal literacy and community-level higher education. The results are given in Figure 4.2 and show that the relationship is positive for both nutrition outcomes and for both education variables. This is supported by the Pearson's Correlation coefficients. The correlation coefficient for community-level maternal literacy and height-for-age is 0.37 ($P<0.001$), and the corresponding coefficient for weight is 0.39 ($P<0.001$). Meanwhile the correlation between community-level higher education and height is 0.29 ($P<0.001$) and 0.19 ($P=0.017$) for weight.

The crude relationship was also explored using multi-level regression techniques, which enable the examination of association between community-level education and

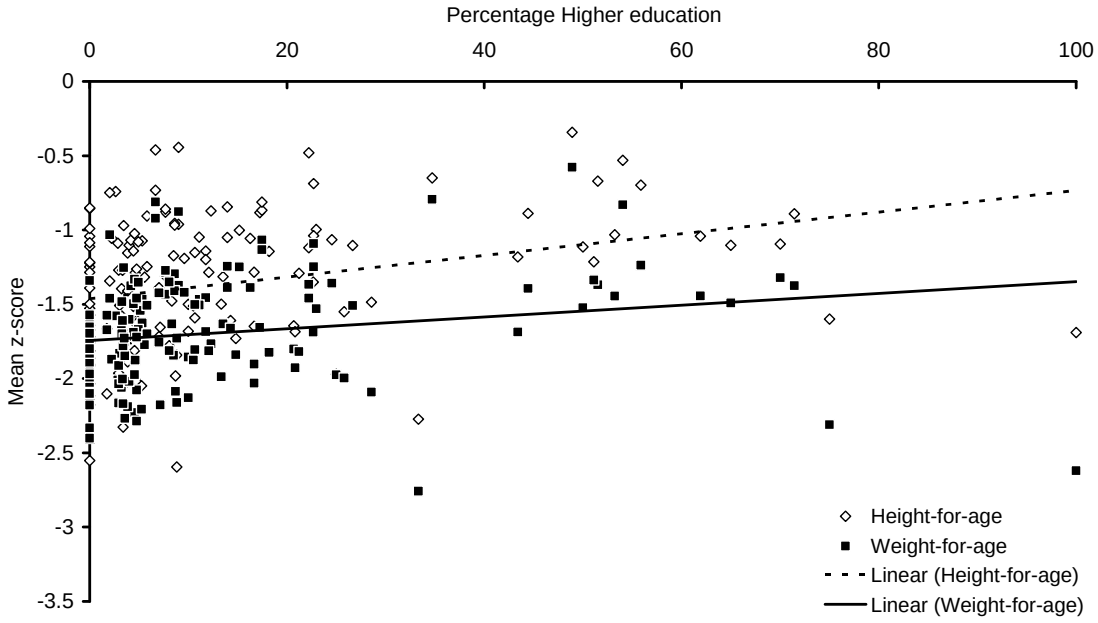
individual-level nutrition. Model A in Table 4.1 and 4.2 presents the unadjusted results for community-level maternal literacy and community-level higher education respectively. They confirm the visual impression of Figure 4.2, that community-level education (both indicators) is strongly and positively associated with child nutrition. The size of the regression coefficients are similar for both nutrition outcomes and for both education exposures. They suggest, for example, that an increase from 0% to 100% in community-level maternal literacy is associated with a mean increase of 0.62 height-for-age z-scores. However, it is likely that much of this effect can be explained by other factors, such as parental education and other household- and individual-level characteristics. The next section presents the findings of the adjusted analysis.

Figure 4.2 A scatter diagram of the mean height- and weight-for-age z-score per community by community-level maternal literacy (a) and community-level higher education (b) expressed as a percentage (N=131)

a) Community-level maternal literacy



b) Community-level higher education



4.2.4 Adjusted association

The next step in the analysis is to control the effect of confounders. The results are shown in Model B and C in Table 4.1 (community-level maternal literacy) and Table 4.2 (community-level higher education), and can thus be directly compared with the results in Model A (the unadjusted results). Model B gives the results adjusted for potential confounders and risk factors, but excludes parental education. Model C gives the results adjusted for all confounders and risk factors, and includes parental education.

A comparison of Model A (unadjusted results) and Model B shows that adjustment for non-education confounders and independent risk factors diminishes the effect estimates for community-level maternal literacy, although the effect remains statistically significant for both height-for-age (0.49 95% CI 0.18 – 0.81 P=0.002) and weight-for-age (0.26 95% CI 0.02 - 0.50 P=0.031). Similarly, the effect estimate for community-level higher education is significant for weight (0.43 95% CI 0.04 – 0.83 P=0.032) but borderline for height (0.45 95% CI -0.06 - 0.97 P=0.085). The next step is to adjust for parental education, which is likely to be an important confounder of this relationship.

Model C shows the regression output when parental education is included in the model, along with other confounders and independent risk factors. The results suggest that once the education of mothers and fathers has also been accounted for, the effect on both height and weight of community-level maternal literacy is reduced. The statistical significance of the effect disappears for child weight-for-age (0.08 95% CI -0.03 – 0.62 P=0.496) but remains borderline for height-for-age (0.30 95% CI -0.03 – 0.62 P=0.073). Meanwhile, the effect of community-level higher education disappears altogether for both height-for-age and weight-for-age.

The results suggest that parental education is an important confounder of the relationship between community-level education and child nutrition. This is to be expected given the strong correlation between community and household education indicators, partly

explained by the fact that the community-level higher education variable is a direct function of maternal education, and because literacy is a key outcome of education.

Community-level education is likely to affect child nutrition over the longer term by influencing the basic and underlying causes of nutrition, such as the availability of resources (see Figure 1.1 for a conceptual framework for the determinants of malnutrition). The stronger effect on height-for-age than weight-for-age is therefore plausible because the former is an indicator of long-term malnutrition whereas the latter is more influenced by acute malnutrition. For the remaining analysis in this chapter I focus on stunting rather than underweight and use height-for-age z-score as the main nutrition outcome.

Table 4.1 Regression output: the crude and adjusted association between community-level maternal literacy and height-for-age (a) and weight-for-age z-scores (b) (N=5474)

a) Height-for-age z-scores

		Model A			Model B			Model C		
		Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant		-1.597	0.080	0.000	-1.830	0.163	0.000	-1.699	0.166	0.000
Community-level mat lit. (0-1)		0.624	0.120	0.000	0.493	0.160	0.002	0.295	0.165	0.073
Age of child (mo)					-0.005	0.000	0.000	-0.004	0.000	0.000
Sex of child (0=F 1=M)					-0.145	0.029	0.000	-0.140	0.029	0.000
Age of caregiver (yrs)					0.008	0.003	0.004	0.008	0.003	0.006
Housing quality score (0-1)					0.358	0.064	0.000	0.241	0.065	0.000
Land ownership (0=no 1=yes)					0.057	0.040	0.158	0.034	0.040	0.389
Adults in household (No.)					0.008	0.009	0.372	0.006	0.009	0.545
Children in household (No.)					-0.065	0.017	0.000	-0.055	0.017	0.001
Economic sectors (No.)					0.027	0.021	0.195	0.018	0.021	0.398
Country (0=Vietnam 1=AP)					0.127	0.117	0.278	0.028	0.118	0.810
Urbanity (0=rural 1=urban)					0.163	0.114	0.152	0.115	0.113	0.312
Maternal education	Primary							0.054	0.045	0.223
	Secondary							0.048	0.051	0.345
	Higher							0.221	0.060	0.000
Paternal education	Primary							0.018	0.044	0.677
	Secondary							0.125	0.048	0.010
	Higher							0.212	0.051	0.000

b) Weight-for-age z-scores

		Model A			Model B			Model C		
		Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant		-1.944	0.061	0.000	-1.753	0.128	0.000	-1.623	0.127	0.000
Community-level mat lit. (0-1)		0.672	0.092	0.000	0.262	0.122	0.031	0.083	0.122	0.496
Age of child (mo)					-0.001	0.000	0.000	-0.001	0.000	0.001
Sex of child (0=F 1=M)					-0.111	0.025	0.000	-0.107	0.025	0.000
Age of caregiver (yrs)					0.001	0.002	0.770	0.000	0.002	0.942
Housing quality score (0-1)					0.227	0.054	0.000	0.120	0.055	0.028
Land ownership (0=no 1=yes)					0.077	0.034	0.024	0.056	0.034	0.096
Adults in household (No.)					0.015	0.008	0.052	0.013	0.008	0.101
Children in household (No.)					-0.049	0.014	0.001	-0.041	0.014	0.005
Economic sectors (No.)					0.017	0.018	0.339	0.010	0.018	0.586
Country (0=Vietnam 1=AP)					-0.255	0.085	0.003	-0.349	0.083	0.000
Urbanity (0=rural 1=urban)					0.292	0.082	0.000	0.246	0.078	0.002
Maternal education	Primary							0.044	0.038	0.242
	Secondary							0.074	0.043	0.089
	Higher							0.238	0.051	0.000
Paternal education	Primary							0.017	0.038	0.660
	Secondary							0.062	0.041	0.133
	Higher							0.166	0.043	0.000

Table 4.2 Regression output: the crude and adjusted association between community-level higher education and height-for-age (a) and weight-for-age z-scores (b) (N=5474)

a) Height-for-age z-scores

		Model A			Model B			Model C		
		Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant		-1.475	0.082	0.000	-1.570	0.132	0.000	-1.507	0.134	0.000
Community-level high educ. (0-1)		0.854	0.246	0.001	0.453	0.263	0.085	0.062	0.269	0.818
Age of child (mo)					-0.004	0.000	0.000	-0.004	0.000	0.000
Sex of child (0=F 1=M)					-0.144	0.029	0.000	-0.140	0.029	0.000
Age of caregiver (yrs)					0.008	0.003	0.004	0.008	0.003	0.006
Housing quality score					0.372	0.064	0.000	0.249	0.065	0.000
Land ownership (0=no 1=yes)					0.057	0.040	0.153	0.033	0.040	0.403
Adults in household (No.)					0.008	0.009	0.400	0.005	0.009	0.565
Children in household (No.)					-0.067	0.017	0.000	-0.056	0.017	0.001
Economic sectors (No.)					0.028	0.021	0.173	0.018	0.021	0.382
Urbanity (0=rural 1=urban)					0.196	0.127	0.123	0.180	0.124	0.146
Country (0=Vietnam 1=AP)					-0.103	0.096	0.284	-0.109	0.094	0.244
Maternal education	Primary							0.062	0.044	0.164
	Secondary							0.058	0.051	0.256
	Higher							0.232	0.060	0.000
Paternal education	Primary							0.021	0.044	0.634
	Secondary							0.129	0.048	0.008
	Higher							0.215	0.051	0.000

b) Weight-for-age z-scores

		Model A			Model B			Model C		
		Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant		-1.746	0.070	0.000	-1.654	0.103	0.000	-1.581	0.105	0.000
Community-level high educ. (0-1)		0.670	0.203	0.001	0.431	0.201	0.032	0.069	0.205	0.737
Age of child (mo)					-0.001	0.000	0.000	-0.001	0.000	0.001
Sex of child (0=F 1=M)					-0.110	0.025	0.000	-0.107	0.025	0.000
Age of caregiver (yrs)					0.001	0.002	0.768	0.000	0.002	0.940
Housing quality score					0.230	0.053	0.000	0.122	0.055	0.026
Land ownership (0=no 1=yes)					0.076	0.034	0.025	0.056	0.034	0.099
Adults in household (No.)					0.015	0.008	0.059	0.013	0.008	0.105
Children in household (No.)					-0.052	0.014	0.000	-0.041	0.014	0.004
Economic sectors (No.)					0.019	0.018	0.285	0.010	0.018	0.564
Urbanity (0=rural 1=urban)					0.267	0.087	0.002	0.252	0.085	0.003
Country (0=Vietnam 1=AP)					-0.374	0.062	0.000	-0.386	0.061	0.000
Maternal education	Primary							0.047	0.038	0.214
	Secondary							0.077	0.043	0.076
	Higher							0.241	0.051	0.000
Paternal education	Primary							0.018	0.038	0.639
	Secondary							0.064	0.041	0.123
	Higher							0.167	0.044	0.000

4.2.5 Effect-modification

So far the results have shown that community-level maternal literacy has an independent effect on child height-for-age, adjusting for parental education and child nutrition. However, it is possible that the main effect is misleading because it masks differential effects between population sub-groups. For example, it is possible that community-level education has a greater impact on children who are poor or who live in rural areas. Therefore potential effect-modification by urbanity, household wealth, child age-group and country were examined.

There is no evidence of effect-modification by household wealth (P=0.371), urbanity (P=0.147), child sex (P=0.874) or child age-group (P=0.752). However, there is a difference in the effect of community-level maternal literacy between Vietnam and AP (P=0.008) with the effect being stronger in Vietnam. The regression results have been stratified by country in Table 4.3 and show that the effect of community-level maternal literacy has a strong effect on child height in Vietnam (0.81 95% CI 0.29 - 1.31 P=0.002) but not AP (0.12 95% CI -0.31 – 0.55 P=0.577).

It may be argued from a methodological point of view that the analysis should be conducted separately for each country due to the differences in the sampling procedure which affects how a community is defined. The extent to which differences in methodology may explain the results will be discussed further in Section 4.4.2.

Table 4.3 The effect of community-level maternal literacy on height-for-age z-score in AP and Vietnam

		AP (N=2696)			Vietnam (N=2778)		
		Coeff	SE	P	Coeff	SE	P
Constant		-1.876	0.166	0.000	-1.895	0.229	0.000
Com-level mat lit. (0-1)		0.121	0.217	0.577	0.806	0.260	0.002
Age of child (mo)		-0.004	0.001	0.000	-0.005	0.001	0.000
Sex of child (0=F 1=M)		-0.124	0.047	0.008	-0.155	0.034	0.000
Age of caregiver (yrs)		0.018	0.005	0.000	0.001	0.003	0.859
Housing quality score (0-1)		0.262	0.099	0.008	0.185	0.084	0.027
Land ownership (0=N 1=Y)		0.055	0.059	0.351	0.005	0.053	0.918
Adults in household (No.)		0.017	0.014	0.225	-0.001	0.012	0.926
Children in household (No.)		-0.068	0.025	0.007	-0.048	0.022	0.031
Economic sectors (No.)		-0.019	0.042	0.651	0.025	0.021	0.249
Urbanity (0=rural 1=urban)		0.094	0.158	0.552	0.206	0.150	0.169
Maternal education	Primary	0.075	0.085	0.378	0.041	0.050	0.407
	Secondary	0.039	0.085	0.646	0.066	0.061	0.282
	Higher	0.275	0.092	0.003	0.173	0.077	0.024
Paternal education	Primary	-0.051	0.078	0.513	0.109	0.053	0.039
	Secondary	0.144	0.081	0.075	0.202	0.060	0.001
	Higher	0.122	0.073	0.095	0.400	0.072	0.000

Table 4.4 The effect of parental education on child height-for-age z-score in communities with low and high prevalence of community-level maternal literacy

		Community-level literacy<= 50% (N=2502)			Community-level literacy> 50% (N=2972)		
		Coeff	SE	P	Coeff	SE	P
Constant		-2.050	0.226	0.000	-1.340	0.141	0.000
Age of child (mo)		-0.004	0.001	0.000	-0.004	0.001	0.000
Sex of child (0=F 1=M)		-0.124	0.049	0.011	-0.154	0.034	0.000
Age of caregiver (yrs)		0.010	0.005	0.034	0.005	0.003	0.163
Housing quality score (0-1)		0.272	0.101	0.007	0.215	0.084	0.010
Land ownership (0=N 1=Y)		0.055	0.063	0.383	0.005	0.050	0.925
Adults in household (No.)		0.008	0.014	0.543	0.006	0.012	0.618
Children in household (No.)		-0.051	0.025	0.046	-0.063	0.022	0.005
Economic sectors (No.)		0.026	0.041	0.529	0.007	0.022	0.744
Country (1=AP 0=Vietnam)		0.352	0.173	0.042	-0.244	0.143	0.087
Urbanity (0=rural 1=urban)		0.212	0.183	0.247	0.198	0.135	0.142
Maternal education	Primary	0.115	0.086	0.181	0.033	0.050	0.506
	Secondary	0.064	0.095	0.500	0.054	0.058	0.353
	Higher	0.158	0.113	0.162	0.242	0.067	0.000
Paternal education	Primary	-0.070	0.077	0.358	0.122	0.054	0.024
	Secondary	0.131	0.087	0.130	0.204	0.059	0.001
	Higher	0.128	0.081	0.116	0.346	0.066	0.000

It is hypothesised that the effect of parental education may be modified by community-level education. Potential effect-modification was assessed using the LR test to compare Model C in Table 4.1 with the equivalent model containing two interaction terms, one for maternal education and child nutrition and one for paternal education and child nutrition. The results show evidence of positive effect-modification by maternal education (P=0.030), suggesting that community-level maternal literacy has a greater impact on children who already have educated mothers, and that maternal education has a stronger effect in areas with high rates of literacy. A similar pattern was found for paternal education (P=0.034). Table 4.4 shows the effect of parental education in areas with relatively low and high prevalence of community-level maternal literacy. The results show that parental education has a much stronger impact on child nutrition if they are living in an area where the majority of mothers are literate. However, in areas where the community-level maternal literacy is below 50%, the effect of parental education is statistically non-significant.

4.2.6 Adjusting for community-level variables

It is plausible that the relationship between community-level maternal literacy and child height is confounded by community-level wealth and other variables. However, contextual factors like service provision and infrastructure are not available for analysis. I have therefore aggregated individual-level variables to create community-level indicators and act as proxies for community-level socio-economic status (see Section 2.2.2 for more details about methods). These variables were added as fixed effects and the output is given in Table 4.4 (Model A and B).

A comparison of the coefficients for community-level maternal literacy in Table 4.1 Model C and Table 4.5 Model B shows that adjustment for confounders at the community-level makes little difference to the effect estimate for community-level maternal literacy, which changes from 0.30 (95% CI -0.03 – 0.62 P=0.073) to 0.31 (95% CI 0.00 – 0.63 P=0.052). Meanwhile, the effect of community-level higher education remains statistically non-significant (Table 4.5 Model A). The findings suggest that the

community-level variables used in the analysis do not substantially confound the relationship between community-level education and child height-for-age.

4.2.7 The role of community size

The analysis has not specified a minimum sample size of households within communities, because any minimum cut-off would be arbitrary and the model is thought to automatically weight the effect of community-level variables according to community size. However, this has meant that within the 131 communities, some are very small (see Section 4.2.2). To assess whether the inclusion of such communities will influence the results, I repeated the analysis, excluding the 32 communities with less than 20 households (9% of the sample of households), which were all in AP. The reason AP has more small communities than Vietnam is due to differences in sampling methodology, as explained in Section 2.1.2.

The results are given in Table 4.5 in Model C and D and can be compared with Model A and B in the same table. This shows large differences in the size of the coefficients and the strengths of the association for community-level maternal literacy between a model including and excluding the smallest communities. Originally the effect size of this variable on child height-for-age was 0.31 (95% CI 0.00 – 0.63 P=0.052). However, with the exclusion of small communities the effect is stronger at, 0.43 (95% CI 0.07 – 0.79 P=0.019). This suggests that the inclusion of small communities dilutes the effect of community-level maternal literacy.

The analysis was repeated for each country separately to confirm that the results are unchanged (not shown). Despite excluding the smaller communities, the results confirm that community-level maternal literacy remains a non-significant predictor of child height-for-age in AP and a significant predictor in Vietnam.

Table 4.5 Regression output: the effect of community-level education on child height-for-age, among all 131 communities (N=5474) and excluding 31 small communities (N=5059)

	All communities						Excluding small communities					
	Model A			Model B			Model C			Model D		
	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant	-2.651	0.579	0.000	-2.830	0.575	0.000	-3.087	0.634	0.000	-3.224	0.620	0.000
Com-level higher educ. (0-1)	0.254	0.257	0.324				0.363	0.286	0.205			
Com-level mat. lit. (0-1)				0.313	0.161	0.052				0.427	0.182	0.019
Age of child (mo)	-0.004	0.000	0.000	-0.004	0.000	0.000	-0.004	0.000	0.000	-0.004	0.000	0.000
Sex of child (0=F 1=M)	-0.137	0.029	0.000	-0.137	0.029	0.000	-0.124	0.030	0.000	-0.124	0.030	0.000
Age of caregiver (yrs)	0.008	0.003	0.010	0.008	0.003	0.011	0.007	0.003	0.019	0.007	0.003	0.020
Housing quality score	0.261	0.068	0.000	0.263	0.068	0.000	0.276	0.071	0.000	0.279	0.071	0.000
Land ownership (0=N 1=Y)	0.044	0.041	0.280	0.044	0.041	0.279	0.051	0.043	0.232	0.051	0.043	0.233
Adults in household (No.)	0.004	0.009	0.654	0.004	0.009	0.654	0.007	0.009	0.492	0.006	0.009	0.494
Children in household (No.)	-0.049	0.017	0.005	-0.049	0.017	0.004	-0.051	0.018	0.004	-0.052	0.018	0.003
Economic sectors (No.)	0.013	0.021	0.542	0.013	0.021	0.538	0.013	0.021	0.533	0.013	0.021	0.530
Country (0=VN 1=AP)	0.123	0.125	0.324	0.237	0.136	0.082	0.266	0.139	0.055	0.371	0.143	0.009
Urbanity (0=rural 1=urban)	0.101	0.142	0.475	0.077	0.137	0.576	0.157	0.157	0.317	0.090	0.155	0.562
Maternal educ. Primary	0.060	0.044	0.177	0.054	0.044	0.227	0.059	0.045	0.192	0.053	0.045	0.242
Secondary	0.068	0.051	0.183	0.060	0.051	0.240	0.064	0.052	0.214	0.057	0.052	0.271
Higher	0.229	0.060	0.000	0.222	0.060	0.000	0.245	0.061	0.000	0.239	0.061	0.000
Paternal educ. Primary	0.022	0.044	0.624	0.019	0.044	0.664	0.019	0.045	0.673	0.017	0.045	0.711
Secondary	0.135	0.048	0.005	0.132	0.048	0.006	0.121	0.050	0.015	0.118	0.050	0.017
Higher	0.212	0.051	0.000	0.213	0.051	0.000	0.199	0.053	0.000	0.199	0.053	0.000
Com-level wealth (0-1)	-0.563	0.198	0.004	-0.610	0.190	0.001	-0.654	0.203	0.001	-0.709	0.194	0.000
Com-level age (mean mo.)	-0.006	0.004	0.107	-0.006	0.004	0.109	-0.007	0.005	0.128	-0.007	0.005	0.158
Com-level sex (0-1)	-0.095	0.249	0.701	-0.164	0.246	0.505	-0.169	0.294	0.567	-0.305	0.293	0.297
Com-level adults (mean No.)	0.066	0.053	0.215	0.080	0.053	0.129	0.027	0.062	0.663	0.063	0.062	0.309
Com-level children (mean No.)	-0.448	0.088	0.000	-0.396	0.091	0.000	-0.461	0.097	0.000	-0.373	0.103	0.000
Com-level age-care (mean yrs)	0.056	0.019	0.004	0.058	0.019	0.002	0.068	0.023	0.003	0.069	0.022	0.002
Com-level sectors (mean No.)	0.160	0.104	0.124	0.126	0.103	0.223	0.275	0.119	0.020	0.188	0.117	0.107
Com-level land own (0-1)	-0.135	0.176	0.443	-0.152	0.172	0.378	-0.026	0.204	0.898	-0.110	0.198	0.577

4.3 Education distribution

So far in this chapter I have shown that community-level maternal literacy is an independent predictor of child height-for-age. The next step in the analysis is to assess whether the distribution of educated adults is also important. In this section I will explain the rationale for examining education distribution, the methods used and the results of the analysis.

4.3.1 Justification for examining education distribution

Rather than mass education, is perhaps children's nutrition more dependent on the education of individuals in the close proximity? It has previously been hypothesised that the education effect is proportional to the distance between the person's dwelling and that of the child in question (Kravdal 2004). One would therefore expect that, on average, the education effect of direct neighbours would be more important for children's well-being than that of those living in a separate part of the community.

Unfortunately no education data are available for children's neighbours, so a proxy indicator is used instead which measures the distribution of educated people within the community. By definition, the greater the spread of educated people within a community, the greater the likelihood that a neighbour will be educated if the percentage of educated people is kept constant. Let us take an example of two villages to illustrate this point, both of which have one third of their population classified as 'educated'. While all the educated people in village A are concentrated in a small number of households, the educated people in village B are evenly distributed among households. In this example the number of people who could benefit from having an educated neighbour is greater in village B than in village A. Education distribution, that is the distribution of educated individuals among households, may therefore be used as a community-level indicator of neighbours' education. An indicator of community-level education which incorporates the distribution of the educated people within the community, should, if the above

speculation is correct, be a stronger predictor of child nutrition than the simple measure of education prevalence.

4.3.2 The measurement of education distribution

Two methods for measuring education distribution

In Chapter 2 I summarise the methodological theory proposed by Basu and Foster (1998), and developed further by Gibson (2001), to calculate a community literacy rate that takes account of the intra-household sharing of literacy services between literates and illiterates (the 'intra-household externality' of literacy). One useful feature of the method is the categorisation of women into three groups:

- literate women
- illiterate women living with at least one literate adult
- illiterate women who live only with other illiterate adults

This categorisation can be applied to the YL data-set. Literacy data are available for mothers but not for other household members. Mothers will thus be categorised into the following groups:

'Literates':	Any mother who self-reports being able to read and write without difficulty
'Proximate literates':	Any illiterate mother (who cannot read and write without difficulty) who lives with at least one adult who has completed higher education
'Isolated illiterates':	Any illiterate mother who lives only with adults who have not completed higher education

Once each woman has been categorised into one of these three groups, the education distribution variable can be measured at the individual- or community-level:

1) Individual level: the above categorical variable (illiterate, proximate literate, literate) will be in the regression analysis instead of the original education variable (none, primary, secondary, higher).

2) Community-level: the proportion of mothers in the community who are either 'literate' or 'proximate literate' is calculated. This variable is thus a measure of community-level maternal literacy which takes into account the intra-household externality of education.

4.3.3 Crude association

The crude association between child nutrition and individual-level education distribution is given in Figure 4.3. It shows the mean height- and weight-for-age z-score of children with illiterate, proximate literate or literate mothers. The relationship is positive and linear, and the confidence intervals between children with illiterate and proximate literate mothers do not overlap, which suggests children with proximate literate mothers have a nutritional advantage over the isolated illiterates. The wider confidence interval for the proximate literates is due to a smaller sample size of mothers in this category compared with literate and illiterate mothers.

The crude association between child nutrition and community-level education distribution is given in Figure 4.4. It shows a positive relationship between child nutrition and community-level education distribution. However, the figure is very similar to the scatter plot in Figure 4.2, which shows the crude association between child nutrition and community-level maternal literacy, a variable that does not take into account the distribution of educated people within the community. Similar patterns are expected given that one variable is essentially a function of the other (see Table 2.3 for further details on how these variables were created). Multivariate regression analysis is therefore necessary to account for confounders and thereby assess the difference between the two variables in their ability to predict child nutrition. If the community-level education distribution variable can explain a greater amount of variation in child nutrition than the community-level maternal literacy variable, then this would suggest that the distribution of educated people is an important determinant of child nutrition.

Figure 4.3 The mean height- and weight-for-age z-score (and 95% confidence intervals) for children of mothers who were illiterate, proximate literate and literate

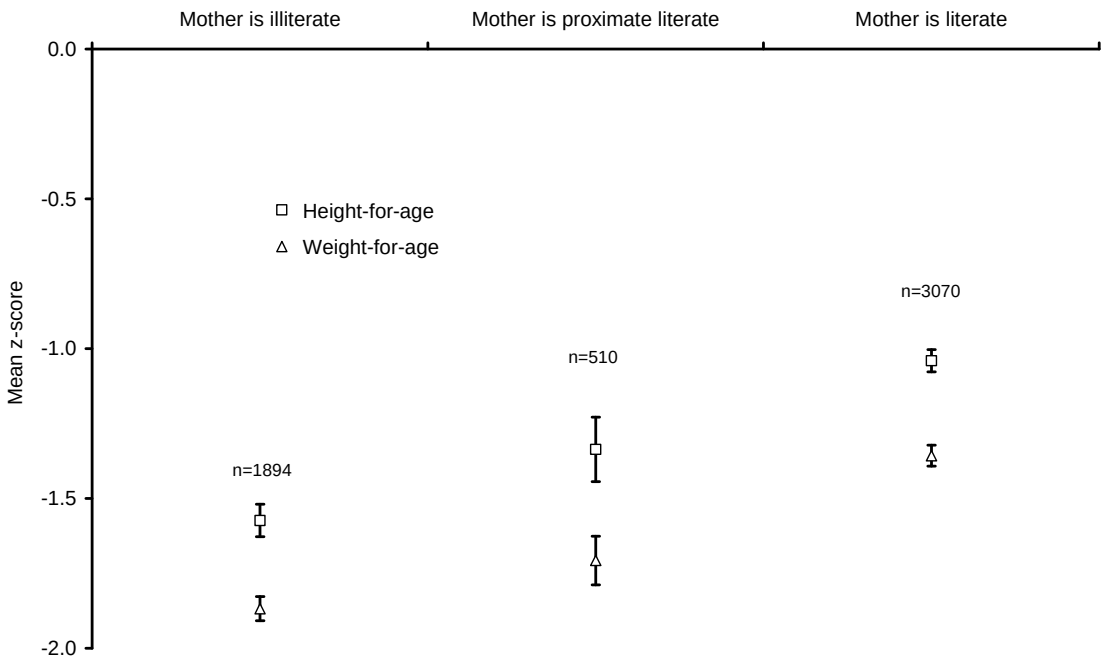
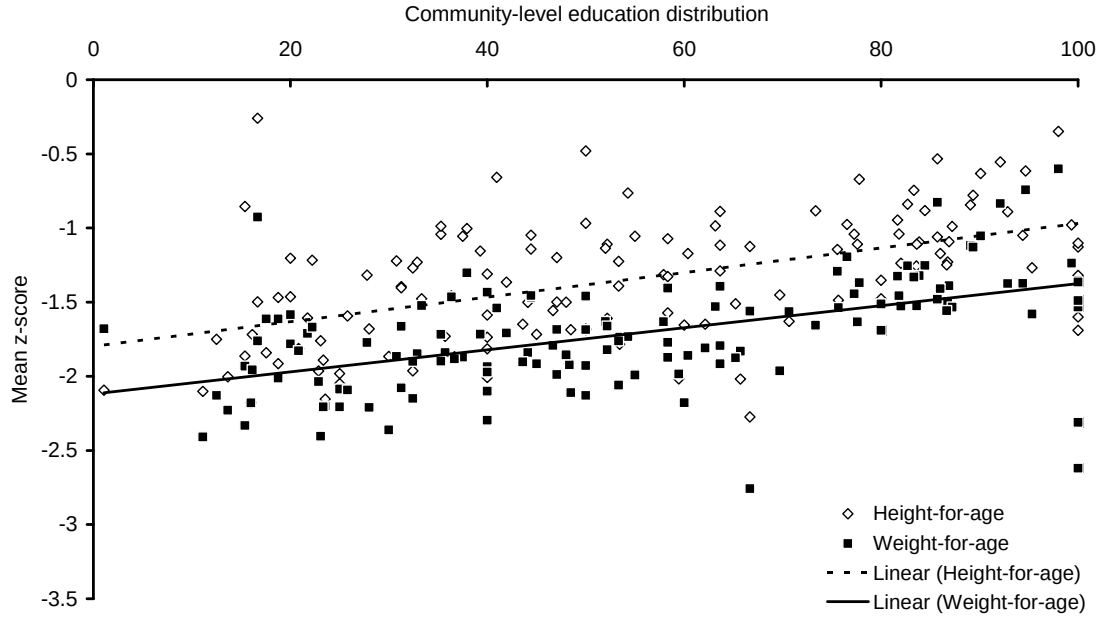


Figure 4.4 A scatter diagram of the mean height- and weight-for-age z-score per community by community-level education distribution expressed as a percentage (N=131)



4.3.4 Adjusted association

I have shown that there are important differences between countries in the effect of community-level maternal literacy, with the effect being strong in Vietnam and small and statistically non-significant in AP (Section 4.2.5). I have also shown that the inclusion of small communities in the sample dilutes the overall effect (Section 4.2.7). Therefore, for the analysis in this section, I will stratify the result by country and exclude small communities. I will continue to use height-for-age as the nutrition indicator of interest as there is no evidence to show that weight-for-age is associated with community-level education.

Firstly I will explore the effect of individual-level proximate literacy. The results are given in Table 4.6, excluding communities with less than 20 households. The results show that there is no effect of mothers' proximate literacy on child nutrition, thereby suggesting that the crude association shown previously in Figure 4.3 disappears once confounders are controlled. However, there are important problems with this analysis. Proximate literacy is highly correlated with paternal education because an illiterate mother can only be considered a proximate literate if she lives with at least one other adult in the household (typically the husband) who is educated to the higher level. It is therefore likely that including paternal education in the model reduces the effect of proximate literacy because the two variables are highly correlated. To assess whether the results presented in Table 4.6 are confounded by paternal education, the paternal education variable was excluded from the model and the regression re-run. The results show that in both Vietnam and AP the effect of proximate literacy increases but nevertheless remains statistically non-significant (0.10 95% CI -0.05 - 0.18 P=0.149 and 0.22 95% CI -0.07 - 0.37 P=0.286 respectively). The results suggest that there is no additional benefit on child nutrition of illiterate mothers living with highly educated individuals. One possible reason for this is that a positive finding is out-weighed by the potential negative effects of having an illiterate mother living with at least one highly educated adult. As most families are nuclear, the highly educated adult would refer to the husband. Although the proximate literacy variable aimed to capture the externality of

education within a household, such a large imbalance in parental education and literacy (an illiterate mother and highly educated father) may also represent low female autonomy associated with negative impacts on child nutrition (Section 1.3.2). I conclude that the individual-level proximate literacy variable is an inappropriate measure of the distribution of education within the community because it is affected by issues related to female autonomy, which are not dealt with in this study. Instead I will focus on the community-level variable, which has the added benefit of being more comparable to community-level maternal literacy. While the latter is a straightforward proportion of literate mothers, the former is both the proportion of literate mothers and the proportion of proximate literate mothers in the community.

The results show that community-level education distribution has a positive effect on height-for-age in Vietnam (0.82 95% CI 0.30 – 1.31 P=0.002) but is statistically non-significant in AP (0.34 95% CI -0.19 - 0.86 P=0.206) adjusting for parental education and other confounders.

The results in Table 4.5 can be compared with the results in Table 4.3 to assess the difference in effect between community-level maternal literacy and community-level education distribution in Vietnam, these are identical indicators except that the latter accounts for the distribution of educated individuals. Community-level maternal literacy has a strong positive effect on child height (0.80 95% CI 0.29 - 1.31 P=0.002) and the indicator that accounts for the distribution of education has a similar effect (0.82 95% CI 0.30 – 1.31 P=0.002). The coefficients suggest that the distribution of educated individuals within the community has little additional impact on child nutrition.

As I have now established that there is no difference between the two indicators in their effect on child nutrition in Vietnam, I will undertake no further exploratory analysis using the community-level education distribution variable.

Table 4.6 Regression output: the effect of education distribution measured at the community and individual level (proximate literacy) on child height-for-age in Vietnam and AP, only including the 99 communities with minimum sample size of 20 households (N=5474)

		Vietnam						AP					
		Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant		-1.923	0.236	0.000	-1.419	0.138	0.000	-2.028	0.201	0.000	-1.941	0.173	0.000
Com-level educ. Dist (0-1)		0.819	0.263	0.002				0.339	0.268	0.206			
Maternal lit.	Proximate lit.				0.109	0.146	0.456				0.051	0.086	0.552
	Literate				0.217	0.055	0.000				0.212	0.078	0.007
Age of child (mo)		-0.005	0.001	0.000	-0.005	0.001	0.000	-0.004	0.001	0.000	-0.004	0.001	0.000
Sex of child (0=F 1=M)		-0.154	0.034	0.000	-0.152	0.034	0.000	-0.089	0.051	0.079	-0.087	0.051	0.089
Age of caregiver (yrs)		0.001	0.003	0.856	0.001	0.003	0.682	0.018	0.006	0.001	0.019	0.006	0.001
Housing quality score		0.187	0.083	0.025	0.187	0.084	0.025	0.286	0.110	0.010	0.300	0.110	0.006
Land ownership (0=N 1=Y)		0.005	0.053	0.918	0.002	0.053	0.975	0.066	0.065	0.305	0.065	0.065	0.317
Adults in household (No.)		-0.001	0.012	0.932	-0.002	0.012	0.841	0.021	0.015	0.149	0.023	0.015	0.130
Children in household (No.)		-0.047	0.022	0.033	-0.046	0.022	0.035	-0.071	0.028	0.010	-0.074	0.027	0.007
Economic sectors (No.)		0.024	0.021	0.254	0.021	0.021	0.326	-0.017	0.046	0.711	-0.015	0.046	0.736
Urbanity (0=rural 1=urban)		0.202	0.150	0.180	0.311	0.164	0.059	0.028	0.169	0.870	0.169	0.141	0.231
Maternal educ.	Primary	0.109	0.053	0.039				0.088	0.092	0.338			
	Secondary	0.202	0.060	0.001				0.023	0.090	0.800			
	Higher	0.399	0.072	0.000				0.306	0.096	0.002			
Paternal educ.	Primary	0.041	0.050	0.411	0.104	0.052	0.044	-0.055	0.084	0.510	-0.064	0.084	0.443
	Secondary	0.066	0.061	0.281	0.204	0.058	0.000	0.111	0.087	0.203	0.087	0.087	0.317
	Higher	0.174	0.077	0.024	0.430	0.066	0.000	0.079	0.079	0.316	0.090	0.084	0.282

4.4 Summary and discussion

4.4.1 Summary of findings

I examined the effect on child nutrition of community-level education using two indicators: community-level maternal literacy and community-level higher education. The crude analysis suggests that there is a strong positive effect of both indicators on child nutrition. This effect diminishes once parental education is adjusted for. Although the effect on height remains statistically significant for community-level maternal literacy, any hint of an effect of community-level higher education disappears altogether once adjustments are made for confounders. There is no effect of either indicator on weight-for-age once confounders were controlled. The role of community-level maternal literacy on child height was examined further by country, providing evidence to suggest that the effect is strong in Vietnam and small and statistically non-significant in AP. Other community-level variables appear not to confound the relationship substantially. Excluding communities with sample sizes below 20 households led to an overall increase in the size and significance of effect, although it remained statistically non-significant in AP. The analysis also showed that children of educated parents are more likely to benefit from community-level maternal literacy than children of uneducated parents. Put in a different way, parental education has a stronger effect on nutrition in communities where the general level of maternal literacy is high than in areas where literacy is relatively low. There is no evidence of community-level maternal literacy confounding the effect of parental education on child nutrition.

In the second part of the chapter I explored the role of education distribution. I used two indicators of education distribution: one at the individual-level and one at the community-level. The results suggest that there is no effect of the individual-level proximate literacy variable on child nutrition. However, conceptual and statistical difficulties with the use of this variable have led me to focus on the community-level variable to examine the role of education distribution. A comparison between community-level maternal literacy and community-level education distribution showed little difference in their effect on child nutrition. This suggests that an

indicator which accounts for the distribution of educated individuals does not explain any more variation in child nutrition than the conventional measure.

4.4.2 Implications of findings

The results suggest that an individual-level perspective in the study of adult education for child nutrition may not capture the full effect of education and literacy. Although the mechanisms underlying the relationship between child nutrition and community-level maternal literacy are not known, one may speculate that children benefit from having literate neighbours, either because they help with childcare, pass on health knowledge to the mother or exert positive influences upon mothers' care-giving behaviour.

Not many studies have used multi-level modelling techniques to examine the effect of community-level education on child nutrition adjusting for parental education and other confounders. However, the findings from these few studies have pointed towards the independent role of community-level education (see Section 1.4.2 for a full review of the literature). The findings presented here suggest that an individual-level perspective may fail to capture the entire impact of education, because there are benefits of the education of others in the community beyond that of the parents' own education. Similarly, in the previous chapter I concluded that a narrow focus on the mother-and-child pair would overlook the important contribution of other household members' education to child nutrition. In this chapter, having expanded the analysis further, I again conclude that future research needs to expand the focus from mothers to these 'influential others' – family, friends or neighbours.

In this chapter I have shown a strong effect of community-level maternal literacy, whereas no observable effect was found for community-level higher education once confounders were controlled. It is important to speculate on the reasons for this difference in effect between the two indicators – one based on maternal literacy and the other based on the prevalence of 'higher' education in all adults. Perhaps it is literacy rather than formal education within the community that matters for child nutrition because the sharing of literacy services can easily benefit surrounding illiterates, more so than other school-based attributes such as self-confidence and

status. Others have also argued that literacy underlies the spill-over effect of education (Basu, Narayan et al. 2001). No data were available for paternal literacy, which is needed in order to assess the role of female versus male literacy within the community. However, in Chapter 9 I will explore the role of women's communication network – their sex, education and location – which will enable further conclusions to be drawn about the role of these 'influential others' and the identification of characteristics (such as sex) which matter most (Kravdal 2004). Kravdal's study in India showed that it was the general educational level among women that is important, not the educational level among men.

The sharing of health knowledge between literates and illiterates is one possible mechanism by which community-level maternal literacy benefits child nutrition. Literate women are more likely to comprehend health messages than illiterate women, and these messages may be passed on through word of mouth. The mediating role of health knowledge has been much discussed in the relevant literature in recent years and will be explored fully with regards to maternal education in Chapter 5. No data is available on the sharing of childcare duties between women in the community, or other ways in which literate women may influence the care behaviour of illiterate mothers. In addition to the transmission of knowledge and attitudes, Kravdal hypothesises that community-level education may affect the quality of health-care institutions, the prevalence of potentially fatal infectious diseases and the imitation of behaviour. Clearly further research is necessary to explore the mechanisms that underlie the role of community-level education.

I have hypothesised that the distribution of education is an important determinant of education over and above the absolute prevalence of education. It seems plausible that the externality of education would increase with the wide dispersion of educated individuals, so that a concentration of educated individuals would reduce the externality because fewer uneducated people would be proximate – and hence 'exposed' – to educated people. In this chapter I have furthered the methods used by Basu and Foster (1998) and Gibson (2002) by applying multi-level modelling techniques. I used both an individual-level indicator (proximate literacy) and a community-level indicator (community-level education distribution).

Conceptual and methodological difficulties with the individual-level indicator led me to focus on the community-level indicator. A comparison was made between two indicators of community-level education – one which accounts for education distribution and one which does not. The effect of both indicators was strong in Vietnam, but statistically non-significant in India. The results suggest that there is no additional benefit of education distribution over and above the absolute prevalence of maternal literacy in the community. It is possible that the planned economy of Vietnam, and the traditionally strong social integration within communes, means that the clustering of educated people within households is of less importance. It is difficult to comment on this without further in-depth understanding of neighbourhood networks within communes in Vietnam. Although the findings here present no evidence to suggest that an equitable distribution of education is important, further research would be necessary to draw any firm conclusions about the importance of education-distribution for child health and nutrition, for example by using a measure of the variance of individual education within a community or the gini-coefficient (Vinod, Wang et al. 2001).

Approximately 10% of mothers reported that they had not lived in the community for the entire lifetime of their child (be it 1 or 8 years). I therefore make the assumption here that such as small proportion is unlikely to introduce bias in the results. Migration is an important issue to consider in any community-level analysis of nutrition. Child nutritional status is dependent on their diet and health throughout their lifetime, which themselves are a result of factors further back in time. If the family has moved in that period it is not plausible that community-level factors, such as education, may play a role in determining nutritional status.

The community-level variables may be failing to capture the aggregate effect of education because the geographical determination of community is inappropriate. The issue of ‘community’ definition has been mentioned in previous studies. Kaplan, for example, asks whether a ‘community’ has any phenomenological identity, whether the inhabitants believe they are part of this community, or whether that actually matters (Kaplan 2004). It may be that the level of conceptualisation of the construct does not always match the level at which it is practically measured (Boyle and Williams 1999; Macintyre, Ellaway et al. 2002; Diez Roux 2004). The definition of

'community' may explain, at least in part, the stronger impact of community-level education found in Vietnam than in AP, although these between-country differences were also shown for household-level education in Chapter 3. There are important differences between Vietnam and AP in social structure and study methodology. In Vietnam, a community was defined as a 'commune', which commonly has its own local government, primary school, commune health centre, post office and a market, and with an average population of 7000 people (Tuan, Lan et al. 2004). Despite the economic transition of the last 20 years Vietnam's social structure is still largely influenced by the socialist planned economy. India's social Organization, on the other hand, is less structured. The YL definition of a 'community' in AP yields more diverse groupings, with villages of varying sizes being defined as separate communities, and administrative borders being used to collate smaller hamlets. Variations in the sampling methodology reflect the underlying societal differences, but this may cause statistical problems due to the unevenness in the number and size of the communities sampled. The small number of observations in some of AP's communities provide an inaccurate assessment of community-level education, which explains the sharper overall effect observed when the smallest communities were excluded from the analysis.

The assumption is made that the community-level variables, which are derived from the data on the individuals who live within the community, capture a community-level property that is more than the summary of individual properties. Therefore, when discussing the derived community-level education variables we need to examine the measurement of education of the individual. In this study no attempt was made to weight or assign scores to each of the four levels of individual-level education, for example 1,2, 3 and 4 for 'none', 'primary', 'secondary' and 'higher'. This was done deliberately to avoid making assumptions about the relative 'value' of each level of education, the drawback being that it was impossible to calculate the mean degree of education per community. Instead two binary definitions were used to classify an 'educated' mother, which were then aggregated to form the community-level education variables. Given that the results of the previous chapters have shown an incremental increase in the education effect on nutrition by level of schooling completed, such a binary classification may be insufficiently sensitive in capturing

community-level education effects and may explain why no effect was observed for community-level higher education.

I have attempted to account for the potentially confounding effect of community-level variables. It is likely, for example, that the availability of hospitals and health centres positively confounds the relationship between education in the community and child nutrition because educated people tend to live (or migrate to) areas with adequate service provision, services known to benefit child health and nutrition. It is also possible that services lie on the causal pathway between community-level education and child nutrition, an educated population may increase the demand for public investment in health and education facilities. Although data on local service provision was not available for analysis, the inclusion in the model of other community-level variables that aimed to capture the general socio-economic standard made little difference to the effect of community-level maternal literacy. Further research is necessary to determine the role of community-level services and other factors in mediating or confounding the effect of community-level education (Escobal and Torero 2002).

4.4.3 Next steps

Thus far I have demonstrated the important role of the education of various household members and of the community as a whole. The results raise the questions: Who are these 'influential others'? What are the mechanisms by which their education has an impact upon children's nutrition? The next step is therefore to explore the characteristics of women's communication networks – the people with whom she speaks to the most – and the effect of these characteristics on child nutrition. Also, further research is necessary to explore causal pathways. In the last two chapters it has only been possible to speculate about the ways in which these household- and community-level education effects operate. The next step is to examine potential mechanisms which underlie these relationships. The rest of the thesis will use data from the Knowledge and Networks Study to explore potential mediators of the maternal education effect, such as her knowledge of health and nutrition and her ability to communicate. The aim is to paint a picture of adult education for child nutrition that challenges the individualistic approach to the study of child nutrition by

attempting to uncover the inter-relationships between mothers and their families, friends and neighbours; inter-relationships which in turn have a bearing on child nutrition.

CHAPTER 5

THE ROLE OF MATERNAL HEALTH AND NUTRITION KNOWLEDGE: A REVIEW OF THE LITERATURE

This chapter is split into four sections. In the first section I outline the specific research questions. In the second section I describe the methods of the literature search; in the third section I present the results. Finally, in the fourth section, I discuss key emerging themes in the light of previous research.

5.1 Research questions

The specific research questions of the literature search are:

1. What are the determinants of mothers' health and nutrition (HN) knowledge in India?

The literature search is limited to studies in India because this is the location in which the Knowledge and Network (KN) study was undertaken. I hypothesize that the determinants of mothers' knowledge are likely to be context-specific. For this reason I have narrowed the search to capture studies conducted in India rather than the whole world, nevertheless recognizing that India is a large and diverse country. Narrowing my search further to Andhra Pradesh state would have substantially reduced the number of studies eligible for inclusion.

2. Does maternal HN knowledge mediate the effect of maternal education on child nutritional status?

The second question aims to capture studies undertaken in any country because an exploratory search suggested that no such study has been undertaken in India.

5.2 Method

5.2.1 Inclusion criteria

The inclusion criteria used to select studies for review are outlined in Table 5.1.

5.2.2 Identifying data

Electronic databases were systematically searched to identify published data. The search was undertaken in October 2004. The names and description of the databases used, the search terms applied and the number of hits identified for each question are provided in Table 5.2. Search terms were selected by searching the MeSH thesaurus of the National Library of Medicine using the Popline keyword guide and by hand-searching relevant articles to determine standard keywords. Inclusion criteria were pilot tested on a sub-sample of the studies found, then refined and finalised. The retrieved articles were scanned, first by title only (thereby excluding articles with noticeably irrelevant titles) and then by title and abstract. Suitable articles were selected and obtained from London libraries. A cited reference search (Web of Science) was conducted for the selected articles in order to identify further studies. Additional references were retrieved by checking the cited references in each selected article.

Table 5.1 The inclusion criteria for studies selected

	Inclusion criteria
Language	English
Publication date	1980 -
Location	India (q.1), worldwide (q.2)
Publication status	Published in peer-reviewed journal and available from a library in the UK
Study design	All
Subjects	Mothers and children
Methods	Any method that adjusts for confounding
Definition of HN knowledge	Quantitative or qualitative assessment of individual mothers' knowledge of nutrition and/or health in general
Definition of education*	Formal schooling, individual measurements
Definition of nutrition*	Anthropometric indices, individual measurements

* for question 1 only

Table 5.2 Data bases, search terms and hits for searches conducted in October 2004

Data base	Search expression and hits Question 1	Question 2
Pubmed: Medline, 1966-, (updated monthly). The standard general medical database; it covers 4,300 journal titles in clinical and laboratory medicine and non-clinical aspects of health care; now also available free as PubMed on the Internet (www.ncbi.nlm.nih.gov/entrez/query.fcgi).	('Education'[MeSH] OR 'Educational status'[MeSH]) AND ('Knowledge'[MeSH] OR 'HN knowledge, Attitudes, Practice'[MeSH]) AND ('Nutrition'[MeSH] OR 'Nutritional Status'[MeSH] OR 'Growth'[MeSH]) = 528 hits	('Knowledge'[MeSH] OR 'HN knowledge, Attitudes, Practice'[MeSH] OR belief OR beliefs OR attitude) AND ('Nutrition'[MeSH] OR 'Nutritional Status'[MeSH] OR 'Growth'[MeSH]) AND India = 224 hits
Embase: 1980-, (updated weekly). The European equivalent of Medline but with a stronger emphasis on European medical journals; about 3,500 journals.	knowledge and (education or educational status) and (nutrition or nutritional status or malnutrition or growth) = 657 hits	(knowledge or belief or beliefs or attitude or attitudes) and (nutrition or nutritional status or malnutrition or growth) and India=41 hits
*Web of science*s: - Index to Scientific and Technical Proceedings, 1982- (updated monthly); gives details of papers presented at over 4000 conferences per year and their subsequent publication; multidisciplinary. - Scisearch, 1981- (updated weekly); covers about 4000 journals from the whole range of sciences; abstracts available; offers citation searching.	(education OR educational status) AND (nutrition OR nutritional status OR malnutrition OR growth) AND (knowledge OR knowledge sources) = 415 hits	(nutrition OR nutritional status OR malnutrition OR growth) AND (knowledge OR knowledge sources OR belief OR beliefs OR attitude OR attitudes) AND India = 55 hits
Popline 1970-, (updated quarterly); covers literature on population, reproductive health, family planning, fertility etc, often derived from unpublished sources.	(knowledge / knowledge sources) & (education / educational status) & (nutrition / nutritional disorders / growth) = 245 hits	(knowledge / knowledge sources / belief / beliefs / attitude / attitudes) & (nutrition / nutritional disorders / growth) & India = 160

5.3 Results

5.3.1 Q. 1: the determinants of maternal HN knowledge in India

The literature search identified four studies for question 1. The large number of initial hits (Table 5.2) was reduced to this small number of studies because the vast majority did not satisfy the inclusion criteria in Table 5.1. I decided not to include further search-terms in the electronic data-base search, which would have reduced the number of initial hits, for fear of missing key articles and preferring instead to screen each article by hand as explained in Section 5.2.2. Summary details are given in Table 5.3. No study was found with a main aim to examine the determinants of maternal HN knowledge in India, so this information was extracted from studies that had a slightly different focus.

Abbi (1988): Socio-economic status is a determinant of HN knowledge

The study by Abbi (1988) in Gujarat is one of the first studies that looks at the relationship between maternal HN knowledge and child nutrition while controlling for socio-economic status. He measures HN knowledge with a score (0-9) based on 9 questions about weaning, diet during diarrhoea, management of diarrhoea, awareness of ORS, causes and treatment of PEM, interpretation of growth charts and perception of own child's nutritional status. The results showed that the maternal HN knowledge score has a statistically highly significant effect on all child nutrition indices ($P<0.001$), although differences were found between each HN knowledge component. Household socio-economic status, measured by per capita monthly income, was a significant confounding variable for the effects of various aspects of HN knowledge on WAZ and HAZ (the exception was the knowledge of ORS preparation). I cannot assess the degree and direction of confounding because the results were not presented fully, only summarised in the text. The authors conclude that unless mother's economic status improves simultaneously with HN knowledge women may not be able to practise what they know, but that it is nevertheless essential to increase their HN knowledge (Abbi, Christian et al. 1988). By identifying socio-economic status as a confounder of the knowledge – nutrition relationship, this study is included in this review as it indirectly

asserts that socio-economic status is a determinant of HN knowledge. The importance of socio-economic status in determining mothers' HN knowledge is explored further 3 years later by Ruel in Lesotho (1991), a study which will be reviewed in the next section (5.3.2).

Kutty (1989) : no effect of education on HN knowledge

Kutty's study (1989) in Kerala explores the HN knowledge of 78 women. HN knowledge is assessed by field investigators reading 50 statements, 10 on each of the following topics: awareness of child health status (which probed respondents' awareness of how child survival potential had improved in Kerala), breastfeeding and care during child birth, care of sick children, concepts about the appropriateness of artificial feeding, and immunization. These include positive and negative statements, and mothers were asked to respond as 'agree', 'disagree' or 'don't know'. The 78 mothers were split into two groups of 39 according to schooling of below 10 years or at least 10 years. The results showed that there was no difference in HN knowledge between the two education groups. However, the authors are cautious about concluding that there is no relationship between women's HN knowledge and education and raise the issue of 'sensitivity' and 'specificity' to the kind of questions that were asked. They argue that the questions asked were not sufficiently specific to distinguish between women who felt strongly positive towards these aspects compared to women with less positive attitudes. The study also showed that husbands' education positively changes mothers' attitudes towards immunization, but exerted little influence on other knowledge areas. However, as the authors themselves point out, it is likely that husbands' education acts as an indicator of household income because the study did not otherwise adjust for socio-economic status (Kutty 1989). This suggests that there is potential effect-modification by household socio-economic status of the relationship between maternal HN knowledge on child nutrition, a finding replicated by Ruel (1992).

Gupta et al. *(1991): no effect of education on HN knowledge*

Gupta et al. (1991) conducted a study in a poor Muslim area of New Delhi. It was a case-control study nested within a larger longitudinal study. Twenty-six severely malnourished

children (<60% weight for age median) were matched with 26 normally nourished children by age, sex and income. Mothers' KAP scores (Knowledge, Attitudes and Practice) were compared between the two groups and assessed by asking 37 questions carrying one mark each. The questionnaire included questions about the nutritional requirements of children, the nutritional value of foods, growth monitoring, ORS, immunization, breastfeeding and weaning. During analysis only the results of 14 questions were used but the choice of questions is not made clear, nor its justification. Despite the small sample size, this study showed that women with malnourished children have a lower KAP score than women with normally nourished children, both among the literate ($P<0.05$) and the illiterate mothers ($P<0.01$). The study found that education did not significantly affect the nutritional KAP of mothers. The authors state in the text that the difference in KAP scores of literate and illiterate mothers was not statistically significant for mothers of neither malnourished nor normal children, but they do not present the exact results that led to this conclusion. It is worth considering the possibility that the small sample size of the study may explain the absence of an observable difference between the education groups.

Sivaramakrishnan and Patel (1993): the cultural determinants of HN knowledge

The authors explore the role of traditional belief systems (Sivaramakrishnan and Patel 1993) by examining women's reasoning about the cause and treatment of three types of childhood PEM in rural South India. Mothers were interviewed and their answers assessed using cognitive analysis methods. The paper provides a good summary of the two main health systems in India. The ancient holistic system of Ayurvedic medicine co-exists with modern medicine and makes a substantial contribution to health care. Within the Ayurvedic system there exist many folk traditions of local health care practices that often involve the use of home remedies for the treatment of diseases. The philosophy underlying these systems of medicine is different from the theories of modern medicine. In the traditional view health is order and disease is disorder, so that a focus is on the restoration of an equilibrium and the patient is treated holistically. From the biomedical point of view however, disease is interpreted in terms of pathophysiology and the focus is on correcting the physiological and biomedical conditions that cause symptoms of

disease. The study examines the way in which this dual framework for HN knowledge and dietetic practices influences the conceptualisation of the cause and treatment of various childhood nutrition deficiencies. Mothers were interviewed and the explanations of childhood diseases were verbally recorded, transcribed and analysed using cognitive methods of analysis. The role of education was examined. The results showed that the explanations given by uneducated mothers relate to the interpretation of the traditional Ayurvedic systems of health and disease practiced in India. Educated women, however, tended to use more biomedical terms in their explanations, but their underlying thinking about the causes of disease and health were fundamentally based on traditional beliefs. In short, there is little difference between educated and uneducated women in their health beliefs.

Short description of excluded studies

Many studies about women's HN knowledge have been published in Indian journals, particularly the Indian Journal of Paediatrics, but were excluded from the review because they did not satisfy the methodological criteria of adjusting for confounding. A large number of studies were purely descriptive, aiming to gather information on the HN knowledge of a particular group of mothers in a certain setting [for example (Khan, Ansari et al. 1985; Bahl and Kaushal 1987; Singhal, Taneja et al. 1989; Pant and Chothia 1990; Subbiah 2003)]. Common topics of assessment were knowledge about the nutritional value of breast milk and colostrum, timing of introduction of complementary foods, frequency of feeding and duration of breastfeeding, and feeding during diarrhoea. Other studies which aimed at exploring traditional beliefs of feeding (Arora, Singh et al. 1985; Kapil, Sood et al. 1990; Sharma and Thakur 1995) were excluded from the review because they did not explicitly examine determinants of HN knowledge. Kapil (1990) for example notes that some foods were preferred while others were resisted during episodes of illness, depending upon the 'hot' and 'cold', 'light' and 'heavy' characteristics. 'Cold' foods like curd and butter milk were restricted during an episode of cough while 'hot' foods like tea and ginger with honey, were preferred. During diarrhoea 'light' foods like *khichri*, diluted milk were preferred while 'heavy' foods like undiluted milk and *roti* were restricted. The study by Saitu (1997) is similar to others excluded from the review

because it simply examines the effect of maternal HN knowledge on child nutrition, without exploring the determinants of HN knowledge in any way (Saito, Korzenik et al. 1997).

5.3.2 Q. 2: HN knowledge as a mediator of education effect on nutrition

The literature search identified three papers that satisfied the inclusion criteria for question 2. Summary details are given in Table 5.3. All studies recognised the problem of 'endogeneity' of HN knowledge. This issue will be discussed in depth in Chapter 8, which will also explain the methods used by the authors to overcome this problem.

Ruel et al. *(1992): the mediating effect of HN knowledge depends on household socio-economic status in Lesotho*

Since the early 1990s further studies have been conducted, all outside India, specifically aiming to explore the potential role of HN knowledge in mediating the effect of education on child nutrition. The study by Ruel et al. (1992) in Lesotho has been much cited, not only as evidence for the mediating role of HN knowledge, but also as one of the earliest studies to show an interaction between HN knowledge and wealth in their impact on child nutrition (Ruel, Habicht et al. 1992). In this study HN knowledge is measured by asking mothers 50 questions about breastfeeding, timing of introduction of complementary foods, ORS, and withholding food during episodes of diarrhoea, that gave a score of 0-50. A binary education variable is created with a cut-off set at the completion of primary school. The results are stratified by wealth group to examine whether maternal schooling is equally important for poorer and wealthier households and whether the effect is mediated by HN knowledge in both groups. The results show that among the wealthier households, the association between maternal education and child nutritional status is mediated by HN knowledge. Meanwhile for poorer households, HN knowledge is not associated with child nutritional status, although maternal education does have a large and statistically significant positive effect. The findings suggest that HN knowledge acts as an intermediary variable between women's education and children's nutrition among wealthier households, but not among the poorer households.

Glewwe (1999): HN knowledge explains the education effect in Morocco

Glewwe's study in Morocco (1999) has also been highly cited because it provides an in-depth analysis of the mechanisms underlying the relationship between maternal education and child nutrition. He uses cross-sectional data for 1495 mother-child pairs, where children's ages ranged from 0 to 5 years. Multivariable analysis was used to adjust for child age and sex, land ownership, irrigation and parental height. The author identified three pathways through which education may influence child nutrition: first, formal schooling may directly transfer HN knowledge to future mothers; second, literacy and numeracy skills acquired in school may help mothers diagnose and treat their children; and third, an increased familiarity with modern society so that, through schooling, women become more receptive to modern health messages. Glewwe shows that mother's HN knowledge alone appears to be the crucial skill in improving children's nutrition. Moreover, he suggests that this HN knowledge is not obtained directly in school, but outside the classroom using skills acquired in school. He demonstrates this by showing that schooling alone has no contribution and may in fact have a negative effect (due perhaps to the reduced time spent at home for girls in school). He argued that children in Morocco are rarely taught about health and nutrition in school, but that they learn how to read and write, how to listen to people in authority and they gain self-confidence. All of these skills, he hypothesises, help children tap into sources of information outside school such as the mass media, health professionals or other people in their neighbourhood. Glewwe's study is important, not only because he confirms that HN knowledge is a crucial skill for improving child nutrition, but also because he argues that skills gained in schools help mothers diagnose and treat child health problems through the acquisition of HN knowledge outside school. The author draws a useful distinction between knowledge that is acquired though an individual's own initiative and experience, and the type of HN knowledge and perceptions that are more commonsensical and based on traditional beliefs and customs.

Kovsted et al. *(2002): HN knowledge explains education effect in Guinea Bissau*

The most recent study included in the present review of literature is by Kovsted et al. (2002) and took place in Bissau, the capital of Guinea Bissau (Kovsted, Pörtner et al.

2002). Kovsted examines the effect on two outcomes – child height-for-age and mortality – but only height-for-age will be considered here because mortality is an outcome excluded from the present review. The authors analyse cross-sectional data taken from a larger longitudinal study. Mothers' HN knowledge is measured by asking a single question about malaria, and multivariable regression analysis is conducted to adjust for maternal and child characteristics and fathers' education (the latter is used as a proxy for family income). The results show that HN knowledge mediates the effect of education on child nutrition: if HN knowledge is not included in the model, maternal education (measured as years of education) is a highly significant predictor of height-for-age z-score (-0.40, $P<0.05$), but once HN knowledge is included in the model the effect diminishes (-0.17, P=NS).

The three studies reviewed for question 2 demonstrate some similarities and differences. They are similar in the study design, all being cross-sectional, but different in the way they measured HN knowledge. For example, while Kovsted uses only one question about malaria, Ruel uses 50 questions on a range of subjects related to child health and nutrition. The studies and the issues they raise will be discussed further in the next section in the context of other relevant research not included in the review.

Table 5.3 Summary of studies selected for inclusion in the review for question 1 (a) and question 2 (b)

a) Question 1

Study	Setting	Study Design	Sample size	Measure of HN knowledge	Determinants of HN knowledge.	Statistical methods
Abbi et al. (1988)	Gujarat State, India.	Cross-sectional	2618 mothers	Score (0-9) based on 9 questions about weaning, diet during diarrhoea, management of diarrhoea, awareness of ORS, causes and treatment of PEM, interpretation of growth charts and perception of own child's nutritional status.	Socio-economic status	Multivariable regression analysis adjusting for socio-economic status
Kutty (1989)	India, Kerala state	Cross-sectional	78 mothers	50 statements about: awareness of child health status, breastfeeding and care during child birth, care during sickness, and the appropriateness of artificial feeding and immunization. Mothers responded 'agree', 'disagree' or 'don't know'.	Parental education	Stratification by maternal and paternal education
Gupta et al. (1991)	India, poor urban area	Case-control, within a larger longitudinal study	26 matched pairs of malnourished (<60% WAM) and normal children, and their mothers	37 question (14 used in analysis) about nutritional requirements of children, nutritional value of foods, growth monitoring, ORS, breastfeeding and weaning, immunization.	Maternal literacy	Chi-square test of mean HN knowledge scores between mothers (illiterate and literate) of malnourished or normally nourished children, matched by age, sex and income.
Siva-krishnan & Patel (1993)	India, Tamil Nadu state	Qualitative, cross-sectional	108 mothers	Mothers were interviewed and their explanations of childhood nutritional problems were verbally recorded, transcribed and then analysed using cognitive methods of analysis.	Local belief systems	Simple quantitative analysis of frequency of responses and in-depth qualitative analysis using cognitive methods

b) Question 2

Study	Setting	Child age	Study Design	Sample size	Child nutrition outcome used in multivariate analysis	Measure of education	Measure of HN knowledge	Statistical methods
Glewwe (1999)	Morocco: all areas	0-5 yrs	Cross-sectional	1495 mother-child pairs	Height-for-age z-score	Years in school	5 questions, score 0-5 (other types of knowledge also measured). Vaccination, treating infections, polio, diarrhoea and safe drinking water	Multivariable regression analysis adjusting for child age and sex, land ownership and irrigation and parental height. Adjusts for endogeneity
Kovsted (2002)	Bissau, capital of Guinea-Bissau	0-5 yrs	Longitudinal, but data used for analysis is cross-sectional	221 mother-child pairs	height-for-age	Years in school	One question about malaria	Multivariate analysis adjusting for child age and sex, father's education (a proxy for family income) and religion. Adjusts for endogeneity
Ruel (1992)	Rural Lesotho	0-24 mo	Cross-sectional	921 mother-child pairs (0-24mo)	Weight (kg)	Binary: primary school or less, more than primary	50 questions, score 0-50: breastfeeding, timing and introduction of foods into the child's diet, use of ORS, diet during diarrhoea	Multivariate analysis adjusting for family composition, agricultural involvement, sources of income, wealth, environmental conditions, parity, clinical attendance, employment and child age and sex. Adjustment for endogeneity

5.4 Summary and Discussion

5.4.1 Summary

The number of studies selected for inclusion in the review were 4 and 3 for Question 1 and 2 respectively.

An important finding is the lack of evidence for education being a determinant of HN knowledge among mothers in India. Instead maternal HN knowledge appears to be more strongly associated with socio-economic status. There is evidence to suggest that the effect of HN knowledge on child nutrition is greater among mothers with high socio-economic status than among mothers of low socio-economic status. Qualitative research showed that educated women tended to use more biomedical terms in the explanations about health and ill-health, but their underlying thinking was fundamentally based on traditional beliefs, similar to the uneducated women. Overall, the studies in India about the determinants of HN knowledge suggest that education plays a relatively small role in comparison with wealth.

Only three studies directly assessed the role of maternal HN knowledge in mediating the effect of education on child nutrition and were all conducted in Africa. They suggest that maternal HN knowledge may mediate the effect of education and that this is most likely to occur among the wealthier households. No known study has examined the role of maternal HN knowledge in mediating education effects on child nutrition in India. All three studies raised the methodological issue of 'endogeneity' of knowledge, which has not been discussed in this chapter because it will be explored in depth in Chapter 8. The review of the literature raised a number of key themes, which will now be discussed with reference to previous research.

5.4.2 Knowledge in philosophy and public health

The studies reviewed in this chapter have provided examples of different measurements of HN knowledge in terms of the testing instruments used and the subject matter. This variety reflects an uncertainty about what knowledge is and its purpose. A quick reminder would therefore be useful about the roots of knowledge and its meaning in Western philosophy and public health medicine. From the time of Aristotle, and long before him, knowledge has been a well debated concept in Western philosophy, traditionally being defined as a 'justified true belief' (Musgrave 1993). It is argued that knowledge can lead to liberation because '..when a student can adeptly create, retain, understand and use knowledge they are also able to liberate themselves from the bondage of ignorance as well as from the oppression of the 'knowledgeable.' (Cabrera 2002). In that way, knowledge is power (Musgrave 1993). It has also been referred to as a 'global public good for health' (Kaul and Faust 2001), supported by research showing that once a population has acquired a certain level of knowledge, it tends to persist even in situations when health facilities have become paralyzed (Caldwell 1996).

In public health, the study of knowledge often forms part of KAP surveys, which assess individuals' knowledge, attitudes, and practices regarding, for example immunization (Streatfield, Singarimbun et al. 1990) or fertility (Cleland 2001). Knowledge is usually assessed in order to see how far community knowledge corresponds to biomedical concepts, and deviations are often termed 'beliefs' (Good 1994). Investigations into other types of knowledge, such as traditional knowledge, is frequently neglected. Furthermore, the assumption is often made that changing knowledge leads to a change in behaviour. In recent years, however, there has been an increasing recognition that changing knowledge does not necessarily lead to changes in behaviour, and a more ethnographic view of knowledge is emerging, which views knowledge as a cultural belief in itself (Good 1994).

The concept of knowledge has important implications for the debate about its diffusion. When and how can knowledge be transmitted? Bishai (1996) makes a useful distinction

between ‘competence’ and ‘knowledge’. Whereas knowledge is best thought of as information that can be easily transferred from one person to another, for example within a classroom or through reading and speaking to others, ‘competence’ is the ability to apply knowledge appropriately and is much harder to teach. Competence may therefore be an innate ability (Bishai 1996). The difficulties in disentangling women’s skills and identity is discussed throughout this thesis. The main implication is that any study of knowledge must acknowledge the diversity in knowledge types that exist and the implications this has on the instruments used to measure it.

5.4.3 Maternal knowledge about child health

Studies have shown a positive effect of maternal nutritional knowledge on child nutritional status in many different countries, for example in Ethiopia (Christiansen and Alderman 2001), India (Sivaramakrishnan and Patel 1993), Lesotho (Ruel, Habicht et al. 1992), Guinea-Bissau (Kovsted, Pörtner et al. 2002) and Indonesia (Webb and Block 2003). These studies were not included in the review because they did not specifically explore the role of knowledge in mediating the education effect. It is clear that, although HN knowledge is often measured and discussed in the epidemiological literature, the concept of ‘knowledge’ and the mechanisms by which knowledge is believed to impact upon health are rarely made explicit.

In reviewing previous studies on maternal nutritional knowledge, Ruel (1992) notes that mothers were not always tested on topics directly associated with child nutrition. The author cites the CEBU study in the Philippines as an example, which tested mothers on their knowledge of the nutritional values of foods, a topic which is unlikely to directly impact on the breastfeeding and weaning practices of under fives (Bouis and Haddad 1987). It is unsurprising, says Ruel, that no association between mothers’ knowledge and child growth was found in this study (Ruel, Habicht et al. 1992). However, in the chapters to come, I propose a contesting argument. In short, I will propose that mothers’ knowledge about seemingly irrelevant topics may represent a broader understanding and interest in the wider world that, although not directly related to child nutrition, serve to

benefit children because women with such an outlook and awareness are better able to care for their children through other means.

The diversity in knowledge indicators used in previous studies cannot be overstated. One study in Ethiopia for example uses mothers' capability to correctly assess their children's nutritional status (Christiansen and Alderman 2001). Meanwhile the study by Kovsted (2002) reviewed above, uses only a single question about a woman's awareness of malaria (Kovsted, Pörtner et al. 2002). Moursund and Kravdal (2003) use the NFHS of 1998-99 in India to investigate whether differences in women's autonomy explain the relationship between education and contraceptive use. They found that the inclusion of an indicator of mothers' awareness of ORS, AIDS and ways to prevent HIV infection reduced education effects substantially. Such indicators capture modern 'acquired' knowledge, which contrasts with the more traditional common-sense type knowledge often passed from one generation to the next, a distinction also made by Glewwe (Glewwe 1999). It is likely that modern acquired HN knowledge is strongly correlated with women's access to and use of media, and her communication patterns.

5.4.4 Diffusion of knowledge through media and communication

The literature reviewed in this chapter suggests that women obtain knowledge outside school, and Glewwe suggests that one mechanism is speaking to family members. Anthropological demographers have long been examining the role of kinship systems and social interaction for fertility behaviour, although few studies exist on health. 'Communication networks' will in this thesis refer to the group of people that women verbally interact with on a daily basis. They are important in determining women's choices of behaviour because individuals rarely make decisions in social isolation but do so rather in conjunction with others. A number of studies have looked at the diffusion-effect of information about contraceptives and family planning methods (Montgomery and Casterline 1996; Casterline 2001; Cleland 2001; Palloni 2001) or the role of networks as cultural forces that transmit values and reinforce social norms (Kohler,

Behrman et al. 2001). There is a general consensus within this literature that networks are useful for 'social learning' and 'social influence', where social learning refers to the increased acceptance of new approaches through the learning of others' experiences and social influence refers to the normative influences on behaviour, capturing the fact that preferences are affected by the attitudes and behaviours that prevail in the social environment (Foster and Rosenzweig 1995; Montgomery and Casterline 1996; Kohler, Behrman et al. 2001).

The underlying principle of 'diffusion' is nothing new and has, since the 1950s and 60s, been researched within agriculture, anthropology, sociology, geography, communications and marketing (Cleland 2001). Researchers have come to realise that the composition of networks is important in determining the balance of social learning and social influence (Valente, Watkins et al. 1997; Madhavan and Adams 2003). Heterogeneous networks, for example, where members do not know each other well or have different personal characteristics are more likely to provide their members with new information compared with homogenous close-knit networks (Valente, Watkins et al. 1997).

Relatively few studies have examined the role of communication networks in the spread of nutritional knowledge, perhaps because nutritionists and epidemiologists have primarily regarded women in isolation from the surroundings in which they live (Macintyre and Ellaway 2000). Qualitative studies in Thailand and Kenya nevertheless suggest that women talk to each other about family size and family planning (Entwistle, Rindfuss et al. 1996; Rutenberg and Watkins 1997; Kohler, Behrman et al. 2001) and recent studies in Senegal (Aubel, Toure et al. 2004) and Bolivia (Bender, McCann et al. 2000) suggest that grandmothers are important influences on mothers' HN knowledge and behaviour. A study in Pakistan, for example, suggests that mother-in-laws influenced parental decisions about family size (Kadir, Fikree et al. 2003).

Mass media may also provide a channel for the diffusion of knowledge. A recent study of contraceptive use among uneducated women in India draws attention to role of education, networks and media for women's behaviour (McNay, Arokiasamy et al. 2003). The study

provides evidence of diffusion effects, many of which operate at levels beyond the uneducated women's own individual circumstances. For example, they find significant relationships between women's contraceptive use, others' use of contraception and others' education. The study also found that mass media is an important diffusion channel.

It has long been recognised that media has an important role to play in human development and public health. It is commonly used in social marketing campaigns for health promotion in India (Saibaba, Ram et al. 1993). UNICEF has recently introduced the concept of children's 'information deprivation' which, when severe, is defined as the lack of access to TV, radio, telephone and newspapers at home (Gordon, Nandy et al.). Thomas et al. (1991) use data from the 1986 Brazilian DHS to show that almost all the impact of maternal education on child survival and height could be explained by indicators of access to information, such as reading newspapers, watching television and listening to the radio (Thomas, Strauss et al. 1991).

5.4.5 Decontextualized language skills

Decontextualized language skills have been shown to be important for obtaining knowledge through the comprehension of health messages (Snow 1990; Stuebing 1997; Wells 1999; LeVine, LeVine et al. 2001) (this issue was introduced in Chapter 1, Section 1.3.2, and will be discussed further in Chapter 9 and 10). This is a language type which is detached from the speaker and intends to address the information needs of a hypothetical listener, for example the language used in media broadcasts, books and newspapers. The meaning of the message is conveyed in words alone, rather than the vocal inflections and non-vocal cues one often uses in face-to-face conversations. As it is a monolog and therefore lacks feedback from the listener, it becomes important to accurately assess the information needs of the audience and provide relevant information in an efficient and clear manner. Listeners or readers of decontextualized language need to be able to recognise and decode words in order to comprehend messages. Both listeners or readers who are proficient in decontextualized language are able to analyse and revise their own knowledge on the basis of new information they receive (Snow 1990). Even in schools

where there are no books and where the quality of schooling is questionable, it has been shown that children gain experience in analysing and revising their knowledge in the light of new information presented to them (Stuebing 1997). LeVine refer to the INCAP study to argue that this benefit of education can even be achieved from only 3-4 years of attendance in low-quality schools. LeVine argues that girls in developing countries are often exposed to academic language in schools for the first time in their lifetime because their parents are likely to be uneducated (LeVine, LeVine et al. 2001; LeVine, LeVine et al. 2004). By learning to master decontextualized language, educated women have a greater ability to communicate to people in authority than uneducated women. Several studies suggest that because they can express themselves effectively to health workers they are often better treated by them (Joshi 1994; Kaufman and Cleland 1994; Dexter, Levine et al. 1998; Schnell-Anzola, Rowe et al. 2005).

5.4.6 Next steps

The literature reviewed here demonstrates the lack of evidence for the role of HN knowledge in mediating the effect of maternal education on child nutrition. The reason may be rooted in the methods of conceptualizing and measuring knowledge. There is therefore a need to explore different knowledge types in India, their measurement, determinants and effects on child nutrition. Also, more methodological discussion is necessary to address the problem of 'endogeneity' which has been repeatedly raised as an issue in the study of maternal knowledge for child health and nutrition. The Knowledge and Networks study, which will be described in the next chapter, was specifically designed to address these research gaps.

CHAPTER 6

METHODLOGY OF THE KNOWLEDGE AND NETWORKS STUDY

The chapter is divided into three main sections. In the first section I provide the background of the study and its objectives. In the second section I describe the design of the study. Finally, in the third section, I describe the variables and methods used in the statistical analysis.

6.1 Background and objectives

In Chapters 3 and 4 I show that the education of household and community members is important for child nutrition, over and above the education of the mother. The next step is to explore in further depth the mechanisms that underlie the relationship between adult education and child nutrition and the identification of the 'influential others' whose education is important for a child's nutritional status.

The Knowledge and Networks study was specifically designed to explore the role of mothers' health and nutrition (HN) knowledge in mediating the effect of education, because these are potential pathways debated in recent literature. Furthermore, the study examines the role of mothers' communication ability and communication networks, the people with whom she speaks to the most, and identifies the characteristics of these networks which are important in determining maternal HN knowledge relative to other determinants such as education and the access to media.

The objectives of the study are:

1. To examine the effect of mothers' education, their use of media, characteristics of their communication networks and their communication ability in determining their health and nutrition (HN) knowledge.
2. To examine the role of maternal health and nutrition (HN) knowledge in mediating the education effect on child nutrition, using both conventional and econometric methods
3. To examine the role of mothers' communication in mediating, modifying or confounding the effect of maternal education on child nutrition

6.2 Study design

The Knowledge and Networks study is a cross-sectional study of 302 women taking part in the Young Lives (YL) study in AP.

6.2.1 Sampling

Sampling sites

Both rural and urban areas were included in the study in order to cover a range of different physical and social contexts. The four districts or 'sites' selected to represent urban and rural AP were: Hyderabad city (urban), Mahbubnagar (rural), Anantapur District (rural) and Anantapur City (urban), from which 50, 100, 100 and 50 women were sampled respectively. The sites were purposively selected. The urban sites were selected first for practical reasons; Hyderabad is the capital of AP and Anantapur is the nearest town included in the YL study. For practical reasons, rural sites were chosen that were geographically close to the urban centres. The sites were selected in this way to facilitate the Organization of the fieldwork, while maximising the coverage of contexts within AP.

Sampling within sites

Within each of the four sites, I selected women by using a stratified random sampling method. A sampling frame was developed by drawing up a list of all the eligible women per community within each site. Women were randomly chosen within each community and the number sampled per community was proportional to the number of women available for selection. As a consequence the sample drawn in urban communities was approximately 50% of the eligible population, whereas in rural areas about 25-35% of eligible women were sampled. A greater proportion were sampled in urban areas to achieve the desired sample size. This method of sampling was used for practical purposes. As the KN field investigators would be working alongside the YL team, who were simultaneously undertaking a 'tracking' exercise of the entire YL cohort, the sampling methodology helped ensure that the workload of the field investigators was consistently proportional to the YL team, thereby aiding Organization of fieldwork and allowing the two teams to work in parallel as much as possible. By working in tandem with the YL tracking, the field investigators would have less difficulty locating YL participants, and were able to interview them immediately after the tracking team had conducted a separate short interview for their own identification purposes. Instead of visiting the YL participants on two separate occasions this approach has the added benefit of reducing the disruption of the lives of the participants.

6.2.2 Sample size

In the rural areas 200 women were sampled and in the urban areas 100 women were sampled, giving a total sample size of 300 women. The smaller sample of urban women reflects the smaller pool of YL participants in urban areas eligible for selection. A total sample size of 300 was based on the number which was feasible to manage and possible within the study's budget. It was expected that a random selection of YL respondents from the selected study sites would mirror the distribution of education to yield approximately 190 and 110 uneducated and educated women respectively, where 'educated' refers to the completion of primary schooling. With a power of 80% and a significance level of 1%, this sample size would allow the detection of a difference of at

least 0.5 child height-for-age z-scores between each education group. In order to explore the underlying mechanisms between maternal education and child nutrition, it is essential that a positive association is observed, which is why the sample size calculation was based on this relationship.

6.2.3 Eligibility criteria

Of all the YL respondents (the main caregiver of the child) only biological mothers were eligible for selection. Only participants of the YL study who were biological mothers of 1-year old children were eligible for inclusion. Non-biological caregivers or mothers of 8-year old children were excluded. Cases were excluded from selection that did not have both first and last family names or were missing an address because these cases would be harder to locate. Of the 853 YL respondents in the study sites 97% (926) were eligible for selection and 302 mothers were drawn from this group.

6.2.4 Fieldwork

Local collaboration

The work was undertaken in collaboration with the India YL partners at the Centre for Economic and Social Studies (CESS) in Hyderabad. The partners aided with the hiring and training of staff to contribute to the development of the questionnaire, undertake the survey and enter the data. CESS is an autonomous research institute, supported by the Government of AP and the Indian Council of Social Science Research (ICSSR) and is engaged in multi-disciplinary research and training in social sciences. The Centre focuses on issues and problems affecting the socio-economic wellbeing of poorer and weaker sections of society, and provides inputs to policy makers based on its research. The resources available at the Centre were therefore beneficial to the study. The findings, which have been reported back to CESS, will contribute to the on-going work of the Centre and to the policy-influencing activities central to the YL study.

Conduct of fieldwork

Preparation for the fieldwork (development of questionnaire and piloting) took place in July and August 2004 and the field-work was undertaken between 23/08/04 and 30/09/04. Three field-teams were formed, each consisting of two field investigators and one supervisor, all were female and had Batchelor degrees. Despite difficulties, the recruitment of female team workers was considered essential as the questionnaire content concerned health, nutrition and more sensitive issues about familial influences; issues which women are more comfortable discussing with other women.

One field-team was responsible for Hyderabad, one for Mahbubnagar District and one for both Anantapur District and Anantapur City. The field-investigators worked in pairs to interview the respondents, with one asking the questions referring to a question-sheet written in the local language and the other marking the corresponding code for each answer on a copy of an English questionnaire. The use of two field investigators for interviewing was done to maximise the quality of the data collected in two ways, first there would be less disruption by coding and flicking of pages, and second, as some of the questions required somewhat lengthy 'story telling' by the field investigator, it was essential to establish rapport with the respondent and have a conversation that flows as naturally as possible. Having a partner to take responsibility for coding enabled such a conversation to take place.

The supervisor was responsible for checking the questionnaire, reporting any problems to a contact person at CESS and liaising with the YL tracking team. The supervisor also helped organise the interviews by distracting on-lookers by talking to them. Field investigators were each given a camera to take photographs of the respondents and their families and neighbourhoods.

6.2.5 Ethics

Ethical clearance for this study was obtained from the London School of Hygiene and Tropical Medicine. Local approval for the YL project as a whole in India had previously been granted. Informed consent was obtained from the respondent before the interview

took place (see Appendix A for a copy of the information sheet and consent form). The field investigator read from a standard information sheet in the local language, which summarised the background and aim of the study, and thereafter the consent form. The respondent was requested to sign the consent form if literate or thumb-print the form if illiterate.

6.2.6 Training

One-week training was provided to field investigators prior to the fieldwork with the help of senior female 'expert' researchers who had experience in child development and the practicalities of conducting surveys in poor rural and urban areas in AP. During the training the questionnaire was field-tested in a poor urban settlement in the local area. This urban area was not included in the main study. A field-manual was developed to facilitate the training, which would be used for reference during the fieldwork. Other survey materials included two copies of a poster showing an infant receiving polio-drops, with one version showing the text 'for a life free of polio – only two drops!' and one not showing the text (the translation of the slogan into the local Telugu language is 'polio rahita keevitaaniki ronde chukkalu'). The field-manual also contained a descriptive justification for the study which was discussed during the training. Participatory methods were used in the training sessions in order to establish a sense of ownership of the study among the field investigators, along with a clear understanding of the study aims. For example a particularly important matter was the idea that a 'don't know' response is itself an answer. As the study aimed at assessing women's knowledge it was crucial that the field investigators did not probe or help the respondent during the interview, instead accepting a lack of response or 'don't know' answers at face value.

6.2.7 Developing the questionnaire

A copy of the English version of the questionnaire is given in Appendix B. The questionnaire was developed via the following steps:

- A first draft was designed in the UK, using other questionnaires and studies as guides, such as The Young Lives Questionnaires (www.younglives.org.uk) and UNICEF Multiple Indicator Cluster Surveys (UNICEF 2000)
- In India the questionnaire was discussed and re-drafted with the help of a female child-care expert who had experience of doing research in rural areas (Dr Majuri) and a female researcher with experience of conducting research in poor urban areas of Hyderabad (Dr Swaroopa)
- The questionnaire was piloted in an urban slum settlement, similar in type to the YL urban sites (The 'Old Customs Slum', Begumpet, Hyderabad, 7-8th July 2004). Nine interviews were undertaken with women of different educational and socio-economic backgrounds by two trained field investigators. This was supervised by myself and a female researcher with experience of working in urban settlements
- A focus group discussion was undertaken in the same urban settlement on the 9th July 2004. Eight women took part, 3 of whom had previously been interviewed during the piloting. The aim of the exercise was to explore answers to the questions in the questionnaire in a more relaxed and free environment. The discussion was led by Dr Swaroopa and observed by myself and field investigators who took detailed notes of the discussion in the local language which were translated and discussed thereafter. A checklist of topics was created prior to the focus group discussion to ensure that all topics were covered.
- Following the piloting and focus group discussion, a meeting was held with everyone who had been involved in developing the questionnaire and piloting it. The feedback led to further changes to the questionnaire
- The questionnaire was translated and back-translated into Telugu and Urdu (local languages) and differences in translation were discussed
- Final edits were based on the comments received by my supervisor, Sharon Huttly and Professor Galab (YL co-ordinator at CESS), and the discussion that arose from the translation procedure

6.3 Variables and analysis

6.3.1 HN Knowledge and general awareness

Two different types of knowledge were measured in terms of a scores: HN knowledge and general awareness. The questions used and allocated scores are as given in Table 6.1. Eight questions were used to develop the HN score, with 0.5 points allocated to each correct answer. Five questions were used to develop the general awareness score, with 0.5 - 1 points allocated to each question. This scoring system was developed in order to enable HN knowledge and general awareness scores to be comparable, both with a minimum score of 0 points and a maximum of 4.

Table 6.1 The measurement of HN knowledge (a) and general awareness (b)

a) HN knowledge

No.	Question	Answers	Scores
1	Should a child be given more/less same amount of food when he/she has diarrhoea?	Less/same/Do not know More	0.5 0
2	What is the ideal age for introducing solid foods into a child's diet?	4-6 months Other age/ Do not know	0.5 0
3	How do you prepare ORS?	Mentions mixing water with salt and sugar Other explanation/ Do not know	0.5 0
4	Do you know why babies receive an injection in the shoulder?	Mentions BCG vaccine or TB Other answer/ Do not know	0.5 0
5	At what age should a baby get a measles vaccine?	9 months Other age/ Do not know	0.5 0 0
6	Rajitha has a small baby boy. It is her first child. They live with her husband and his parents in a small house. One day the baby gets diarrhoea. She doesn't know if she should continue giving breastmilk or not. What do you think she should do?	Continue breastfeeding Stop breastfeeding/ Do not know	0.5 0
7	In Rajitha's neighbourhood there are some children who are very short in height for their age. Other children are both short and thin. Do you know what is the reason for children not growing?	Any of the following: Children eat bad/dirty food; Children eat small quantity of food; Children are sick/ lack of medical attention; Mother's milk is not good; Mother's health is not good; Mother's diet/ nutrition; Poor sanitation/ cleanliness in the home or outside; Genetic reason Do not know	0.5 0
8	What is this picture advertising? (picture shown of infant receiving polio drop in its mouth)	Polio drops/ drop Other/ Do not know	0.5 0
	TOTAL		**4**

b) General awareness

No.	Question	Answers	Score
1	Where can you obtain a birth certificate?	Correct Incorrect/ Do not know	1 0
2	Which district does your village/ urban area belong to? (correct answer provided to field investigator by checking notes)	Correct Incorrect	1 0
3	What is the name of the chief minister of AP?	Mentions YS Rajasekhar Reddy (recently elected) or Chandra Badu Naidu (previous) Other name/ Do not know	0.5 0
4	What is the name of the Prime Minister of India?	Mentions Manmohan Singh (recently elected) or Vajpayee (previous) Other name/ Do not know	0.5 0
5	Other than Telugu and Hindi (and Urdu) what languages are spoken in India?	Mentions at least 2 languages Mentions at least 3 languages Mentions <2 languages	0.5 1 0
	TOTAL		**4**

6.3.2 Education

The respondent was asked for the highest grade completed in school. If she dropped out in grade 5 the field investigator would enter '04' as the completed grade, the indicator used for education. In case of a Batchelor degree '15' was entered and separate codes were given for a qualified health professional (nurse, doctor, midwife etc). If the respondent had never been to school, the field investigator would enter '00'. Separate numerical codes for non-curriculum schooling, night school and adult schooling were included.

6.3.3 Media

Women were asked if they use the telephone, watch TV, listen to the radio or read the newspaper in their daily lives either within or outside their household. They could answer 'yes' or 'no'.

6.3.4 Communication networks

Women were asked to name the individuals, within and outside their household, with whom they talk to the most. Although the maximum number of people to enter is 6 on the questionnaire form, it was possible to add further information overleaf. If the respondent said she does not talk to anyone, or feel close to anyone, then no names are entered. The field investigator then established the sex of each person mentioned, their relationship to the respondent and where they live, and inserted this information into the table. Finally, they asked the respondent about the grade that the network members have completed at school, and whether they were literate or illiterate. The definition of a literate person is someone who was reported to be able to both read and write. Although both measures were collected in the field, I used the literacy variable in the analysis because piloting revealed that mothers had some difficulties recalling the exact grade completed by network members, especially the individuals who live outside her own household.

6.3.5 Communication ability

In this study I do not attempt to measure the mothers' grasp of decontextualized language (Section 2.4.2) which has been done in the past by assessing their ability to define nouns (Snow 1990; Joshi 1994). Instead I use a crude indicator of the mothers' ability to communicate during the interview, as determined by the field investigator. The three different categories of 'communication ability' are:

'good' communicates fluently, with little need for clarification
'medium' communicates with some difficulty and some clarification necessary
'poor' communicates with much difficulty with much clarification needed

6.3.6 Data management and analysis

Data preparation

The data were double-entered in Microsoft Access at CESS, and a checking programme was developed using Access to compare the two data-sets and produce a list of errors, which would be corrected with reference to the original paper questionnaires. The final data-set was then cleaned by myself using a number of consistency checks. Cases with missing values for other variables included in a regression model would be excluded from that particular part of the analysis. All changes to the data-set have been documented. The KN data were linked with YL data from AP by using the key field for 'child ID', which would uniquely identify the mother and child pair. By linking the two data-sets, information about socio-economic status and other household characteristics could be added to the database and included in the analysis. The age, sex and names of each child, as collected by the YL and KN study were compared to ensure that the same mother and child were included.

Methodological consideration

The benefit of linking YL and KN data is that it avoids re-collecting background information, such as household socio-economic status, which is unlikely to change in two years. However, because the outcome (child nutrition) was measured in 2002 and the exposure (maternal education, knowledge, communication etc) was measured two years later in 2004, the assumption is also that the latter variables are stable over time. I believe that this is a fair assumption to make; first because it is impossible for a woman to alter her status of formal education (I do not include adult education as a type of education), and second, because it is doubtful – albeit theoretically possible – that a mother will substantially alter her communication ability, communication network, her access to media and her level of knowledge and awareness within the two year period.

Data cleaning

The original sample size (N=302) was reduced with the exclusion of 4 cases with questionable ID and 5 cases with questionable age and sex data. Two cases were omitted because they were the sole observation per community (the Stata mixed effects models requires more than 1 case per community in order to specify community as a random effect). Cases were also omitted if they had missing values for any of the variables used in the analysis.

Statistical software

Data were entered into Microsoft Access and converted into STATA (StataCorp 2003) format using STATTRANSFER. STATA Version 8 was used for data management purposes and all statistical analyses (StataCorp 2003).

Statistical analyses

For descriptive analysis I used chi-squared tests, Students' T-tests and F-tests to assess the statistical significance of differences between proportions, 2 means or >2 means respectively. Multi-variable regression analysis was used to simultaneously adjust for multiple confounders. Further details about the use of mixed-effects models and econometric methods will be explained in the results chapters.

CHAPTER 7

THE DETERMINANTS OF MATERNAL HEALTH AND NUTRITION KNOWLEDGE

In this chapter I examine the relative importance of four determinants of mothers' health and nutrition (HN) knowledge in Andhra Pradesh – her education, use of media, the characteristics of her communication networks and ability to communicate as assessed during the interview. The chapter is split into four sections. In the first section I introduce the analytical framework. In the second section I describe the patterns and crude associations between HN knowledge and general awareness. In the third section I present the results from multivariable regression analysis. Finally, in the fourth section I summarise and discuss the results.

7.1 Introduction

7.1.1 Background

In this chapter I will explore the determinants of HN knowledge, and, for comparative purposes, general awareness in the AP study population. The inclusion of general awareness in the study is justified on conceptual and methodological grounds. First, given that there is no consensus about the type of maternal knowledge which is important for child nutrition, I may hypothesise that general awareness represents a type of understanding and perception which may play a crucial role in childcare. For example, mothers' general awareness may be associated with a willingness to embrace the modern ethos, an eagerness to learn and the courage and self-confidence to move and interact

with the world beyond her immediate family (Section 6.4.2). Second, the relationship between child nutrition and maternal general awareness does not suffer from reverse causality, which is a potential methodological problem for assessing the relationship between child nutrition and maternal HN knowledge (see Section 9.2.1). Although I will not explore any impacts on child nutrition in this chapter, the analysis will underlie and complement the analysis undertaken in the next chapter.

The framework in Figure 7.1 illustrates the broad hypothesis that child nutrition is determined, at least in part, by maternal HN knowledge: improvements in child nutrition come about through changes in mothers' care behaviour, which in turn depend on the acquisition of HN knowledge (other determinants of child nutrition have been presented in the conceptual framework for malnutrition in Figure 1.1). The dashed lines around the care and nutrition component in Figure 7.1 illustrate that these factors are not directly observed. Instead the focus is on the potential determinants of maternal HN knowledge: her education, media, characteristics of her communication networks (size, education, sex and location) and her ability to communicate as assessed during the interview. In this chapter I will explore the independent effects of these factors on maternal HN knowledge. However, I will not examine their role in mediating the education effect. This issue will be explored further in Chapters 8 and 9.

The analytical framework shows that the factors identified as potential confounders are household wealth and assets (ownership of land, number of adult and children in the household and the number of economic sectors the household is involved in), setting (urbanity and/or site), mothers' age and ethnic group and the education of the household and community. The inclusion of parental education as a potential confounder is borne out of the results presented in Chapter 3, which showed that education of other household members affects child nutrition independently of maternal education and may confound the maternal education - child nutrition relationship. Grandmother education is not included because less than half (46%) of households in the AP sub-population had grandmothers present (N=127). Community-level education has also not been included as

a potential confounder because the findings in Chapter 4 show that it had no impact on child nutrition in AP adjusting for parental education and other confounders.

7.1.2 Objectives

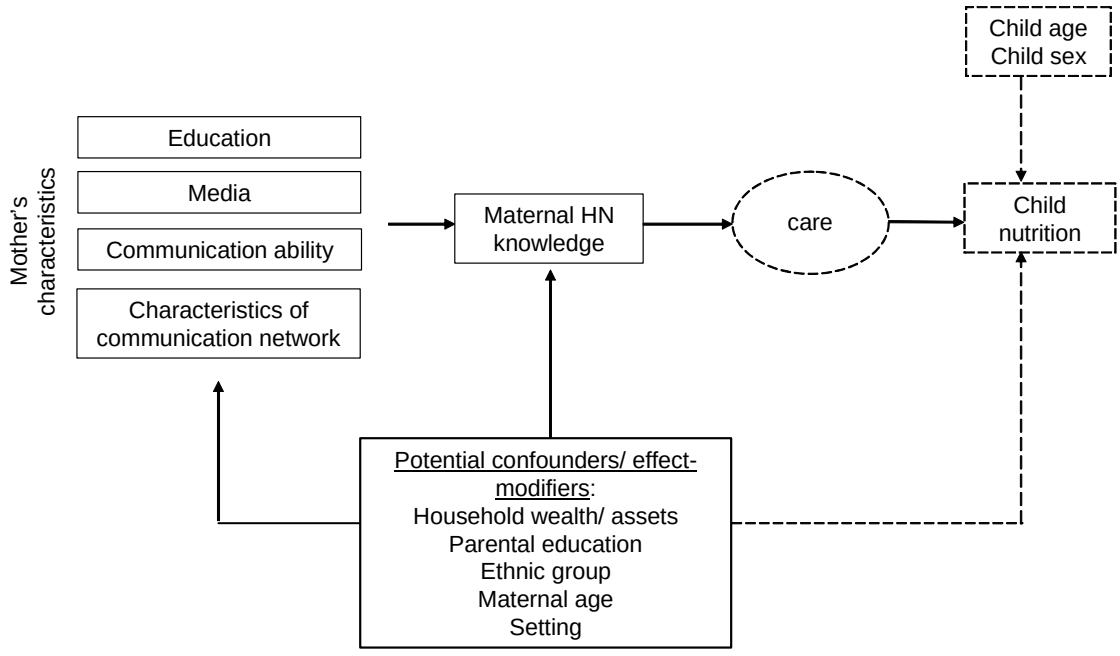
The overall objective of this chapter is:

- To examine the role of mothers' education, their use of media, the characteristics of their communication networks and their communication ability as determinants of their health and nutrition (HN) knowledge

Specific objectives are:

- To describe and compare patterns of mothers' HN knowledge and general awareness
- To compare the determinants of HN knowledge with those of general awareness
- To hypothesise about alternative explanations for the associations found

Figure 7.1 Analytical framework: illustration of hypotheses related to the determinants of maternal HN knowledge and its effect on child nutrition



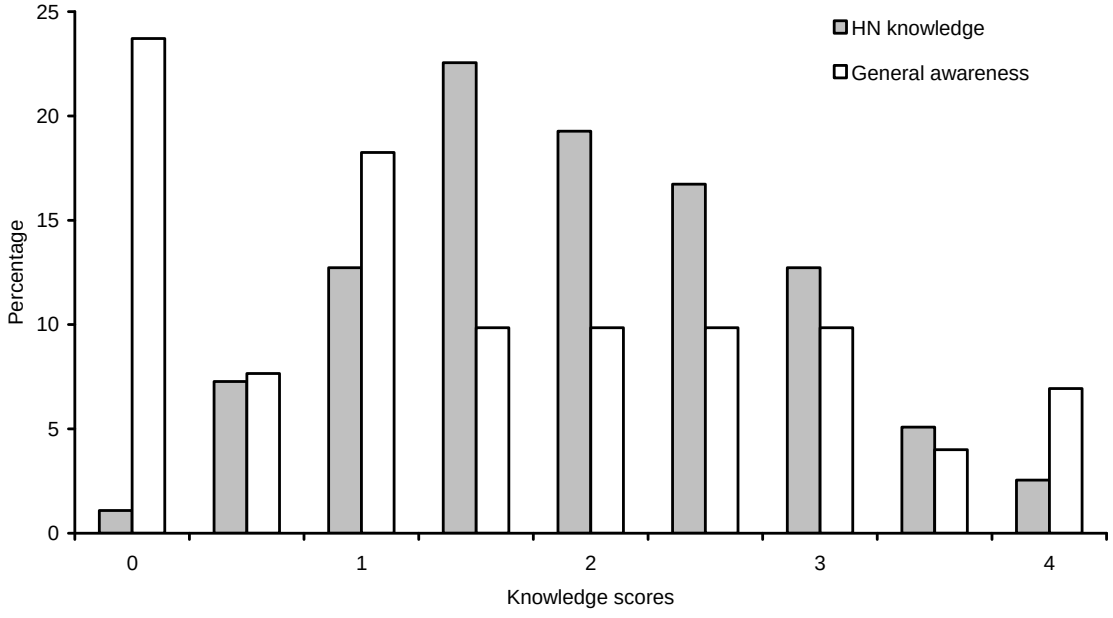
7.2 Patterns and crude associations

7.2.1 HN knowledge and general awareness

The number of cases omitted due to missing values was 19, leaving a sample size of 272 and 274 respectively. Figure 7.2 gives the frequency distribution of HN knowledge and general awareness. The figure shows that the distribution of HN knowledge has a 'normal' shape, whereas general awareness is skewed to the right. This is because a large proportion of mothers scored zero points for the general awareness questions.

Mothers with high general awareness scores typically also have high HN knowledge scores. There is a strong positive correlation between the two indicators. The Pearson Correlation coefficient is 0.65 (P<0.001).

Figure 7.2 The distribution of HN knowledge and general awareness scores



7.2.2 Education

Maternal education is defined by the highest grade obtained in school. The results in Table 7.1 show that the distribution of this variable is highly skewed because almost 60% of mothers have never been to school and have been assigned '0' grade, while 25% completed grade 1-8 and 16% completed grade 9 and above. A comparison with the data for the larger YL sample shows that the distribution of education is similar (see Section 4.1.2).

The results in Table 7.1 suggests that the crude effect of education on HN knowledge and general awareness scores is positive. Educated mothers have higher mean scores than uneducated mothers. The difference in HN knowledge scores between uneducated and educated mothers is substantial. For example, uneducated mothers have a mean HN knowledge score of only 1.56 compared to 2.79 for mothers who have completed grade 9 and above. The results differ from previous studies (reviewed in Chapter 5) showing little difference in HN knowledge between educated and uneducated women (Kutty 1989; Gupta, Mehrotra et al. 1991). The equivalent difference for general awareness is even greater.

Table 7.1 Average HN knowledge and general awareness scores per category of maternal education, media score, communication network characteristics and communication ability (N=272)

			HN knowledge (0-4 pts)			General awareness (0-4 pts)		
		N	Mean	SE	P	Mean	SE	P
Maternal education (grade)	0	160	1.556	0.056		0.863	0.071	
	1-8	68	2.463	0.089		2.088	0.126	
	9-	44	2.705	0.124	<0.001	3.114	0.130	<0.001
Media								
Telephone	No	115	1.583	0.072		0.830	0.084	
	Yes	157	2.252	0.069	<0.001	2.048	0.099	<0.001
Radio	No	156	1.887	0.071		1.387	0.105	
	Yes	118	2.077	0.081	0.087	1.726	0.110	0.026
Newspaper	No	152	1.664	0.064		0.898	0.078	
	Yes	120	2.354	0.078	<0.001	2.338	0.105	<0.001
TV	No	83	1.560	0.082		0.837	0.112	
	Yes	189	2.148	0.064	<0.001	1.839	0.090	<0.001
Com. Network								
Size (N)	0-2	64	1.523	0.114		1.125	0.159	
	1-4	121	1.930	0.075		1.517	0.115	
	5-9	87	2.351	0.085	<0.001	1.856	0.128	<0.001
Literacy (%)	0	56	1.545	0.101		0.893	0.146	
	1-49	92	1.962	0.079		1.315	0.111	
	50-	124	2.165	0.087	<0.001	1.984	0.118	<0.001
Living outside HH (%)	0	54	1.602	0.130		1.093	0.177	
	1-49	46	2.033	0.120		1.446	0.189	
	50-	172	2.067	0.065	0.002	1.695	0.093	0.002
Male (%)	0-49	128	2.199	0.070		1.770	0.104	
	50-	144	1.764	0.076	<0.001	1.323	0.109	0.004
Communication Ability	Poor	59	1.441	0.105		0.559	0.098	
	Med.	89	1.708	0.078		1.039	0.097	
	Good	124	2.407	0.073	<0.001	2.351	0.104	<0.001

7.2.3 Media

Table 7.1 shows that around 70% of mothers have access to television and around half have access to radio, telephone and newspapers. Access to television, telephone and newspapers are strongly and positively associated with both HN knowledge and general awareness scores (P<0.001) but the association with radio is less strong.

7.2.4 Communication networks

Data were collected on the size of mothers' communication networks – the people with whom they speak to the most – and the sex, literacy and location of the network members. Education was measured as literacy (literate/illiterate) because piloting revealed that the mothers had difficulties recalling the exact grade completed by all network members (see Section 6.4.4 for further information about methods). The mean network size is 4 people. Table 7.1 shows that about 80% of mothers (216 out of 272) have networks which included at least one literate person; a similar proportion (218 out of 272) have a network which include at least one person outside the household; and just less than half of mothers (128 out of 272) have networks where the majority of members are female.

Table 7.1 shows that all network characteristics are associated with HN knowledge and general awareness scores ($P<0.005$). Higher maternal HN knowledge scores and general awareness scores are associated with mothers having communication networks with members who are largely literate, female or living outside the household. For example, the mean HN score is 2.17 for mothers whose networks have a literacy rate above 50%, compared to only 1.55 for mothers whose networks are composed entirely of illiterates; the mean HN score is 2.35 for mothers with large networks (>5 members) compared to only 1.52 for mothers with small networks (<3 members); the mean HN score is 2.07 for mothers whose network largely consisted of people outside the household compared to only 1.60 for mothers whose network consist solely of people within the household; and finally, the mean HN score is 2.20 for mothers whose network members are mainly female compared to only 1.76 for mothers whose network members are mainly male. The patterns are similar for mothers' general awareness.

I undertook further analysis of networks members (N=1150) to establish which types of individuals were reported to be members of mothers' communication networks. The results showed that the most common network member is the husband (24%) followed by the mother, mother-in-law and a female friend or neighbour (each 13%). However, if the

analysis is stratified by sex and location, the main male member within the household is the husband (75%) and the main female member is the mother-in-law (64%). Outside the household the main male member is the brother (24%) followed by the father, father-in-law or brother-in-law (13-16% each). These results are useful for the interpretation of findings presented later in this chapter, which will show that the sex and location of network members are important determinants of maternal HN knowledge.

7.2.5 Communication ability

Table 7.1 shows that women's scores in HN knowledge and general awareness were positively associated with her communication ability ($P<0.001$). The difference in mean HN knowledge scores between mothers with poor and good communication ability scores is 1.44 and 2.41 respectively, and even larger for general awareness at 0.56 and 2.35 respectively.

So far the crude analysis has suggested that there exist strong associations between maternal HN knowledge and education, media, communication networks and communication ability. It is likely, however, that much of this association can be explained by confounding factors. Multivariable analysis is therefore necessary to adjust for confounders and the correlation between education, media, communication networks and communication ability.

7.3 Adjusted associations

Multivariable regression analysis is undertaken in a staged fashion. The first step involves estimating the effect of education on HN knowledge and general awareness adjusting for confounders. The second step involves estimating the effect of media, communication network characteristics and communication ability respectively, adjusting for maternal education and confounders. The third step also adjusts for the correlation between these factors in order to develop a combined model. To account for the hierarchical structure of the data-set, and the resulting spatial clustering of observations

within sites and communities, the site variable (N=4) is specified as a fixed effect. Meanwhile community is specified as a random effect (see Section 3.3.4 for further explanation of fixed and random effects). The urbanity variable is excluded from the model because it is highly correlated with site. Mixed-effects regression analysis is conducted with the use of the 'xtreg' command in Stata. Data were available for analysis for 272 cases (see Section 6.3.6 for more information on data cleaning procedure).

7.3.1 Education

Model A in Table 7.2 (a) and (b) gives the output of regression models that examine the effect of maternal education on HN knowledge and general awareness respectively, adjusting for confounders. The results show that education is a strong positive determinant of both HN knowledge and general awareness scores. An increase in one grade is associated with a mean increase of 0.09 HN knowledge scores (95% CI 0.07– 0.12 P<0.001) and 0.18 general knowledge scores (95% CI 0.15 – 0.21 P<0.001). The findings suggest that despite the adjustment for confounders the strong association observed in Table 7.1 remains.

Further analysis was undertaken to address a weakness in part 1 of this study, where the definition of education meant that it was impossible to distinguish between the effect of completing '0' or '1-4' grades in school. The education variable in Model A was substituted by a categorical variable to denote the mothers' completion of the following grades: 0, 1-4, 5-6, 7-8 and 9 and above. This categorisation would enable a difference to be assessed between women with '0' and '1-4' grades. The results showed that all levels of schooling are positively associated with both HN knowledge and general awareness and there is little difference in the size of the regression coefficient associated with having '1-4' grades compared with '5-6'. The results suggest that even a small amount of schooling is associated with improved women's HN knowledge and general awareness scores.

7.3.2 Media

The crude effect of watching TV and listening to the radio, which was shown previously in Table 7.1, disappears once other confounders are controlled. Meanwhile the use of telephones and newspapers remain statistically significant predictors for both HN knowledge and general awareness. The results in Table 7.2 (a) show that the difference between mothers who use telephones and those who do not is associated with a mean difference in total HN knowledge scores of 0.25 (95% CI 0.04 – 0.46 P=0.021). The mean difference in general awareness scores, shown in Table 7.2 (b), is even greater at 0.41 (95% CI 0.17 – 0.65 P<0.001). There is a borderline significant effect of reading newspapers for HN knowledge (0.21 95% CI -0.03 – 0.42 P=0.076), whereas the equivalent effect on general awareness is highly significant (0.40 95% CI 0.14 – 0.67 P=0.003). Overall the results suggest that the adjustment for confounders along with the adjustment for the correlation between different media types leads to the disappearance of the crude effect observed earlier of TV and radio for HN knowledge and general awareness. Of the four media types, only telephone use and newspapers remain statistically significant predictors of both outcomes.

The effect of reading newspapers is probably capturing the role of literacy. It is plausible that newspapers are a source of health information and current affairs, particularly the latter. Meanwhile the effect of telephone usage on both HN knowledge and general awareness can be explained in several ways. First the telephone itself may be acting as a channel for the diffusion of knowledge, so that information is transmitted through the telephone device from one person to another. Second, and more likely, is the possibility that in the Indian society telephone use is a measure of female independence and a freedom to interact with others beyond immediate household members. Related to this is the third option, that telephone use represents an acceptance of modern technology and ethos, perhaps correlated with awareness of modern medicine, and the practice of speaking formally and to strangers, which is a useful skill when dealing with bureaucratic government services and obtaining information from people in authority. The role of communication will be explored in depth in Chapter 9.

7.3.3 Communication networks

Four characteristics of communication networks were explored: its size (number of members) and the literacy, sex and location of its members. The results presented in Model C in Table 7.2 (a) suggest that network size is the only statistically significant network characteristic which is associated with HN knowledge score (0.11 95% CI 0.05 – 0.17 P<0.001). The crude relationship shown previously in Table 7.1 for the sex, literacy and location of network members disappears once adjustment is made for confounders and for the correlation between different network characteristics. The picture is different for general awareness. The results in Model C in Table 7.2 (b) show that an improvement in mothers' general awareness score is associated with, not only larger networks (0.10 95% CI 0.03 – 0.18 P=0.008), but also a higher literacy rate among its members (0.43 95% CI 0.00 – 0.85 P=0.048).

Given that husbands are the most commonly reported network member (see Section 7.2.4), it is possible that the inclusion of paternal education in the model reduces the effect of the network literacy variable shown in Model C in Table 7.2 (a) and (b). The analysis was therefore repeated excluding the paternal education variable, but no difference was found in the effect of network literacy on either outcome, which remained a statistically non-significant predictor of HN knowledge (0.09 95% CI -0.23 - 0.42 P=0.574) and a significant predictor of general awareness (0.43 95% CI 0.04 - 0.82 P=0.030), once adjusted for other network characteristics and other confounding factors.

It was hypothesised that certain types of network members are more important than others in determining maternal HN knowledge and general awareness; both their mere presence in the network and their education. Further analysis was therefore undertaken to explore the role of sex and location of network members by substituting the network size, sex and location variables in Model C [Table 7.2 (a) and (b)] with the following variables: the number of males within the household, the number of males outside the household, the number of females within the household and the number of females outside the household. The results showed that of the four indicators, it was the number of females living outside the household which is most strongly related to both HN

knowledge and general awareness (0.17 95% CI 0.11-0.25 P<0.001 and 0.23 95% CI 0.14 – 0.31 P<0.001 respectively) adjusting for network literacy, maternal education and other confounders. It was shown earlier in Section 7.2.4 that these women are likely to be maternal mothers or female friends or neighbours. It is possible that contact with female family and friends outside the household may represent either, one, a sharing of knowledge, or two, status and mobility which improves acquisition of HN knowledge through other means.

It is possible that the non-significant effect of network literacy on HN knowledge shown in Model C in Table 7.2 (a) masks a differential effect between sub-groups. Further analysis was therefore undertaken to explore this possibility. The results show that literacy among females outside the household had a significant effect on HN knowledge (0.73 95% CI 0.11 - 1.35 P=0.021) and general awareness (1.06 95% CI 0.33 - 1.80 P=0.004), whereas the literacy of females inside the household or males either inside or outside the households had a non-significant effect, adjusting for maternal education and other confounders. However, for both HN knowledge and general awareness the positive effect of literacy among females outside the households disappears once network size is included in the model. This suggests that the size of the network matters more than literacy.

7.3.4 Communication ability

The results in Model D in Table 7.2 (a) and (b) suggest that mothers' communication ability is an important predictor of her HN knowledge and general knowledge scores, adjusting for confounders. An increase from 'poor' to 'medium' or from 'medium' to 'good' communication ability is associated with a mean increase of 0.34 HN knowledge scores (95% CI 0.22 – 0.46 P<0.001). The equivalent mean improvement in general awareness scores is 0.54 (95% CI 0.42 – 0.68 P<0.001).

There is a concern that the communication ability variable is biased because it represents the opinion by the field investigator of the respondent's ability to express themselves and conduct a conversation during the interview, rendering it subjective and susceptible to

interviewer bias. However, the inclusion of the site variable in the model should control for the differences between field investigators in making this judgement because all respondents in each site were interviewed by the same team of field investigators. Moreover I repeated the analysis for each site separately and observed the same effect of communication ability, which suggests that any potential observer bias would not alter the overall results (not shown). The problem nevertheless remains that the field investigators assessed the respondent's HN knowledge and general awareness prior to classifying her communication ability. It is possible that her acquired scores for HN knowledge or general awareness could have influenced the field investigator's perception of her communication ability. This problem could not be overcome in the analysis.

7.3.5 Combined model

Because education, media use, communication network characteristics and communication ability are all likely to be associated with each other, I included indicators of each in a combined model in order to examine independent effects. While each factor was represented by at least one indicator, the indicators which have been previously shown to be non-significant predictors of HN knowledge or general awareness were excluded. For example, when developing the combined model for HN knowledge, I found that once education, network size and communication ability were controlled for, the effect of telephone use was rendered a statistically non-significant predictor of HN knowledge. It has therefore been excluded from the combined model. Similarly, when developing the combined model for general awareness, I found that network size and the percentage of network members who were literate and living outside the household were also no longer significant predictors of general awareness, and have also been excluded.

The final results are given in Table 7.2 (a) and (b) as Model E. The results show that HN knowledge is best predicted by education, communication ability and size of communication networks. General awareness is best predicted by education, communication ability, reading newspapers and using the telephone.

Table 7.2 Regression output: the determinants of HN knowledge (a) and general awareness (b) (N=274)

a) HN knowledge

	Model A (education)			Model B (media)			Model C (networks)			Model D (communication)			Model E (combined model)		
	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant	1.900	0.322	0.000	1.745	0.327	0.000	1.561	0.365	0.000	1.664	0.302	0.000	1.335	0.308	0.000
Mat educ (grade)	0.091	0.013	0.000	0.070	0.014	0.000	0.089	0.013	0.000	0.062	0.013	0.000	0.065	0.013	0.000
TV (1=Y 0=N)				-0.101	0.118	0.389									
Tel (1=Y 0=N)				0.247	0.107	0.021									
Radio (1=Y 0=N)				0.130	0.100	0.195									
Newsp. (1=Y 0=N)				0.210	0.119	0.076									
NW size (no.)							0.114	0.032	0.000				0.099	0.027	0.000
NW literacy (%)							0.105	0.181	0.563						
NW live out (%)							0.014	0.174	0.935						
NW sex (% male)							-0.243	0.232	0.295						
Com. Ability (0-2)										0.340	0.060	0.000	0.288	0.061	0.000
Pat. educ. Prim.	-0.131	0.145	0.364	-0.119	0.142	0.402	-0.154	0.144	0.284	-0.128	0.137	0.349	-0.134	0.133	0.314
Sec.	0.040	0.138	0.771	-0.031	0.139	0.822	-0.005	0.143	0.972	-0.060	0.131	0.649	-0.042	0.128	0.744
Higher	-0.016	0.125	0.898	-0.029	0.127	0.823	-0.032	0.129	0.806	-0.049	0.118	0.677	-0.036	0.116	0.757
Mat. age (yrs)	-0.008	0.011	0.498	-0.008	0.011	0.477	-0.003	0.011	0.758	-0.010	0.011	0.327	-0.007	0.010	0.520
Hous. qual. (0-1)	0.100	0.208	0.630	0.051	0.207	0.804	0.150	0.202	0.457	0.123	0.195	0.528	0.132	0.190	0.490
Own land*	0.077	0.138	0.574	0.058	0.140	0.679	-0.057	0.136	0.678	-0.026	0.132	0.842	-0.100	0.130	0.440
Adults in HH	0.035	0.054	0.513	0.055	0.053	0.302	0.041	0.052	0.433	0.035	0.051	0.486	0.036	0.050	0.472
Children in HH	0.001	0.019	0.973	0.003	0.019	0.869	0.002	0.020	0.900	0.010	0.018	0.589	0.007	0.018	0.692
Ethnic grp ST	-0.205	0.207	0.323	-0.163	0.208	0.433	-0.245	0.195	0.209	-0.146	0.190	0.441	-0.193	0.186	0.298
BC	-0.042	0.132	0.747	-0.060	0.135	0.655	-0.077	0.123	0.535	-0.018	0.120	0.879	-0.037	0.118	0.755
OC	0.029	0.154	0.849	-0.001	0.155	0.994	-0.042	0.147	0.773	0.059	0.142	0.679	0.017	0.140	0.903
Site Urb Anan	0.113	0.195	0.564	0.092	0.209	0.658	-0.014	0.176	0.936	-0.023	0.167	0.892	-0.053	0.163	0.744
Mahubnagar	-0.493	0.125	0.000	-0.446	0.138	0.001	-0.395	0.112	0.000	-0.503	0.108	0.000	-0.443	0.107	0.000
Hyderabad	0.327	0.198	0.099	0.484	0.217	0.026	0.058	0.183	0.752	0.367	0.170	0.031	0.175	0.174	0.313

b) General awareness

	Model A (education)			Model B (media)			Model C (networks)			Model D (communication)			Model E (combined model)		
	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant	1.140	0.375	0.002	0.862	0.365	0.018	0.574	0.434	0.186	0.778	0.344	0.024	0.666	0.330	0.044
Mat educ (grade)	0.180	0.015	0.000	0.148	0.016	0.000	0.171	0.015	0.000	0.133	0.015	0.000	0.114	0.015	0.000
TV (1=Y 0=N)				0.028	0.135	0.838									
Tel (1=Y 0=N)				0.413	0.122	0.001							0.258	0.110	0.019
Radio (1=Y 0=N)				0.064	0.115	0.578									
Newsp. (1=Y 0=N)				0.402	0.136	0.003							0.350	0.121	0.004
NW size (no.)							0.101	0.038	0.008						
NW literacy (%)							0.426	0.216	0.048						
NW live out (%)							0.326	0.206	0.115						
NW sex (% male)							0.003	0.276	0.991						
Com. Ability (0-2)										0.543	0.068	0.000	0.468	0.068	0.000
Pat. educ. Prim.	0.038	0.171	0.825	0.033	0.163	0.842	0.008	0.171	0.961	0.032	0.154	0.835	0.023	0.149	0.878
Sec.	0.116	0.163	0.477	-0.061	0.160	0.704	0.022	0.170	0.896	-0.046	0.148	0.755	-0.155	0.146	0.289
Higher	0.066	0.148	0.657	-0.026	0.146	0.857	-0.001	0.153	0.997	-0.010	0.133	0.940	-0.073	0.130	0.576
Mat. age (yrs)	0.007	0.013	0.597	0.006	0.013	0.622	0.007	0.013	0.593	0.003	0.012	0.811	0.003	0.012	0.823
Hous. qual. (0-1)	0.346	0.245	0.158	0.256	0.233	0.272	0.333	0.240	0.165	0.357	0.221	0.106	0.301	0.214	0.159
Own land*	0.149	0.164	0.361	0.111	0.160	0.489	-0.006	0.162	0.970	-0.012	0.148	0.937	-0.024	0.147	0.872
Adults in HH	-0.014	0.064	0.824	0.018	0.061	0.767	0.006	0.062	0.920	-0.011	0.057	0.846	0.005	0.056	0.922
Children in HH	-0.037	0.023	0.104	-0.031	0.022	0.160	-0.028	0.023	0.236	-0.023	0.021	0.255	-0.020	0.020	0.324
Ethnic grp ST	-0.396	0.238	0.096	-0.368	0.227	0.106	-0.436	0.232	0.060	-0.297	0.219	0.175	-0.287	0.208	0.167
BC	-0.306	0.151	0.043	-0.355	0.148	0.016	-0.313	0.147	0.033	-0.262	0.139	0.059	-0.278	0.135	0.039
OC	-0.199	0.179	0.264	-0.286	0.174	0.099	-0.252	0.175	0.150	-0.131	0.163	0.420	-0.201	0.158	0.203
Site Urb Anan	0.354	0.208	0.088	0.227	0.202	0.261	0.211	0.210	0.315	0.181	0.203	0.371	0.098	0.183	0.594
Mahubnagar	-0.665	0.136	0.000	-0.558	0.138	0.000	-0.562	0.134	0.000	-0.693	0.130	0.000	-0.629	0.119	0.000
Hyderabad	-0.196	0.213	0.356	-0.064	0.214	0.763	-0.451	0.218	0.038	-0.164	0.205	0.423	-0.058	0.187	0.758

7.4 Summary and Discussion

7.4.1 Summary of findings

In this chapter I have explored the crude and adjusted effect of mothers' education, use of media, communication network characteristics and communication ability in determining their health and nutrition knowledge and general awareness. Crude analysis suggested all of the above factors were associated with the outcomes. However, once adjustment had been made for confounding factors, the size of this effect was reduced and only a small number of indicators remained statistically significant in the final combined model. For example, an initial effect was found of the literacy among female network members living outside the household on maternal HN knowledge adjusted for maternal education and other confounders. However, once network size was included in the model the effect disappears. The final combined model suggested that mothers' HN knowledge is best predicted by education, communication ability and size of communication network, and that general awareness is best predicted by education, communication ability, use of telephones and reading newspapers.

Although the results cannot provide evidence of causality they nevertheless suggest that education and communication are important for both mothers' acquisition of HN knowledge and awareness in general. The results also suggest that media, in particular the printed media and use of telephones, leads to the acquisition of general knowledge about current affairs, geography and politics, whereas HN knowledge may be transmitted through word of mouth between network member.

7.4.2 Main implications of findings

It is plausible that mothers' patterns of communication – as determined by their communication ability and the size of their communication networks – have an impact on her HN knowledge, because, as the literature reviewed in Chapter 5 suggests, mothers rarely make decisions in isolation but do so in conjunction with others. Networks can be a

source of social learning and influence. Interpersonal and communication skills may enhance women's capacity to care for their children, as discussed previously in Section 5.4.4. In this chapter I have shown that women who reported to have large communication networks were more likely to have higher HN knowledge scores than women who reported to have small networks. Further research is needed to establish whether this relationship is causal. It is possible that women who already possess high HN knowledge deliberately expand their communication networks. However, the cross-sectional study by Valente in Cameroon nevertheless suggests that the association between individual respondents and their networks characteristics is causal, so that a mother's knowledge can indeed be obtained from her network members. Valente found that this is because mothers who reported being encouraged by other network members to use contraception were particularly likely to use it themselves. The encouragement suggests that there is a direct influence from the network members to the individual respondent (Valente, Watkins et al. 1997). If the results of this study are applicable to Andhra Pradesh, it is plausible that increasing the size of communication network leads mothers to acquire more HN knowledge.

The results show an association between maternal education and her HN knowledge. This is particularly interesting given the lack of studies in India that corroborate this result. For example the study by Kutty (1989) and Gupta (1991) both showed that there were no difference between education and uneducated women in their health knowledge (see Section 5.3.1 for a review of the literature).

When speculating about the direction of the causal arrow it is possible to draw a distinction between maternal education and other variables because education represents a decision made in the past and it is impossible for mothers to alter her status of education in response to her knowledge status (other than through adult education programmes, but less than 3% of the original YL sample reported to have done this). It is therefore plausible that education leads mothers to acquire HN knowledge. It is considered unlikely that mothers have been taught in school the answers to the questions used to assess HN knowledge. More likely is the scenario that they have obtained

information outside the classroom. This interpretation supports the proposition by Glewwe (1999) in suggesting that education plays a role in imparting skills rather than knowledge and that the skills – in literacy, numeracy and communication ability – are used to gain HN knowledge from elsewhere, such as the media or by talking to others. The findings by Glewwe would suggest that a full regression model, one which includes education along with media and communication networks, would show a smaller effect of maternal education on HN knowledge because part of the education effect operates through these factors. Nevertheless, despite including all factors in the combined model, I have shown that education remains a statistically significant predictor of knowledge, which suggests that education affects HN knowledge through alternative mechanisms also. It is likely that other potential sources of knowledge, which were not explored in this study, may play a part in mediating the education on knowledge, such as employment outside the home, travelling/migration and attending health programmes.

The results show that the education of the mother herself and that of her communication network is associated with her HN knowledge and general awareness score adjusted for maternal education and other confounders, although this effect disappears once network size is added to the model. The results complement those presented in Chapters 3 and 4 by demonstrating the relevance of the education of people in mothers' households, community and networks.

Any discussion about the meaning of 'general awareness' will contribute to the wider debate about the relative importance of women's identity and acquired skills. Many of the variables used in the analysis are likely to act as proxies for innate characteristics, characteristics which form part of an individual's identity. Both communication ability and general awareness are indicators which may represent both a transferable skill (the ability to communicate well and to pick up information) and individual identity (defined here as a non-transferable characteristic). For example, general awareness may represent a woman's willingness to embrace the modern ethos, an eagerness to learn and the courage, and a self-confidence to move and interact with the world beyond her immediate family. The extent to which these are skills that can be taught, perhaps by going to

school, is not known. It is plausible that general awareness scores act as a proxy for these skills or traits, because it would explain its strong association with communication networks and use of media. Meanwhile, the association between education and general awareness may not be causal because the same characteristics which made the girl attend school and excel academically may be the same characteristics which give her high general awareness scores. This issue is a complex one, and has been studied in detail by others in the past [for example (Behrman, Rosenzweig et al. 1994; Joshi 1994)]. The potential confounding role of otherwise unmeasured personal characteristics will be discussed further in the next chapter.

7.4.3 Next steps

This chapter has shown that HN knowledge is determined by education, along with other factors. The next step in the analysis is to assess the effect of maternal HN knowledge on child nutrition and hence determine its role in mediating maternal education effect on nutrition. The results will be compared with general awareness in order to contribute to the wider debate about the role of women's skills and identity in determining child nutrition.

CHAPTER 8

THE ROLE OF MATERNAL HEALTH AND NUTRITION KNOWLEDGE IN MEDIATING THE EDUCATION EFFECT: SOME METHODOLOGICAL CHALLENGES

The chapter is split into five sections. In the first section I introduce and justify the analysis. In the second section I define and explain the problem of 'endogeneity' and the 'instrumental variable approach' which is used in an attempt to overcome the problem. This is followed by a description of methods and results in the third and fourth sections respectively, which are finally summarised and discussed in the fifth section.

8.1 Introduction

8.1.1 Background

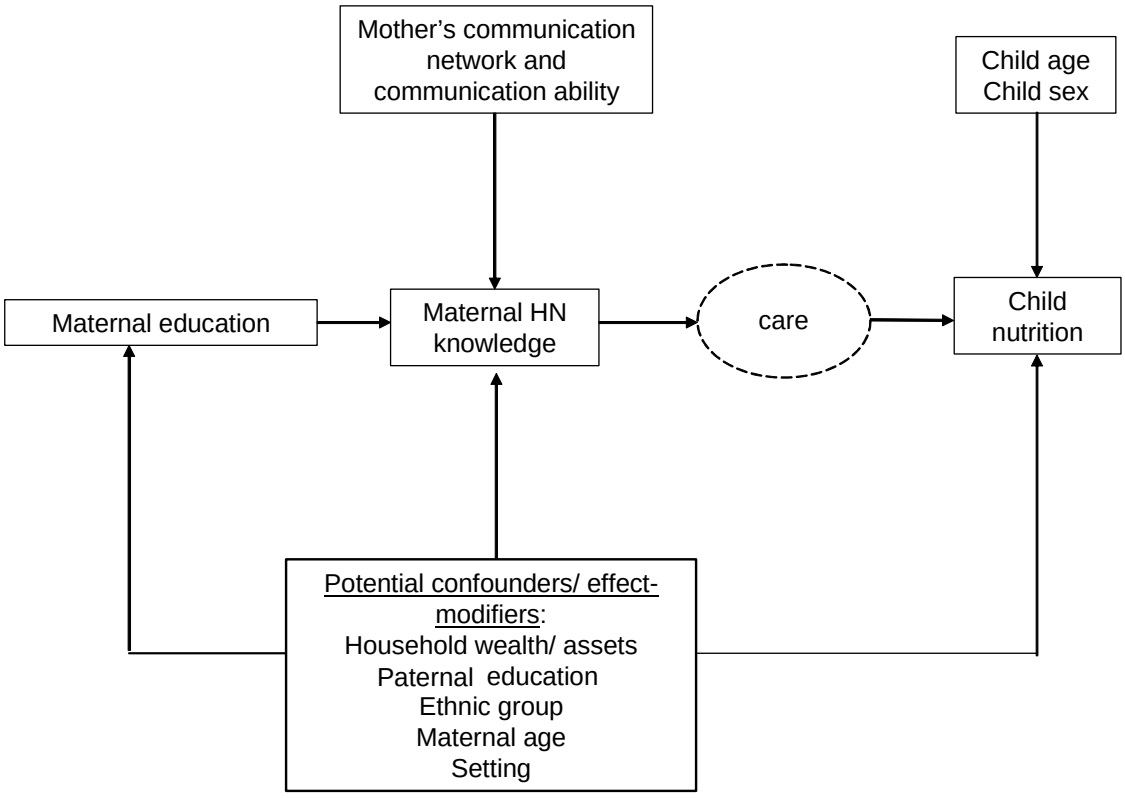
In this chapter I will examine the independent effect of mothers' HN knowledge on child nutrition and its role in mediating the education effect. I will use two estimation procedures, the instrumental variable procedure (IV) and ordinary least squares (OLS) and compare the results.

The findings from the previous chapter will inform the development of an 'instrument' for HN knowledge score which is suspected of being endogenous, a problem which has been identified and explored in the recent literature on this topic (see Section 5.3.2) and which will be explained further in this chapter. For comparative purposes, I will undertake similar analysis for mothers' general awareness. General awareness represents

an alternative type of knowledge which is less likely to suffer from reverse causality than HN knowledge (see Section 8.2.1 for more discussion).

The analytical framework, presented in Figure 8.1, will inform the development of OLS and IV regression models. It illustrates the hypothesis that maternal education affects child nutrition through maternal HN knowledge. Other determinants of HN knowledge represented in the framework, which have been identified in the previous chapter, are communication network characteristics and communication ability. Potential confounders and effect-modifiers of the relationship between maternal education and nutrition have been identified in Chapter 3 and include paternal education, setting (urbanity and/or site), maternal age, household assets (ownership of land, number of adults and children, and number of economic sectors involved in) and household wealth. Mothers' ethnic group (or caste) is also considered to be a confounder. Child age and sex are considered to be independent risk factors of child nutrition.

Figure 8.1 Analytical framework: illustration of hypotheses that maternal HN knowledge mediates the effect of maternal education on child nutrition



8.1.2 Objectives

The overall objective of this chapter is:

- To examine the role of maternal health and nutrition (HN) knowledge in mediating the education effect on child nutrition, using both conventional and econometric methods

Specific objectives are:

- To estimate the independent effect of maternal HN knowledge on child nutrition using OLS and IV methods
- To determine the role of HN knowledge in mediating the education effect and compare it with the role of general awareness using OLS and IV methods
- To assess the strengths and weaknesses of using the IV approach

8.2 The problem of endogeneity: a review of the literature

In this section I will firstly explain the meaning of 'endogenous' and 'exogenous' variables, secondly the reasons why HN knowledge and general awareness may be endogenous variables in the analysis and thirdly the recent application of econometric methods in epidemiology to overcome the problem of 'endogeneity'.

8.2.1 The endogeneity of maternal HN knowledge

Definition of endogenous and exogenous variables

It was mentioned in Chapter 5 that several studies examining the mediating role of knowledge in the education-nutrition relationship have drawn attention to the problem of 'endogeneity' (Ruel, Habicht et al. 1992; Glewwe 1999; Kovsted, Pörtner et al. 2002). This is a problem because, as two of the studies demonstrate, ignoring the endogeneity problem can lead to the underestimation of effect of knowledge on nutrition (Glewwe 1999; Kovsted, Pörtner et al. 2002). The term 'endogeneity' originates from econometrics. An endogenous variable is one that is dependent on other explanatory

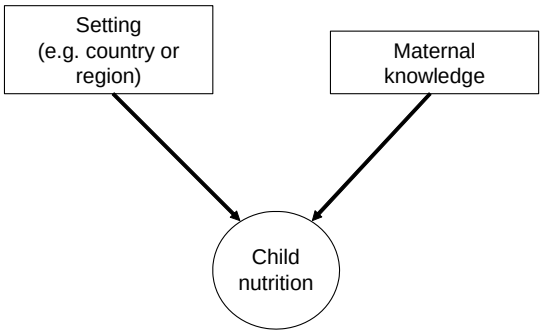
variables in the model or the dependent variable itself. Bias can arise if an endogenous variable is treated as an exogenous variable, whose value is determined by factors or variables outside the causal system under study. An example of an exogenous variable within the causal system of farming is 'rainfall'. However, in a different causal system this variable may no longer be exogenous. For example, in a weather system 'rainfall' may become endogenous because it is determined by other variables within the system. The status of endogenous and exogenous variables is therefore relative to the specification of a particular model (Kennedy 1992; Lewis-Beck, Bryman et al. 2004). When establishing the exogenous and endogenous status of variables in a model it is therefore important to be explicit about all the causal relationships within the system.

Endogeneity due to unobserved factors

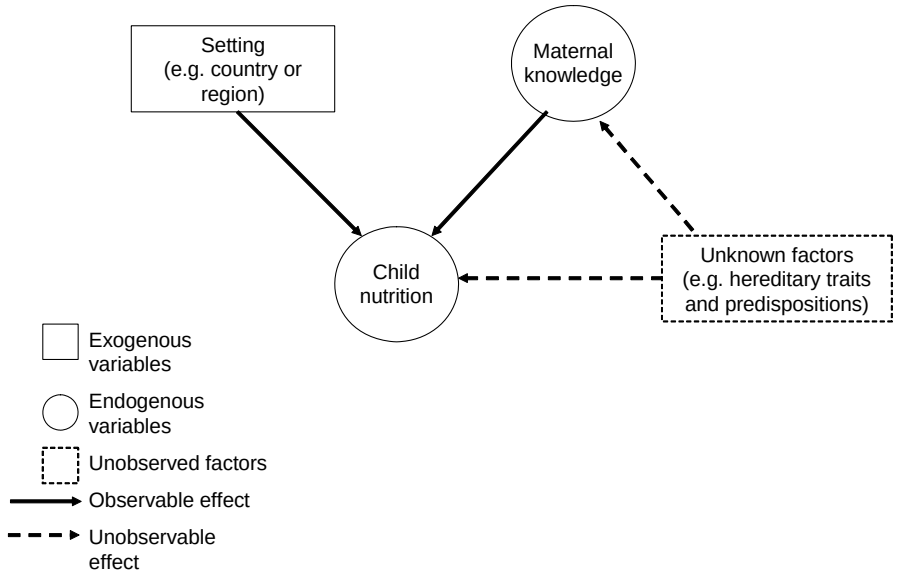
Figure 8.2 (a) illustrates a causal system where an endogenous variable, child nutrition, is dependent upon two exogenous variables, setting and maternal knowledge. These two variables are defined as exogenous because they are not determined by any other factor in the causal system. However, as shown in Figure 8.2 (b), maternal knowledge may be endogenous if it is determined by an unknown factor which is also associated with child nutrition?. This unknown factor acts as a confounder of the relationship between maternal knowledge and child nutrition. The figures therefore show that the recognition of the potential role of unknown factors in the causal system changes the status of the maternal knowledge variable from 'exogenous' to 'endogenous'.

Figure 8.2 An illustration of the change in status of variables, from being exogenous (a) to endogenous (b), which comes about by recognizing the confounding effect of unobserved factors

a) Maternal knowledge is exogenous



b) Maternal knowledge is endogenous



Why HN knowledge may be endogenous

Maternal HN knowledge may be endogenous in a causal system that describes its relationship with child nutrition. This is because HN knowledge is likely to be determined by unobserved factors, such as genetic 'endowments', which also determine child nutrition. Parents with poor health endowments are more likely to have sickly children and more likely to actively seek out HN knowledge than parents of healthy children because 'parents are not passive receptors to threats to health' (Briscoe, Akin et al. 1990). A mother whose child has severe diarrhoea may become more familiar with ORS than a mother with good health endowments whose child is healthy. Thus the problem of endogeneity occurs when unobserved health endowments, such as the genetic predisposition to be sick or short, are causally related to both HN knowledge and child nutrition. It is therefore likely that these unobserved health endowments, which can also be thought of as unknown confounders, can lead to the problem of 'reverse causality' between maternal HN knowledge and child nutrition. Previous studies have shown that ignoring these unknown confounders can lead to an underestimation of the effect of knowledge (Glewwe 1999; Kovsted, Pörtner et al. 2002). This is because the positive effects of health knowledge are outbalanced by the 'reverse causality' effect that occurs when parents with poor health endowments deliberately seek out health knowledge for their sick child.

Why general awareness may be endogenous

The role of general awareness will be examined here and the results compared with the findings for HN knowledge. In contrast to HN knowledge, the relationship between mothers' general awareness and child nutrition is less likely to suffer from reverse causality because mothers are unlikely to seek out knowledge about politics and geography in response to having a malnourished child. Instead, they are more likely to seek out knowledge on health and disease. However, it is likely that general awareness will be associated with mothers' unobserved personal characteristics such as status, self-confidence, eagerness to learn, a modern outlook on the world and so on. These personal characteristics, whether innate or taught, are also likely to benefit child nutrition through improved caring practices. Studies showing unexplained clustering of death and

malnutrition within families have suggested that caregivers' capabilities are important determinants of child health and nutrition, and these capabilities cannot always be measured directly (Das Gupta 1990; Elo 1992; Behrman 2000; Fenn, Morris et al. 2004). It is therefore plausible that ignoring endogeneity due to confounding by unknown factors will lead to effect estimates of general awareness on child nutrition being biased upwards. Ignoring unknown confounders may therefore overestimate the effect of general awareness because the observed positive effect may be explained by alternative factors.

The recent introduction of econometric methods in epidemiology

The problem of confounding by unknown factors has, in recent years, encouraged epidemiologists to turn to econometric methods to attempt to overcome the problem. While epidemiological studies have traditionally been designed to collect data on relevant confounders in advance (and most data analysis methods operate under the assumption that these confounders are available for use in a model or analysis) studies in econometrics and social sciences have relied on data-sets which may not have been constructed with a specific research purpose (such as census data), and the prevailing analysis methods have therefore been aimed towards addressing the problem of endogeneity (Kennedy 1992; Zohoori and Savitz 1997; Gibson 2002; Kovsted, Pörtner et al. 2002; Hogan and Lancaster 2004). In recent years a handful of key epidemiological studies have generated discussion on the application of econometric methods to overcome its associated problems (Briscoe, Akin et al. 1990; Cebu Study Team 1991; Behrman, Rosenzweig et al. 1994; Bollen, Guilkey et al. 1995; Zohoori 1997; Zohoori and Savitz 1997; Greenland 2000; Berg and Mansley 2004; Klungel, Martens et al. 2004; Leigh and Schembri 2004; Davey Smith, Lawlor et al. 2005). Epidemiologists are increasingly recognizing the need to import methods from other disciplines (Mennemeyer 1997; Zohoori and Savitz 1997; Hogan and Lancaster 2004; Kaplan 2004; Leigh and Schembri 2004). A particularly interesting issue of the 'Journal of Econometrics' in 2003 contains a collection of articles by epidemiologists, economists and others discussing this issue and demonstrates the variety of complex techniques available (Adams, Hurd et al. 2003; Adams, Hurd et al. 2003; Hausman 2003; Wagstaff, van Doorslaer et al. 2003). Such methods include the structural approach grounded in econometric simultaneous

equation models (Kennedy 1992; Greene 1997; Hausman 2003), causal analysis and simulation (Greenland and Brumback 2002; Chandola, Clarke et al. 2004), sensitivity analysis (Greenland 1996), use of propensity scores (D'Agostino 1998; Joffe and Rosenbaum 1999) and the instrumental variable approach which will be discussed next. Attention will be focused on the instrumental variable approach because it is the method used by Ruel (1992), Kovsted (2002) and Glewwe (1999) to overcome the problem of unknown confounders in the study of the role of knowledge in mediating the effect of education on child nutrition.

8.2.2 The Instrumental Variable (IV) procedure

The definition of 'instrumental variables'

The term 'instrumental variables' (IV) is used to define an estimation procedure and the exogenous variables used in this estimation procedure. I will here provide an intuitive explanation of the IV approach rather than a formal explanation which is available in econometric text books (Kennedy 1992; Maddala 1997; Baltagi 1998). My explanation will begin by explaining why ordinary least squares analysis (OLS), which is a conventional method for analysing observational data, would yield biased estimates if an endogenous variable is treated as exogenous. Considering the model illustrated in Figure 8.2 (a), an OLS equation describing this model would be:

$$N = \beta_1 S + \beta_2 HN + \mu$$

where S (setting) and HN (maternal knowledge) are variables that explain variation in another variable N (child nutrition) and μ is a random error term. Now let us consider the more complex model in Figure 8.2 (b), where unknown factors confound the relationship between HN and N. It would not be possible to create an OLS equation of this model because the unknown factors are by definition unobserved and can therefore not be included in the model as a way of adjusting for the confounding effect. The IV approach addresses the confounding problem by defining an exogenous variable or variables

(instruments) to act as surrogates for the variable suspected of being endogenous (HN). I will now explain what makes a valid instrument.

The application of the IV approach

The instruments must have two properties to be valid:

1. They must be theoretically related to the endogenous variable, and the association must be strong.
2. They must not, theoretically at least, be directly related to the outcome other than through the instrument itself.

A widely used method for creating an IV is to develop a 'reduced-form' equation using a two-stage least squares (2SLS) approach (Kennedy 1992). In the first stage the endogenous variable (HN) is expressed as a linear function of all the exogenous variables in the system, so that a predicted value for the endogenous variable is calculated. At least one of these exogenous variables is a specifically selected 'instrument', which is known in the literature to be a strong predictor of the variable in question.

The second stage of the 2SLS estimation involves regressing the outcome (N) on the predicted values of the original endogenous variable using OLS. The effect estimate is then an unbiased estimate of the hypothesized relationship between the outcome and original explanatory variable of interest. Additional exogenous variables are usually added to both the first and second stage models in order to improve the precision of the estimation, and it is recommended that the same variables be added to both the first- and second-stage models in order to avoid simultaneous equations bias (Baltagi 1998).

Implications for precision of parameter estimates

Any interpretation of the findings produced using the IV procedure must bear in mind that the instruments are predicted variables. One can therefore not proceed with the interpretation of the findings as if the instruments were ordinary explanatory factors because the instruments are not directly observed and are a construct based on other known factors. Their values are therefore likely to have a greater range than the original variable, leading to a reduction in precision. To account for the fact that the instruments

are predicted values, adjustment needs to be made to the standard errors, which can be done using standard statistical software (see Section 8.3.3 for further explanation).

Examples of the IV approach used in epidemiology

The number of epidemiological applications of the IV approach is growing. A good instrument can be geography, for example the distance from the hospital (Newhouse and McClellan 1998) and time-lagged variables can also be used to avoid the problem of reverse causality (Kennedy 1992). In a randomised controlled trial, randomisation itself is an instrumental variable because it determines who is treated but is not itself related to the outcome. The IV approach is also used in genetic epidemiology where genotypes may be related to a specific predictor of health status but not health itself (Thomas and Conti 2004; Davey Smith, Lawlor et al. 2005). In a recent study genotypes were used to assess the effect of C-reactive protein on blood pressure and hypertension because genotype is associated with C-reactive protein but not with any outcomes. The predicted association between the outcome and the predicted C-reactive protein is therefore un-confounded (Davey Smith, Lawlor et al. 2005).

The IV approach for education effects

Several studies have used the IV approach to examine health-effects of education, especially in the US. These studies use instruments of education created by exogenous policy changes which lead to disruptions of education which are unlikely to correlate with the outcome. The recent work by Lleras-Muney, for example, uses changes in compulsory education laws as instruments for education to show that education has a causal impact on mortality over time (Currie and Moretti 2002; Lleras-Muney 2005).

Methods used by Ruel (1991), Glewwe (1999) and Kovsted (2002)

To overcome the problem of HN knowledge being endogenous Glewwe (1999), Kovsted (2002) and Ruel (1991) all instrument the knowledge variable and conduct two-stage least squares regression analysis. Kovsted's instrument is religion of the household, where the assumption is that belonging to an organised religion in contrast to an animist variant is likely to increase a person's HN knowledge, and yet it is unlikely that religion

is directly related to child nutrition. The study by Ruel et al (1992) used a collection of determinants of maternal knowledge as instruments, such as health clinic access, but did not justify the choice of the instruments used. Glewwe (1999) attempts to adjust for a child's unobserved health endowments by entering the heights of both parents as explanatory variables, since taller parents are likely to have better health endowments, which in turn are inherited by their children. He also argues that entering parental height into the regression model has the additional benefit of purging the dependent variable of variation in height that is not indicative of health status.

8.3 Methods

8.3.1 Developing a causal model

The development of a causal model to illustrate the independent effect of maternal knowledge on child nutrition and its role in mediating the education effect will be done in three stages illustrated in Figure 8.3.

Stage 1 – two determinants of nutrition
I will begin by proposing a prediction equation for child nutrition:

$$N=a_0 + a_1HN + a_2ME + e$$

where N is child nutrition z-score (either height-for-age or weight-for-age), HN is maternal health and nutrition knowledge, ME is maternal education, a_0 is a constant (intercept), a_1 and a_2 denote the sensitivity of N to HN and ME respectively, and *e* is the error term. This model is represented in Figure 8.3 (a). By definition the outcome variable N is taken to be an endogenous variable (represented in the figure by a circle). In contrast maternal education (ME) is assumed to be exogenous (represented by a box) following the assumption made by Thomas (1990) and Glewwe (1991) that it represents a decision made in the past and therefore cannot be altered in response to having a

malnourished child (this assumption will be discussed further in the final section of this chapter in Section 8.5.2). At this stage maternal knowledge, HN, is defined as exogenous because it is not determined by any other factor in the causal system.

Stage 2 – confounding effect of unknown factors

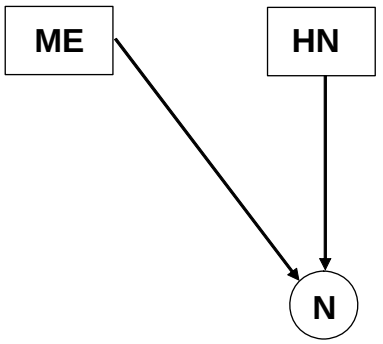
The second stage in the development of the model is to acknowledge the role of unknown factors confounding the HN-N relationship [Figure 8.3 (b)]. Note that the status of the HN variable has therefore changed from being exogenous (represented by the box) to endogenous (represented by the circle). The role of unknown factors cannot be expressed by an OLS equation – by definition – because the factors are unknown and unobserved. Instead the problem of endogeneity of the knowledge variable will be dealt with by using the IV approach, as will be explained below.

Stage 3 – the instrument

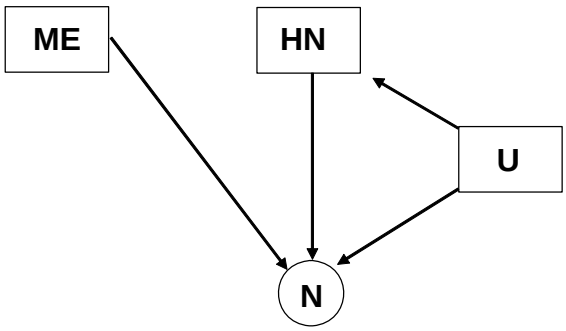
The IV approach will be used to overcome the problem of endogeneity of HN caused by its dependency on known and unknown factors. This involves identifying at least one variable known as an 'instrument', which is a determinant of HN but not N, to act as a surrogate variable. The instrument for HN knowledge is the number of females in the communication network who live outside the household (FCN). I will now justify the choice of instrument.

Figure 8.3 The staged development of a causal model where system where maternal knowledge (HN) is endogenous due to unobserved heterogeneity

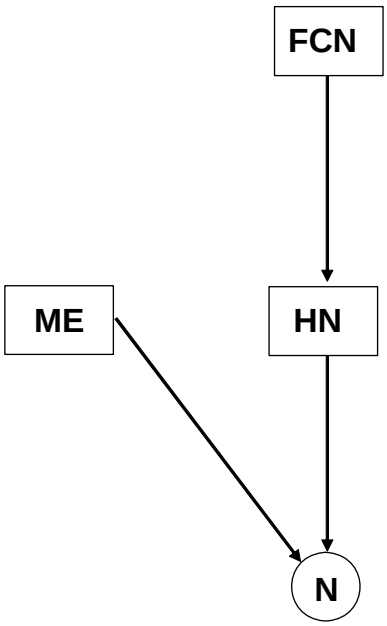
a) Stage 1 – two determinants of nutrition



b) Stage 2 – confounding by unknown factors



c) Stage 3 – the instrument



8.3.2 Identifying instruments

As mentioned earlier in Section 8.2.2, an instrument must be strongly correlated with the exposure of interest (HN knowledge) but not be a direct cause of the outcome (child nutrition). The Knowledge and Networks study data-set offers one potential instrument for HN knowledge – the number of females in the communication network living outside the household (FCN) – which in Chapter 7 was shown to be strongly associated with HN knowledge and unlikely to influence child nutrition other than through maternal HN knowledge. While it is possible that FCN affects child nutrition other than through the mothers' knowledge, for example through childcare, it is unlikely because the network members live outside the household, although I cannot be certain because no data were collected on care-giving. It is also highly improbable that women will expand their female network in response to having a malnourished child. This justification of the use of FCN as an appropriate IV is based on a number of assumptions, the implications of which will be discussed later on in this chapter in Section 8.5.2.

Other variables in the data-set were considered as possible IVs but rejected, such as total network size and communication ability. Although total network size was found to be a stronger determinant of HN knowledge than FCN, the choice of this variable as an instrument is problematic because it is likely to include household members who, as explained above, may directly influence child nutrition through care-giving. It is less likely that network members living outside the household would influence child nutrition through care-giving. Similarly, mothers' communication ability was also shown to be associated with HN knowledge in Chapter 8, but this variable was also rejected as a potential IV as it is unlikely to be exogenous. Mothers' communication ability is probably associated with unobserved personal traits, such as self-confidence, which are also likely to positively impact upon child nutrition. In short, the variables in the data-set limit the availability of suitable instruments. Although FCN was considered the most suitable instrument, it's use is based on a number of assumptions, which will be discussed in Section 8.5.2.

8.3.3 Model development

The next step is to replace the variable HN knowledge, which is deemed to be endogenous, by its predicted value based on the instrumental variable, FCN, in addition to other exogenous variables in the model. Before doing so it is necessary to identify which other variables are exogenous.

As Greenland explains in detail, it is useful to use graphical displays in order to identify confounding and the sufficiency of confounder adjustment (Greenland and Brumback 2002). These graphical displays are essentially an illustration of qualitative assumptions about causal directions and independencies in a population. Figure 8.4 (a) shows that the relationship between the predicted value of HN (depicted by a hat) and child nutrition is determined by household wealth and assets (W and A) and characteristics of the rural/urban setting (S). However, these variables are endogenous because they are themselves determined by ethnic group (EG). In the Indian culture ethnic group or caste is recognised as being a strong predictor of income and the choice of neighbourhood and the effect of caste operates through these factors. It is therefore sufficient to adjust for the effect of EG. The figure shows that EG is a truly exogenous variable in the causal system, along with the age and sex of the child (C) and the age of the mother (MA). All these variables have the common feature of being 'pre-determined'.

This graphical display is used to justify the choice of variables to be included in the IV model. Only ethnic group, maternal age, child age and child sex are included as regressors in the model. The model can now be best described as a set of structural equations:

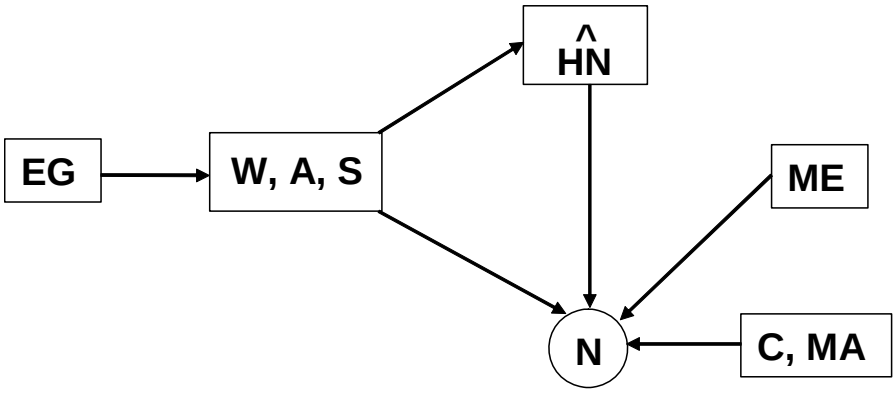
$$HN = \delta + \beta_1 ME + \beta_2 (C, MA, EG) + \beta_3 (FCN) + \alpha_3 N\, \varepsilon_z$$
$$N = \gamma + \alpha_1 ME + \alpha_2 (C, MA, EG) + \alpha_3 HN + \varepsilon_Y$$

The mediation by HN of the ME effect is assessed by comparing the change in coefficients of ME between a second stage model that includes and one that excludes

HN. Instrumenting general awareness will be done in the same manner. Results from the previous chapter showed that FCN was also a determinant of general awareness, along with telephone use and newspaper reading. All three factors will therefore be used as instruments for general awareness. The assumption is made that use of telephones and newspapers are deemed to be suitable IVs because they are strongly correlated with HN knowledge, as shown in Chapter 7, and do not directly determine child nutrition other than through the improvement in general awareness.

It should be noted that this study is substantially smaller than previous studies in this field. Given that all the exogenous variables used here to predict HN knowledge are likely to be measured with some degree of error, it is likely that the small sample size of this study makes it harder to detect an effect than it would be in a larger study where the measurement error would be more diluted.

Figure 8.4 A graphical display of the causal relationships between health and nutrition knowledge (HN; instrumented) and child nutrition (N)



EG Ethnic group
W HH wealth
A HH assets
S Setting
^HN Health and nutrition knowledge (predicted)
N Child nutrition
ME Maternal education
C Child characteristics (age and sex)
MA Mother's age

8.3.4 Running the IV estimation procedure in Stata

I fitted a linear regression model using instrumental variables while adjusting standard errors by using the 'ivreg' command in Stata (see Section 9.2.2 for an explanation of standard error adjustment). All exogenous variables are automatically used in the first stage regression because the nature of simultaneous equations dictates that the exclusion of any exogenous variable as instruments would lead to biased effect estimates (Bairagi 1980).

8.4 Results

In this section I compare the results from the IV and OLS estimation procedures. However, before the results are presented four issues are debated: adjustment for confounders, the lack of effect of ME for child height-for-age, the suitability of the instruments and adjustment for geographical clustering within communities. The number of cases dropped due to missing values was 17, leaving a sample size of 274.

8.4.1 Adjusting for confounders

The small number of mothers compared with other similar studies, along with a small number of sites within which mothers were sampled, contributes to the lack of robustness of effect estimates: borderline significant effects disappear once additional confounders are added to the model. Given the aim is to assess the role of knowledge in mediating the effect of ME on child nutrition, a statistically significant relationship between ME and child nutrition is a prerequisite. Unfortunately, the inclusion of all confounders in the model removes the effect of maternal education, which prevents me from proceeding to the next step of analysis. Therefore I have taken the difficult decision to view the analysis in this chapter as an exercise: an exploration in the application of the IV approach where the focus is on the process of model development (identifying instruments and comparing IV and OLS regression output) rather than effect estimation. This decision was a

necessary one in order to justify the exclusion of a small number of confounders from the analysis – paternal education, communication ability and communication network size – to secure a statistically significant relationship between ME and child nutrition. These confounders were excluded in preference to other confounders because they have not been included in the models in previous studies exploring this question (Ruel, Habicht et al. 1992; Glewwe 1999; Kovsted, Pörtner et al. 2002). The analysis includes the following potential confounders: child age and sex, mothers' age and ethnic group, household wealth and assets (household ownership of land, economic sectors and number of adults and children in the household) and site.

8.4.2 The effect of maternal education on child height and weight

As explained in the section above, a statistically significant relationship between ME and child nutrition is a prerequisite for this analysis given the aim is to assess the role of knowledge in mediating the effect of ME on child nutrition. The effect of ME on child height and weight was therefore assessed. The regression output for the two models estimating the effect on height-for-age and weight-for-age is given in Table 8.1 (Model A and B), adjusting for confounding factors. The results show that ME has a small and statistically non-significant effect on child height (0.02 95% CI -0.03 - 0.06 P=0.461), whereas the effect on weight-for-age was stronger and statistically significant (0.03 95% CI 0.00 - 0.07 P=0.049).

The lack of an observable effect of ME on child height means that weight-for-age will be used as the key outcome in the analysis. It is surprising that an effect on height was not found, as it is an indicator of chronic malnutrition and therefore more plausibly affected by maternal education than weight. Further analysis reveals that the inclusion of site as a fixed effect in the model acts as a much stronger confounder for height-for-age than weight-for-age, as assessed by the reduction in maternal education coefficient by almost 60% from 0.039 to 0.016 for height-for-age compared with only 20%, from 0.043 to 0.037, for weight-for-age. This would suggest that the site variable includes strong confounders of stunting, for example community-level education or wealth, that are less

important for child weight. Including site as a fixed effect therefore explains a large amount of variation in stunting, making it difficult to detect an effect of individual-level factors.

As it has been suggested that even a small amount of maternal education can have beneficial effects on child nutrition (see Section 1.3.1), further analysis was undertaken to assess the effect of education below the completion of primary school. The grade variable was therefore categorized into the following groups: 0, 1-4, 5-6, 7-8 and 9 and above. The results showed that grades 1-4 had a negative effect on height-for-age z-score (-0.64 95% CI -1.34 - - 0.06 P=0.074) and weight-for-age z-score (-0.55 95% CI -1.08 - -0.18 P=0.043). With 0 grades as the reference category, none of the other levels of schooling had a statistically significant effect although the direction of the coefficients turned positive for grades 5 and above. These results go against previous research which indicates that even a small amount of education is good for nutrition (LeVine, LeVine et al. 2004; Basu and Stephenson 2005). It is possible that the small benefits of a mother attending school for less than five years are out-weighed by the negative effects of premature drop-out, which may be associated with wealth factors not sufficiently adjusted for in the model.

8.4.3 Suitability of instruments

As was mentioned earlier in Section 8.2.2 one important condition of a valid instrument is that it is highly correlated with the endogenous variable. A way of assessing this is by regressing 'knowledge' on all exogenous variables and assessing the fit of the models (Bound, Jaeger et al. 1995). The results for HN knowledge and general awareness are given in Table 8.1 (Model C and D). The number of observations available for analysis was 274 (see Section 6.3.6 for data cleaning procedure). The adjusted R^2 was 0.60 for general awareness and 0.38 for HN knowledge, suggesting that the exogenous variables can explain a larger proportion of the variation in general awareness than HN knowledge. This suggests that the instruments for general awareness are likely to perform better than the instruments for HN knowledge.

8.4.4 Accounting for data structure

It is possible to adjust for the geographical clustering of observations within communities and sites while applying the IV method by using the 'svyivreg' command. However, for technical reasons it cannot be used in conjunction with the 'ivendog' command which will later be used to apply a specification test between the IV and OLS models. Therefore no adjustment is made for geographical clustering of observations between communities, although site will remain as a fixed effect in the model. In order to assess whether accounting for within-community correlation would have yielded different effect estimates, the regression output was compared between a model which specifies community as a random effect and another model that does not. Both models include site as a fixed effect. The results are presented in Table 8.2 (Model A and B) and show that there is almost no difference between the effect estimates of key exposures. I can therefore be confident in the results produced later in this chapter without adjustment for geographic clustering between communities.

Table 8.1 OLS regression output: the role of maternal education (ME) for child height-for-age (Model A) and weight-for-age (Model B), and the instruments used to predict HN knowledge (Model C) and general awareness scores (Model D) (N=274)

	Model A (height-for-age)			Model B (weight-for-age)			Model C (HN knowledge)			Model D (general awareness)		
	Mean	SE	P	Mean	SE	P	Mean	SE	P	Mean	SE	P
Constant	-1.425	0.801	0.076	-1.708	0.608	0.005	1.085	0.354	0.002	-0.204	0.407	0.617
ME (grade)	0.017	0.023	0.461	0.034	0.017	0.049	0.105	0.011	0.000	0.161	0.014	0.000
Maternal age (years)	0.015	0.021	0.488	0.009	0.016	0.578	0.002	0.010	0.838	0.020	0.011	0.079
Ethnic group SC	-0.109	0.378	0.773	0.287	0.287	0.319	-0.242	0.195	0.216	-0.404	0.224	0.073
BC	0.109	0.239	0.650	-0.019	0.182	0.917	-0.053	0.119	0.658	-0.465	0.139	0.001
OC	0.103	0.286	0.719	-0.063	0.217	0.771	0.103	0.146	0.478	-0.314	0.170	0.066
Child age (mo.)	0.008	0.014	0.575	-0.012	0.010	0.243	0.008	0.007	0.222	0.012	0.008	0.136
Child sex (0=F 1=M)	-0.058	0.167	0.730	-0.129	0.127	0.307	-0.112	0.085	0.191	0.022	0.098	0.820
Economic sectors (No.)	-0.150	0.135	0.268	-0.077	0.102	0.453						
Housing quality (0-1)	0.732	0.384	0.057	0.288	0.291	0.323						
Own land (0=no 1=yes)	-0.166	0.261	0.526	0.144	0.198	0.467						
Adults in HH (no.)	0.057	0.037	0.124	0.035	0.028	0.214						
Children in HH (no.)	-0.171	0.101	0.091	-0.006	0.077	0.938						
Site Urban Anantapur	-0.568	0.337	0.093	0.011	0.256	0.965						
Mahubnagar	-1.034	0.226	0.000	-0.370	0.171	0.032						
Hyderabad	-0.971	0.346	0.005	-0.114	0.263	0.666						
FCN (no. females)							0.172	0.031	0.000	0.142	0.036	0.000
Newspaper (1=Y 0=N)										0.455	0.121	0.000
Tel (1=Y 0=N)										0.394	0.115	0.001

Table 8.2 OLS regression output: a comparison between a model where 'community' is specified as a random effect (Model A) and another which does not (Model B) (N=274)

		Model A			Model B		
		Coeff	SE	P	Coeff	SE	P
Constant		-2.092	1.102	0.059	-2.092	0.921	0.024
HN knowledge (0-4)		0.202	0.443	0.649	0.202	0.363	0.579
ME (grade)		0.016	0.041	0.703	0.016	0.038	0.680
Maternal age (years)		0.011	0.017	0.529	0.011	0.016	0.516
Ethnic group	SC	0.328	0.296	0.269	0.328	0.297	0.270
	BC	-0.011	0.197	0.955	-0.011	0.182	0.952
	OC	-0.073	0.217	0.737	-0.073	0.218	0.738
Child age (mo.)		-0.012	0.010	0.231	-0.012	0.010	0.242
Child sex (0=fem. 1=male)		-0.116	0.135	0.390	-0.116	0.129	0.370
Economic sectors (No.)		-0.077	0.090	0.397	-0.077	0.103	0.455
Housing quality score (0-1)		0.267	0.278	0.339	0.267	0.294	0.366
Own land (0=no 1=yes)		0.127	0.190	0.505	0.127	0.201	0.527
Adults in HH (no.)		0.036	0.022	0.101	0.036	0.028	0.211
Children in HH (no.)		-0.013	0.082	0.872	-0.013	0.078	0.864
Site	Urban Anantapur	-0.010	0.234	0.965	-0.010	0.259	0.968
	Mahubnagar	-0.279	0.282	0.324	-0.279	0.237	0.241
	Hyderabad	-0.183	0.277	0.509	-0.183	0.291	0.530

8.4.5 Results of the IV estimation procedure

The next stage of the analysis is to regress child weight-for-age on the predicted values of HN knowledge and general awareness, as well as all other exogenous variables. The results, adjusting for maternal education and other variables, are given in Table 8.3. The results suggest that there is no independent effect of HN knowledge or general awareness on child weight if the predicted values are used instead of the original variable.

Although there is no evidence of a direct effect of HN knowledge using this method, it is nevertheless worthwhile comparing the coefficients for ME between a model that includes and excludes the HN knowledge variable (Models C and A respectively). The comparison shows that the coefficient for ME is somewhat reduced with the inclusion of the HN knowledge variable (from 0.04 95% CI 0.01 -0.07 to 0.03 95% CI -0.04 – 0.09).

8.4.6 Results of the OLS estimation procedure

The results obtained using the IV approach above can be compared to those achieved by using OLS which does not attempt to adjust for the endogeneity of knowledge. The results are given in Table 8.4. The results show that HN knowledge scores are not related to child weight, adjusting for maternal education and other variables (0.11 95% CI -0.07 – 0.29 P=0.233). However, general awareness is positively associated with child weight (0.21 95% CI 0.06 – 0.36 P=0.006).

To explore the role of general awareness in mediating the education effect, the coefficients for maternal education can be compared between the models that include and exclude the general awareness variable (Model A and B in Table 8.4). The results show that the coefficient for maternal education is reduced from 0.03 (95% CI 0.00 -0.07 P=0.049) to almost zero (-0.004 95% CI -0.05 - 0.04 P=0.870) with the inclusion of general awareness in the model. This would suggest that general awareness mediates the effect of maternal education on child weight. The results are less clear for HN knowledge. The effect of maternal education effect is diminished slightly with the inclusion of HN knowledge from 0.03 (95% CI 0.00 - 0.07 P=0.049) to 0.02 (95% CI -0.01 - 0.06 P=0.206).

8.4.7 Comparing the OLS and IV results

A specification test can be used to test whether or not the estimates from the two estimating procedures differ significantly from each other. A test for endogeneity is computed, with the null hypothesis being that an OLS estimator of the same equation would yield consistent estimates, by using the ‘ivendog’ command. This ‘Durbin-Wu-Hausman’ test is numerically equivalent to the standard ‘Hausman test’ (Kennedy 1992). A rejection of the null hypothesis indicates that the endogenous regressors' effects on the outcomes are meaningful, and the IV approach is required.

The results of the specification test provided a P value which was statistically non-significant with regards to both HN knowledge and general awareness (P=0.962 and P=0.201 respectively), suggesting that the null hypothesis should not be rejected and that there is no evidence that either HN knowledge or general awareness is endogenous, or that the IV method will yield superior results to OLS.

It is important, however, to be aware of alternative explanations for lack of statistical difference observed between the OLS and IV models. One explanation is that the instrument(s) are weak or invalid. This may explain why the results contradict previous findings by Glewwe (1999) and Kovsted (2002), who provided evidence that the knowledge variable was endogenous using different instruments (Glewwe 1999; Kovsted, Pörtner et al. 2002).

Table 8.3 IV regression output: the role of general awareness (Model B) and HN knowledge (Model C) in predicting child weight-for-age, compared with a model excluding knowledge variables (Model A) (N=274)

		Model A (reference model)			Model B (general awareness)			Model C (HN knowledge)		
		Mean	SE	P	Mean	SE	P	Mean	SE	P
Constant		-1.954	0.511	0.000	-1.965	0.510	0.000	-2.140	0.627	0.001
General awareness (0-4)					0.048	0.157	0.759			
HN knowledge (0-4)								0.133	0.261	0.612
Maternal educ. (grade)		0.043	0.016	0.009	0.033	0.036	0.367	0.028	0.033	0.393
Maternal age (years)		0.012	0.014	0.415	0.011	0.015	0.457	0.012	0.014	0.423
Child age (mo.)		-0.006	0.010	0.548	-0.007	0.010	0.509	-0.007	0.010	0.490
Child sex (1=M 0=F)		-0.170	0.124	0.173	-0.168	0.124	0.175	-0.154	0.128	0.232
Ethnic group	SC	0.232	0.285	0.417	0.255	0.294	0.386	0.268	0.293	0.361
	BC	-0.031	0.174	0.857	-0.008	0.189	0.966	-0.024	0.174	0.893
	OC	-0.001	0.213	0.997	0.010	0.215	0.962	-0.014	0.214	0.948

Table 8.4 OLS regression output: the role general awareness (Model B) and HN knowledge (Model C) in predicting child weight-for-age, compared to a model excluding any knowledge variable (Model A) (N=274)

		Model A (reference model)			Model B (general awareness)			Model C (HN knowledge)		
		Mean	SE	P	Mean	SE	P	Mean	SE	P
Constant		-1.708	0.608	0.005	-1.947	0.607	0.001	-1.912	0.631	0.003
General awareness (0-4)					0.207	0.075	0.006			
HN knowledge (0-4)								0.107	0.090	0.233
Maternal educ. (grade)		0.034	0.017	0.049	-0.004	0.022	0.870	0.024	0.019	0.206
Maternal age (years)		0.009	0.016	0.578	0.007	0.016	0.638	0.010	0.016	0.540
Ethnic group	SC	0.287	0.287	0.319	0.377	0.285	0.187	0.309	0.287	0.284
	BC	-0.019	0.182	0.917	0.049	0.181	0.786	-0.015	0.181	0.935
	OC	-0.063	0.217	0.771	-0.019	0.215	0.931	-0.068	0.217	0.753
Child age (mo.)		-0.012	0.010	0.243	-0.012	0.010	0.252	-0.012	0.010	0.242
Child sex (0=F 1=M)		-0.129	0.127	0.307	-0.130	0.125	0.298	-0.122	0.127	0.335
Economic sectors (No.)		-0.077	0.102	0.453	-0.095	0.101	0.351	-0.077	0.102	0.454
Housing quality (0-1)		0.288	0.291	0.323	0.222	0.288	0.442	0.277	0.291	0.343
Own land (0=no 1=yes)		0.144	0.198	0.467	0.115	0.196	0.559	0.135	0.198	0.496
Adults in HH (no.)		0.035	0.028	0.214	0.043	0.028	0.125	0.035	0.028	0.211
Children in HH (no.)		-0.006	0.077	0.938	-0.002	0.076	0.976	-0.010	0.077	0.898
Site	Urban Anantapur	0.011	0.256	0.965	-0.065	0.254	0.798	0.000	0.256	0.999
	Mahubnagar	-0.370	0.171	0.032	-0.229	0.177	0.198	-0.322	0.176	0.069
	Hyderabad	-0.114	0.263	0.666	-0.076	0.260	0.771	-0.151	0.264	0.569

8.5 Summary

I will summarise and discuss the findings presented in this chapter. Further implications of the results will be presented in Chapter 10.

8.5.1 Summary of findings

This chapter has introduced the problem of endogeneity and explained its relevance to the research question. The problem was deemed worthy of exploration given its recognition in many key studies which found that ignoring endogeneity would underestimate the effect of knowledge. While the terms 'endogenous' and 'exogenous' belong to econometrics, they have much in common with the epidemiological term 'confounding', and examples of econometric methods used in epidemiology have been discussed.

The analysis is viewed as an exercise to explore the application of the IV approach, its pros and cons. The IV approach was used to attempt to account for the endogeneity of knowledge caused by the confounding by unobserved factors. The number of female members of their communication network living outside the household was identified as a potential instrument for HN knowledge and general knowledge based on the findings from Chapter 7, but their validity is deemed questionable. The results from the IV estimation procedure were compared with OLS using the Durbin-Wu-Hausman test. The test results show that the difference is statistically non-significant, thereby providing no evidence of knowledge being endogenous that would justify the use of the IV technique. It is not possible to know whether the test result is statistically non-significant because the instrument is weak or because HN knowledge and general awareness are in fact exogenous.

8.5.2 Implications of findings

Regardless of methods used, there is no evidence presented here for an effect of HN knowledge on child nutrition which operates independently of education and other

variables in the models. This suggests that the findings are robust across different model specifications.

Neither IV nor OLS results suggest that mothers' HN knowledge mediates the effect of education on children's nutritional status. This finding goes against previous studies (Ruel, Habicht et al. 1992; Glewwe 1999; Kovsted, Pörtner et al. 2002), reviewed in Chapter 5, perhaps because the other studies were all conducted in Africa which provides a very different context to that of mothers in AP. However, further research is needed to draw any firm conclusions about the role of women's HN knowledge in AP because of problems with both the OLS method – due to the potential endogeneity of knowledge – and the IV methods – due to the potential weaknesses in the instruments. This issue will be discussed further below.

The main strength of the IV approach is that it attempts to overcome the problem of endogeneity caused by unknown confounders. The findings have, however, revealed problems associated with identifying valid instruments. As explained earlier, instruments must satisfy two conditions: first that they strongly determine the endogenous variable (HN knowledge), and second that they must not be related to the outcome (child nutrition). Although the correlation between the observed and predicted value of knowledge appears reasonably strong, at least for general awareness (R^2=0.61), it is not possible to know whether this correlation is sufficiently strong. A more serious difficulty arises with the assumption that the IVs are not directly related to child nutrition, for two reasons that both relate to the meaning of the variables themselves:

- The effect of FCN on child nutrition may not represent the effect of 'the number of female network members outside the household' *per se* working through HN knowledge or general awareness, but rather mothers' access to practical assistance outside the household that may improve childcare, for example child minding by female friends and family. It is only possible to speculate about the meaning of FCN because no data were available for childcare or other forms of assistance.

- Similarly the effect of TEL on child nutrition may not represent the use of telephones *per se* working through general awareness, but rather mothers' ability and willingness to speak to others, her self-confidence, status, oral literacy, and an eagerness to establish links beyond her immediate surroundings. These women are probably more capable of making decisions and acting upon them than women with low self-confidence, poor oral literacy and with few connections outside her immediate family (one may speculate that reading newspapers, on the other hand, is a more suitable instrument for general awareness than telephone use because it is more feasible direct cause of its acquisition).

It is impossible to know whether or not the instruments used in this analysis are good because there exists no test of the validity. The specification test used above is useful only for confirming that a variable is indeed endogenous. However, if the test is statistically non-significant and null hypothesis not rejected, it is not possible to know whether the result is due to endogeneity or a weakness in the instrument used. It is likely, however, that the instruments are lacking validity for the reasons explained above.

While HN knowledge was hypothesised to be endogenous in this analysis, education was not, following the assumption made by Thomas (1990) and Glewwe (1991) that it represents a decision made in the past and therefore cannot be altered in response to having a malnourished child. One may argue, however, that education too is endogenous. Like HN knowledge it may be determined by unobserved factors, factors which also determine child nutrition. Individual traits, such as intelligence, both help girls do well at school and care for her children in adult life. However, the practical problem of instrumenting education is that the instrument is likely to be highly correlated with the instrument for HN knowledge, leading to co-linearity in the model. This would also render it difficult to explore mediating effects, because the removal of HN knowledge from a model is bound to strongly alter the coefficients for education. While this is a complex issue, what is clear is that each step of the IV procedure involves a number of assumptions that cannot be tested.

The OLS results suggest that general awareness has an independent effect on child nutrition, and that it lies on the causal pathway between maternal education and child nutrition. This supports previous research indicating that mother's capabilities, whether innate or taught, are important determinants of child nutrition and may be enhanced through education (Kaufman and Cleland 1994). I hypothesise that general awareness represents a type of understanding and perception which may play a crucial role in childcare. For example, mothers' general awareness may be associated with a willingness to embrace the modern ethos, an eagerness to learn and the courage and self-confidence to move and interact with the world beyond her immediate family. The effect of general awareness *per se* is therefore likely to be smaller than what I have estimated here. However, it is likely that the OLS results are an over-estimate because of unknown confounders positively modifying the general awareness – nutrition relationship (Section 8.2.1).

8.5.3 Next steps

Given the lack of evidence presented here to suggest that HN knowledge is on the causal pathway between maternal education and child nutrition, it is necessary to explore other potential mechanisms by which maternal education benefits child nutrition. In the next chapter I will therefore examine the role of women's communication patterns. Due to the problems associated with the IV procedure I will cautiously apply the OLS method, as it is a conventional method in epidemiology.

CHAPTER 9

THE ROLE OF MOTHERS' COMMUNICATION

In this chapter I will explore the role of mothers' communication patterns in confounding, mediating and modifying the effect of maternal education on child nutrition. The chapter is divided into four sections. In the first section I introduce the research questions and provide a background to the chapter. In the second section I present the crude results. The third section presents the adjusted results, which are summarised and discussed in the final section.

9.1 Introduction

9.1.1 Background

In the last chapter I showed that neither the OLS nor IV results suggest that HN knowledge mediates the effect of maternal education on child nutrition. Thus the question remains: if health knowledge is not mediating the education effect, what is? What are the alternative mechanisms by which educated mothers are able to have better nourished children than uneducated mothers?

In this chapter I will explore the role of women's communication, as measured by their:

- telephone use
- size of communication network, and
- communication ability during the interview

See Section 6.3 for further details on the measurement of these indicators.

These indicators have been shown to be determinants of HN knowledge and general awareness in Chapter 7. However, it is important to consider the possibility that these communication variables are also endogenous themselves. For example, it is possible that communication ability is endogenous due to the effect of unknown confounders, such as self-confidence or social status, which are independently associated with mothers' communication ability and children's nutritional status. It was for this reason that the validity of the instruments used in Chapter 8 was questioned (see Section 8.5.2). However, there is no way of overcoming this problem using the OLS method. Instead the findings will be interpreted with caution and the assumptions made explicit in the discussion. Weight-for-age will be used as the outcome variable rather than height-for-age, because as explained in Section 8.4.2, there was no effect of maternal education on child height-for-age which is a prerequisite for this analysis.

Figure 9.1 shows two analytical frameworks depicting hypotheses about whether communication lies on the causal pathway between education and nutrition. First, communication may be a mediator of the education effect [Figure 9.1 (a)] because mothers gain oral literacy skills by going to school, they learn to use abstract nouns, to communicate with words rather than rely on non-vocal cues and they gain experience and self-confidence in conversing with people in authority. It has been proposed that these skills aid women in accessing health services and receiving curative and preventative treatment for their children (see Section 5.4.5 for literature review). Second, communication may be a confounder, as illustrated by the arrows from communication to education and nutrition in Figure 9.1 (b), and/or an effect-modifier, as illustrated by the downward arrow from communication onto the arrow from education to nutrition in Figure 9.1 (b). It may confound the relationship because it is plausibly associated with both education and nutrition: an ability to converse effectively may aid girls to progress academically and access modern health treatments later in life. Meanwhile it may positively modify the effect of education if an ability to communicate helps women take advantage of their education, or negatively modify the effect of education if it compensates for a lack of education. All possibilities will be explored in this chapter.

The analytical framework in Figure 9.1 (a) and (b) shows that the factors identified as potential confounders are household wealth and assets (ownership of land, number of adults and children in household, and number of economic sectors household involved with), setting (urbanity and/or site), mothers' age and ethnic group (caste) and education of the household and community. Problems with establishing a statistically significant relationship between maternal education and child nutrition led to the exclusion of household/community education as a confounder, for the reasons explained in detail in Section 8.41.

As shown in Section 5.4.4, previous studies suggest that women's communication ability is important because it improves their access to health services by enabling them to explain symptoms effectively and enter into a dialogue with health professionals. If this were so, one would expect to see a difference in the role of communication between rural and urban areas because modern health facilities are more commonplace in urban areas. For these reasons I will explore rural-urban differences in the role of communication. The full list of objectives is given below.

9.1.2 Objectives

The overall objective of this chapter is:

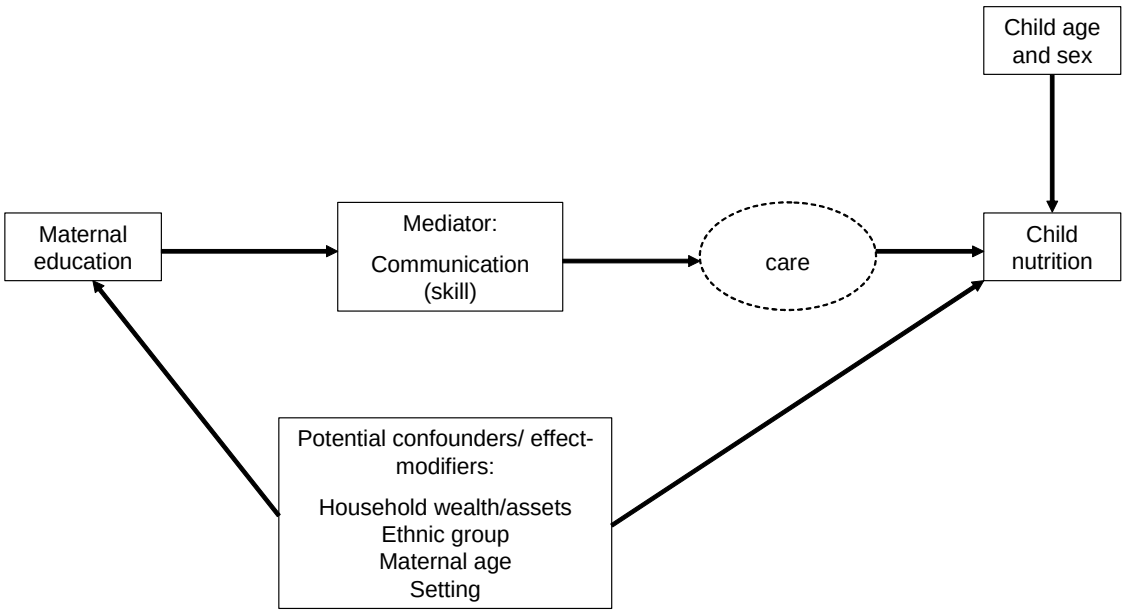
- To examine the role of mothers' communication in mediating, modifying or confounding the effect of maternal education on child nutrition

Specific objectives are:

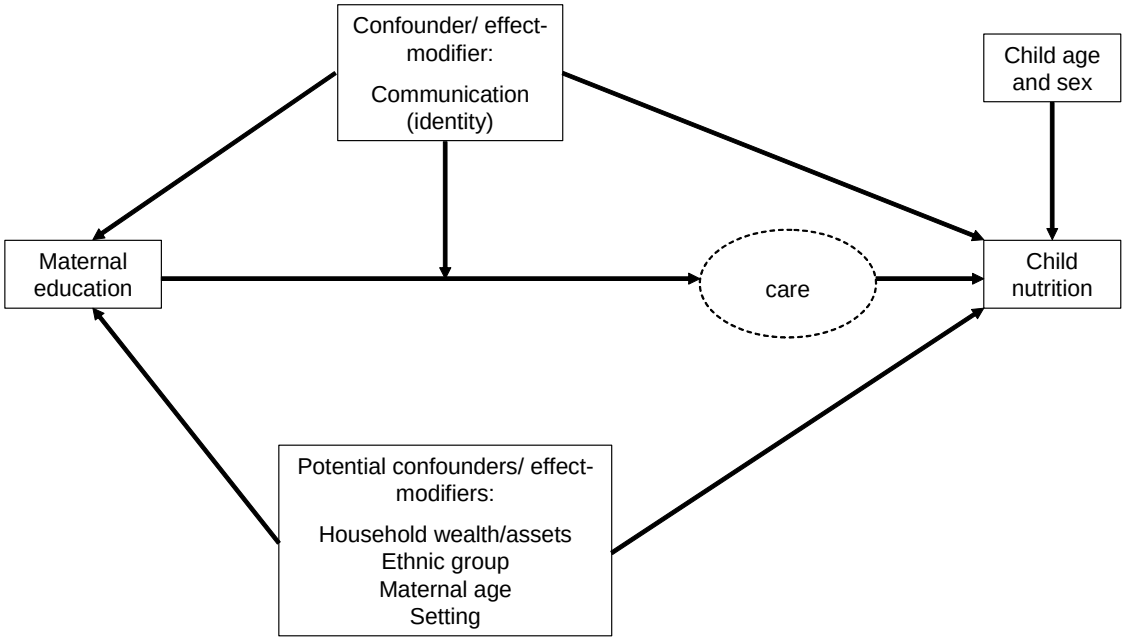
- To identify the indicator of communication which is most strongly associated with child nutrition
- To examine differences between rural and urban areas in the importance of mothers' communication for child nutrition
- To theorize about the mechanisms that underlie the relationships between education, communication and nutrition

Figure 9.1 The analytical frameworks illustrating the hypotheses that communication is a mediator of the education effect on nutrition (a) or a confounder and/or effect-modifier (b)

a) Communication as a mediator:



c) Communication as a confounder and/or effect-modifier:



9.2 Patterns and crude associations

The number of cases dropped due to missing values was 17, leaving a sample size of 274. Table 9.1 shows the patterns of telephone use, communication network size and communication ability during the interview. The three variables are all strongly associated with maternal education, but not all were associated with child nutrition.

9.2.1 Telephone use

There is no statistically significant difference in the prevalence of telephone use by category of child nutrition (P=0.120), although the results hint at a lower prevalence of telephone use among mothers with the more malnourished children. Table 9.1 also suggests that telephone use is associated with indicators of socio-economic status and setting, so that it is most commonly used by women of wealthier households and those living in urban areas. For example, of the women in the least wealthy sub-group (housing quality score <0.2) fewer than 40% use a telephone, compared with above 60% for women in the wealthier sub-groups (P<0.001).

9.2.2 Communication network size

Of the mothers with malnourished children (<-2 WAZ) only 30% have networks with more than three members versus 42% for the mothers with well nourished children (>-1 WAZ). The association between network size and malnutrition is borderline significant (P=0.060). There is also a difference in network size between mothers in rural and urban areas: of urban mothers 40% have networks with more than three members compared with only 28% for rural mothers (P=0.001).

9.2.3 Communication ability

Good communication ability among mothers is associated with better weight-for-age z-scores (P<0.003). For example, only 38% of mothers with malnourished children have

good communication skills compared with 58% for mothers with well nourished children. There was no statistically significant difference between rural and urban areas in women's communication ability (P=0.387) although a borderline significant difference was found between the four sites (P=0.044).

Table 9.1 Patterns of mothers' communication

			Telephone use		Good com. ability		Com. network >3 members	
		N	%	P	%	P	%	P
Main exposure:								
Maternal	0	162	43		28		29	
education	1-8	68	71		62		37	
(grade)	9-	44	93	0.000	84	0.000	36	0.027
Outcome:								
Child WAZ	<-2	128	52		38		30	
	-2 - -1	98	62		48		31	
	>-1	48	63	0.120	58	0.003	42	0.060
Other explanatory variables:								
Age of child	6-8	50	50		50		40	
(mo)	9-11	63	56		44		24	
	12-14	74	50		32		27	
	15-17	87	70	0.010	54	0.633	38	0.157
Sex of child	F	126	60		42		32	
	M	148	56	0.565	48	0.327	32	0.542
Land	No	116	72		46		34	
ownership	Yes	158	47	0.000	45	0.902	30	0.402
Age of mother	-19	29	48		41		21	
(yr)	20-24	131	59		43		34	
	25-29	86	59		48		35	
	30-	28	57	0.918	54	0.537	25	0.422
Housing	0-0.19	31	37		36		32	
quality score	0.2-0.39	51	63		49		31	
	0.4-0.59	54	74		51		33	
	0.6-	22	61	0.000	47	0.104	33	0.474
No. adults in	1 or 2	69	58		44		29	
HH	3 or 4	44	63		47		30	
	5 -	44	52	0.780	46	0.663	37	0.379
No. children	0	145	63		47		31	
in HH	1	75	61		48		37	
	2-	54	39	0.006	37	0.285	28	0.316
No. economic	0	106	58		43		34	
sectors	1-	52	57	0.584	49	0.447	29	0.144
Ethnic group	ST	45	40		40		24	
	SC	18	33		28		28	
	BC	149	57		41		31	
	OC	62	79	0.000	65	0.004	42	0.192
Urbanity	Rural	182	48		43		28	
	Urban	92	76	0.000	49	0.387	40	0.001
Site	Rur. Anantapur	91	56		51		38	
	Urb. Anantapur	48	81		58		25	
	Mahubnagar	91	41		36		18	
	Hyderabad	44	70	0.000	39	0.044	57	0.000

9.3 Adjusted associations

Crude analysis has shown that child nutrition is strongly association with mothers' communication ability, whereas its association is only borderline significant with network size and non-significant with telephone use. However, further analysis is necessary to account for confounding by other factors.

9.3.1 Comparing indicators of communication and education

Table 9.2 presents the effects on child weight of each of these three indicators respectively, adjusted for maternal education and other confounders (Model B-D). The results suggest that the only indicator of communication which is statistically associated with child weight-for-age z-score is mothers' communication ability during the interview (0.21 95% CI 0.03 – 0.39 P=0.022). The effect of telephone use and network size shown earlier in the crude analysis disappears once other factors, including maternal education, are adjusted for.

Further analysis was undertaken to explore whether other characteristics of communication networks were associated with child nutrition, such as sex, location and literacy. The results showed that none of these indicators were statistically significantly associated with the outcome (results not shown).

The rest of the analysis in this chapter will focus only on communication ability as the indicator of communication, given that telephone use, network size and other network characteristics were not associated with nutrition once confounding had been controlled. As explained earlier, there are concerns about the communication variable being biased, but this has partially been addressed by including the site variable in the model (see Section 9.4.2 for further discussion).

9.3.2 Is communication ability a confounder, mediator or effect-modifier?

By definition a variable cannot both be a confounder and an intermediary variable on the causal pathway. However, the method used to assess confounding and mediation is the same, namely the comparison of coefficients for maternal education between models that include and exclude the communication ability variable. Therefore the conclusions drawn from the results depend on prior hypotheses about the causal relationship between the variables.

The results are given in Table 9.2. The regression coefficient of maternal education in a model which does not contain communication ability (Model A) can be compared with that of a model which does contain communication ability (Model D). The coefficient of maternal education decreases from 0.03 (95% CI 0.00 - 0.07) to 0.01 (95% CI -0.02 – 0.05) when the communication ability variable is included in the model, and the association loses its statistical significance (from P=0.049 to P=0.453). This suggests that communication ability substantially mediates and/or confounds the education effect.

The results presented in the last chapter suggested that HN knowledge does not mediate the education effect but that general knowledge does (see Table 8.2 and 8.3). A combined model was therefore generated (Model E) which included general awareness in addition to explanatory variables in Model D. The results show that the effect of maternal education is now markedly reduced, to almost zero, from 0.03 (95% CI 0.00 - 0.07 P=0.049) in the original model, Model A, to -0.01 (95% CI -0.05 - 0.04 P=0.758) in the combined model, Model E. The results also show that the effect of communication ability is smaller in the combined model and statistically non-significant (0.12 95% CI -0.08 – 0.32 P=0.227). Meanwhile the effect of general awareness is somewhat greater and statistically significant (0.16 95% CI 0.00 - 0.33 P=0.056). These findings would suggest that the two indicators are highly correlated with one another, so that including general awareness explains much of the effect of communication ability. It is likely that both are associated with personal characteristics – self-assurance, an eagerness to learn, a modern outlook. I suspect that in school, girls with such characteristics are more likely to improve

their communication skills and general awareness than girls without these characteristics. The correlation between general awareness and communication ability will be discussed in detail in Section 9.4.2 at the end of the chapter.

9.3.3 Rural-urban differences in the role of communication ability

Further analysis of the role of communication ability in rural and urban areas was undertaken for the reasons explained earlier in Section 9.1.1. A dummy variable for a statistical interaction between communication ability and urbanity was added to Model D in Table 9.2. Maternal education was initially excluded from the model to avoid disentangling the effect of communication that originates from schooling. The P-value is statistically significant (P=0.091) and the positive coefficient suggests that living in an urban area increases the impact of communication ability on child weight. It is not known whether this is due to other effects of education which are particularly advantageous in urban areas. Therefore further analysis was undertaken to adjust for the effect of maternal education. Table 9.3 presents the regression results from the models including and excluding the communication ability variable, stratified by rural and urban areas. The results show that communication ability has a strong effect on child weight-for-age in urban areas (0.37 95% CI 0.00 - 0.75 P=0.052) but not in rural areas (0.01 95% CI -0.09 – 0.32 P=0.272).

The same analysis was repeated for general awareness, in order to assess whether a similar urban-rural difference in effect is observed for this variable. Also, given the strong correlation observed between general awareness and communication (Table 9.2 Model E) it would be plausible to expect the effect of general awareness to be greater in urban than rural areas. However, the results showed no evidence of a differential effect of general awareness. Thus despite the correlation between the two indicators, it is communication skills which are identified as particularly important for child nutrition in urban areas.

9.3.4 Modification of the maternal education effect

A dummy variable was entered into Model D in Table 9.2 to represent the interaction between maternal education and communication ability. The results suggests that communication ability positively modifies the effect of maternal education (P=0.053). The regression model was run separately for women with 'good' versus 'poor or medium' communication ability in order to compare the effect of education in these two sub-groups. The results are given in Table 9.4. The results show some differences in effect size of education between the two groups, with the education effect appearing to be larger among women with good communication skills (0.03 95% CI -0.03 - 0.08 P=0.362) compared with poor or medium communication skills (-0.02 95% CI -0.08 - 0.05 P=0.589), although statistically non-significant for both groups. The lack of statistical significance is probably due to the small sample size of women in each sub-group (N=125 and N=150 respectively). Overall the results suggest that communication ability positively modifies, hence complements, the effect of maternal education on child nutrition.

The statistical interaction between education and communication can also be observed by stratifying by education. Table 9.5 shows that the effect of communication ability is substantially stronger among the educated (0.57 95% CI 0.24 - 0.92 P=0.001) than the uneducated mothers (0.16 95% CI -0.05 - 0.39 P=0.136). Further analysis revealed a similar pattern for general awareness. The findings suggest that an educated mother is more likely to have a well-nourished child if she also has good communication abilities and general awareness. The direction of the causal arrow depends on whether communication ability and general awareness are assumed to be innate unchanging traits or something that can be acquired later in life. This will be discussed further in Section 9.4.2.

Table 9.2 Regression output: determinants of child weight-for-age z-score

	Model A (reference model)			Model B (network size)			Model C (telephone)			Model D (communication)			Model E (combined model)		
	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant	-1.708	0.608	0.005	-1.951	0.643	0.003	-1.722	0.609	0.005	-1.896	0.608	0.002	-2.004	0.608	0.001
Mat. Educ. (grade)	0.034	0.017	0.049	0.033	0.017	0.056	0.032	0.018	0.075	0.014	0.019	0.453	-0.007	0.022	0.758
Network size (No.)				0.048	0.042	0.249									
Tel (0=No 1=Yes)							0.081	0.143	0.571						
Communic. (0-2)										0.209	0.091	0.022	0.122	0.101	0.227
Gen. aware. (0-4)													0.161	0.084	0.056
Child age (years)	-0.012	0.010	0.243	-0.011	0.010	0.310	-0.013	0.010	0.229	-0.011	0.010	0.300	-0.011	0.010	0.284
Child sex (1=M 0=F)	-0.129	0.127	0.307	-0.137	0.127	0.279	-0.127	0.127	0.318	-0.156	0.126	0.217	-0.146	0.125	0.247
Maternal age (yrs)	0.009	0.016	0.578	0.010	0.016	0.516	0.009	0.016	0.573	0.007	0.016	0.646	0.007	0.016	0.666
Sectors (No.)	-0.077	0.102	0.453	-0.069	0.103	0.505	-0.079	0.103	0.442	-0.085	0.102	0.405	-0.095	0.101	0.347
Hous. qual (0-1)	0.288	0.291	0.323	0.291	0.291	0.318	0.271	0.293	0.356	0.296	0.289	0.306	0.241	0.289	0.404
Own land (0=N 1=Y)	0.144	0.198	0.467	0.105	0.201	0.602	0.152	0.199	0.446	0.086	0.198	0.663	0.087	0.197	0.658
Adults in HH (no.)	0.035	0.028	0.214	0.034	0.028	0.228	0.036	0.028	0.211	0.039	0.028	0.166	0.044	0.028	0.121
Children in HH (no.)	-0.006	0.077	0.938	-0.006	0.077	0.939	-0.002	0.077	0.975	-0.006	0.076	0.938	-0.003	0.076	0.967
Ethnic Grp ST	0.287	0.287	0.319	0.273	0.287	0.344	0.285	0.288	0.322	0.337	0.286	0.238	0.387	0.285	0.176
BC	-0.019	0.182	0.917	-0.027	0.182	0.880	-0.035	0.184	0.851	0.003	0.180	0.988	0.047	0.181	0.796
OC	-0.063	0.217	0.771	-0.078	0.217	0.721	-0.084	0.220	0.704	-0.038	0.215	0.858	-0.014	0.214	0.948
Site Urb Anantapur	0.011	0.256	0.965	-0.006	0.256	0.981	0.004	0.257	0.989	-0.054	0.255	0.832	-0.087	0.255	0.734
Mahubnagar	-0.370	0.171	0.032	-0.336	0.174	0.055	-0.366	0.172	0.034	-0.365	0.170	0.032	-0.257	0.178	0.151
Hyderabad	-0.114	0.263	0.666	-0.194	0.272	0.477	-0.111	0.263	0.674	-0.086	0.261	0.743	-0.068	0.260	0.795

Table 9.3 The effect of communication ability on child nutrition in rural and urban areas

		Model A Urban (N=92)			Model B Urban (N=92)			Model C Rural (N=182)			Model D Rural (N=182)		
		Coeff	SE	P	Coeff	SE	P	Coeff	SE	P	Coeff	SE	P
Constant		-4.524	1.140	0.000	-4.424	1.121	0.000	-1.260	0.659	0.057	-1.422	0.674	0.036
Maternal education (grade)		0.030	0.025	0.241	-0.004	0.030	0.907	0.038	0.025	0.130	0.026	0.027	0.338
Communic. ability (0-2)					0.373	0.189	0.052				0.116	0.105	0.272
Child age (years)		0.008	0.018	0.656	0.008	0.018	0.667	-0.009	0.012	0.461	-0.008	0.012	0.515
Child sex (1=M 0=F)		0.159	0.231	0.494	0.076	0.231	0.741	-0.363	0.154	0.019	-0.367	0.154	0.018
Maternal age (yrs)		0.077	0.031	0.014	0.061	0.031	0.052	-0.017	0.019	0.373	-0.016	0.019	0.398
Sectors (No.)		0.190	0.244	0.440	0.153	0.241	0.526	-0.116	0.115	0.313	-0.120	0.115	0.298
Housing quality (0-1)		0.218	0.589	0.712	0.088	0.582	0.881	-0.033	0.338	0.922	-0.021	0.338	0.952
Own land (0=No 1=Yes)		0.366	0.585	0.534	0.223	0.579	0.701	0.262	0.220	0.235	0.226	0.222	0.312
Adults in HH (no.)		0.047	0.062	0.455	0.069	0.062	0.271	0.040	0.032	0.214	0.041	0.032	0.200
Children in HH (no.)		-0.090	0.154	0.559	-0.113	0.152	0.458	0.007	0.090	0.939	0.012	0.090	0.895
Ethnic group	ST	-0.473	0.794	0.553	-0.573	0.782	0.465	0.401	0.323	0.217	0.437	0.325	0.180
	BC	0.052	0.315	0.870	0.145	0.313	0.644	-0.073	0.220	0.741	-0.060	0.220	0.787
	OC	-0.355	0.342	0.302	-0.296	0.337	0.382	0.038	0.305	0.900	0.070	0.306	0.818

Table 9.4 The effect of maternal education among women with good communication ability versus women with poor or medium communication ability

		Mother has good communication ability (N=124)			Mother has poor or medium communication ability (N=150)		
		Coeff	SE	P	Coeff	SE	P
Constant		-2.810	0.966	0.004	-0.509	0.791	0.521
Maternal education (grade)		0.025	0.027	0.362	-0.017	0.032	0.589
Child age (years)		0.006	0.016	0.719	-0.026	0.014	0.054
Child sex (1=M 0=F)		-0.122	0.203	0.550	-0.160	0.171	0.350
Maternal age (yrs)		0.025	0.028	0.374	-0.012	0.020	0.553
Sectors (No.)		-0.148	0.155	0.341	0.014	0.137	0.917
Housing quality (0-1)		-0.451	0.513	0.381	0.544	0.346	0.118
Own land (0=No 1=Yes)		0.172	0.338	0.612	-0.014	0.250	0.954
Adults in HH (no.)		0.110	0.054	0.046	0.020	0.034	0.561
Children in HH (no.)		-0.059	0.127	0.643	0.022	0.099	0.824
Ethnic group	ST	0.903	0.553	0.106	0.039	0.333	0.908
	BC	0.061	0.308	0.843	-0.050	0.226	0.825
	OC	0.069	0.334	0.837	-0.243	0.310	0.434
Site	Urban Anantapur	0.431	0.427	0.315	-0.401	0.332	0.230
	Mahubnagar	-0.264	0.277	0.343	-0.557	0.218	0.012
	Hyderabad	0.585	0.453	0.200	-0.570	0.323	0.080

Table 9.5 The effect of mothers' communication ability among uneducated mothers and educated mothers who have completed at least grade 1

		Mother is educated (N=112)			Mother is uneducated (N=162)		
		Coeff	SE	P	Coeff	SE	P
Constant		-3.899	1.042	0.000	-0.909	0.822	0.270
Communic. ability (0-2)		0.569	0.168	0.001	0.163	0.109	0.136
Child age (years)		0.005	0.015	0.732	-0.016	0.014	0.255
Child sex (1=M 0=F)		-0.161	0.206	0.436	-0.150	0.177	0.398
Maternal age (yrs)		0.048	0.030	0.118	-0.018	0.020	0.366
Sectors (No.)		-0.134	0.155	0.389	-0.094	0.144	0.515
Housing quality (0-1)		-0.331	0.527	0.531	0.537	0.360	0.138
Own land (0=No 1=Yes)		0.010	0.333	0.977	0.173	0.267	0.518
Adults in HH (no.)		0.073	0.042	0.084	0.025	0.041	0.541
Children in HH (no.)		-0.012	0.133	0.930	-0.003	0.096	0.977
Ethnic group	ST	0.787	0.836	0.349	0.147	0.327	0.653
	BC	0.056	0.320	0.861	-0.087	0.234	0.711
	OC	-0.044	0.329	0.894	0.159	0.333	0.633
Site	Urban Anantapur	-0.059	0.420	0.888	-0.107	0.359	0.765
	Mahubnagar	-0.403	0.336	0.233	-0.492	0.217	0.025
	Hyderabad	0.167	0.408	0.683	-0.258	0.399	0.518

9.4 Summary and discussion

9.4.1 Summary of findings

In this chapter I have examined the role of mothers' communication characteristics – indicated by their telephone use, size of networks and ability to communicate during the interview – in mediating, confounding and/or modifying the effect of education on child nutrition. Out of the three indicators only mothers' communication ability during the interview was a statistically significant determinant of child nutrition.

The results suggest that communication ability might either confound or mediate the relationship between maternal education and child nutrition, because the effect of maternal education is substantially reduced once communication ability is included in the model.

There was a strong correlation observed between a mother's communication ability and her general awareness. If both variables were included in the model, along with other confounders, the effect of maternal education disappears altogether.

Communication ability has a stronger effect on nutrition in urban than rural areas, but this differential effect was not observed for general awareness. Both indicators positively modify the impact of maternal education on child nutrition.

9.4.2 Implications of findings

Before I discuss the implications of the results presented in this chapter, it is important to address the following methodological issues:

- There is a potential problem of bias in the communication ability variable for two reasons: one that it is subjective because it is determined by the interviewer, and two, the interviewer may be influenced by the status of education and knowledge of the

woman, probably leading to an upward bias in the strength of the association between communication ability, knowledge and education. While the first problem can be overcome (as explained Section 7.3.4), the second problem cannot be solved analytically.

- Endogeneity of communication ability is an issue which is natural to consider given the discussion about the problem in the previous chapter and the consequences of ignoring it. It is possible that the communication ability variable is endogenous for the same reason as HN knowledge, that it is determined by unknown factors which simultaneously determine the outcome. The extent to which the variable is endogenous cannot be known unless the IV procedure is applied and results of specification tests suggest that the IV estimates are superior to OLS estimates. However, the IV approach is considered inappropriate in this study because of the lack of available valid instruments. For this reason the OLS procedure has been used instead, with the assumption that communication ability is exogenous. It is possible, therefore, that the results represent an over-estimate of the effect of communication ability (see Section 8.2.1 for a similar argument being put forward for general awareness).

In this study I have relied on a subjective measure of women's communication ability during the interview, as judged by the field investigator. The results show that, out of the three communication variables, communication ability is the strongest predictor of child nutrition, stronger than education. This begs the question: why are interpersonal skills associated with good nutrition outcomes? Is it because women who can converse and interact effectively are more capable of obtaining relevant health and nutrition knowledge? Or are they better able to access health services? I am not able to answer this question based on the data available. However, the last chapters did not reveal any evidence to suggest that health and nutrition knowledge is on the causal pathway between education and nutrition. It is therefore more likely that alternative mechanisms are involved.

In the beginning of this chapter I explained that communication ability may be both an innate capability (which acts as a confounder or effect-modifier of the education-nutrition relationship) or a transferable skill that can be taught in school (which acts as an intermediary variable). The results appear to present evidence of both confounding or mediation, in addition to positive effect-modification, and do not therefore help me in determining whether communication ability is a transferable skill or an innate capability. It is likely that it is a combination. Within any population there will be a range of communication abilities and these abilities may be enhanced by going to school (Cleland and Kaufman 1998). It is plausible that education reinforces existing personality characteristics that are favourable to effective childcare in later life. Joshi's study in Nepal, for example, found that schooling equips women with specific skills, dispositions or identities which predict mothers' use of medical services and changes in their health behaviour. Other studies, which have been reviewed in Section 6.4.5, have suggested that decontextualized literacy skills are acquired in school, skills which benefit child nutrition through improved comprehension of health messages and better access to services. Although I have not used a refined measure of decontextualized language skills in this study, I still detect a strong relationship between women's communication ability during the interview and their education and children's nutrition.

While some evidence exists to show that education enhances women's innate capabilities, further research is necessary to understand the nature of this effect – whether education benefits women with poor abilities the most (a substitutive relationship) or women with good abilities (a complementary relationship). An example of such as study is Sandiford's work in Nicaragua, which showed that literacy had a stronger impact on child mortality among mothers of low intelligence, signifying a substitutive relationship (Sandiford, Cassel et al. 1997).

I examined differences between rural and urban areas in the role of communication ability in mediating the education effect, in order to develop theories about underlying mechanisms. The stronger effect observed in urban areas can be interpreted in the light of previous findings and literature. In Chapters 3 and 4 I showed that education had a

greater effect on child nutrition in urban than rural areas, and hypothesised that this may be due to there typically being more modern health services in urban areas. Furthermore, previous literature suggests that education enhances women's ability to manipulate critical aspects of the modern world such as bureaucratic institutions that dominate urban life (see Section 5.4.4). It is therefore plausible that the greater importance of education in urban areas for determining child nutrition is explained by the greater importance of communication ability in this setting.

9.4.3 Next steps

The last three results chapters for the KN study have complemented the results of the YL data analysis presented in the first half of this thesis by exploring in depth some key issues that emerged from the cross-country comparative analysis. The next step is to bring together the findings from both studies and interpret them in the light of existing evidence in order to identify knowledge gaps and inform future research.

CHAPTER 10

CONCLUSIONS AND RECOMMENDATIONS

The chapter is divided into four sections. In the first section I summarise the results corresponding to the objectives outlined in chapter 1. In the second section I discuss methodological strengths, weaknesses and considerations. In the third section I discuss the implications of the findings and outline recommendations for future research. Finally I conclude by giving a short summary of the thesis.

10.1 Summary of findings

It is worth recapping on the analysis undertaken before reviewing the results. Figure 10.1 is therefore provided as an illustrated summary of the analysis, chapter by chapter. This is followed by Table 10.1 which presents the findings corresponding to each of the study objectives.

Figure 10.1 displays an arrow from maternal education on the left to child nutrition on the right. The chapter number on the arrow indicates that this relationship was examined in Chapter 3. The figure also shows that the role of education of other adults in the household and community both in determining child nutrition and modifying the effect of maternal education was examined in Chapters 3 and 4. In the middle of the figure is maternal HN knowledge and general awareness. The figure shows that the mediating role of these variables was explored in Chapter 8. It also shows that their determinants, which included maternal education and other characteristics such as media, communication networks and communication ability, were assessed in Chapter 7. Finally, the mediating role of mothers' communication was explored in Chapter 9.

Figure 10.1 An illustration of the analysis undertaken in the thesis

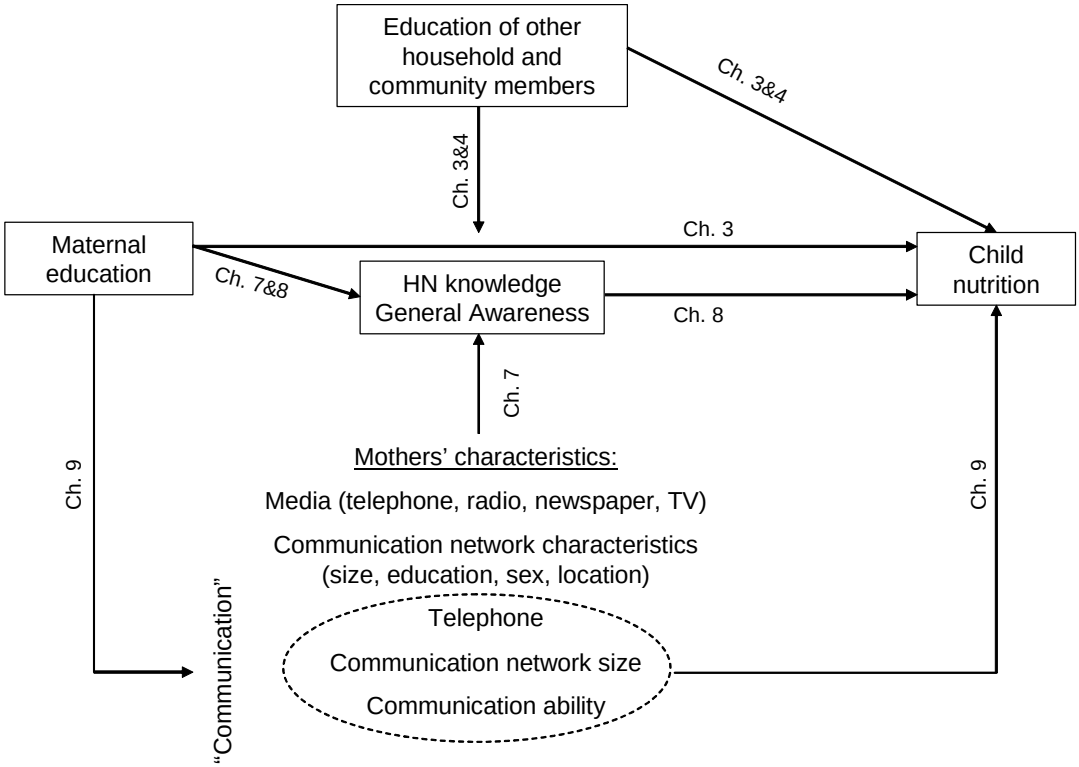


Table 10.1 Summary of findings from Study 1 (the Young Lives study) and Study 2 (the Knowledge and Networks study)

a) Study 1: Young Lives

1) To examine the effect of adult education within the household on child nutrition
• There is a positive effect of maternal education on child height-for-age and weight-for-age z-score, adjusting for confounding factors. The effect is strongest for the highest level of education. The findings add to the large amount of existing evidence that maternal education has a positive effect on child health and nutrition, and contradict the few recent studies in Vietnam showing no effect. • Paternal and grandmother education has a positive effect on child nutrition adjusting for maternal education and other confounders. • The maternal education effect is positively modified by the education of fathers. • Differential effects are found by spatial and social strata. All adults' education has a stronger effect in households that are relatively wealthy and well-educated. While there is no difference between the two countries in the effect of maternal education, the effect of parental education is stronger in Vietnam and the effect of grandmother education is stronger in India. • Grandmother education has a stronger impact on nutrition for boys than girls. A sex difference in effect was not found for parental education.

2) To estimate, using multi-level methods, the effect of community-level education and education distribution on child nutrition, over and above individual-level factors
• Two indicators were used in the analysis of community-level education: community-level maternal literacy and community-level higher education. There is a positive effect of community-level maternal literacy on child nutrition adjusting for parental education and other confounders. The effect of community-level higher education is weaker. • Vietnamese children benefit more from living in communities with high levels of maternal literacy than Indian children. However, caution is needed when drawing conclusions about cross-country differences due to different definitions of 'community' in Vietnam and AP. • Community-level maternal literacy positively modifies the effect of parental education. • Adjusting for the effect of community-level wealth and other factors made little difference to the results. However, excluding the communities with a sample size smaller than 20 households strengthened the results, although the effect in India remained non-significant. • There is no difference in the size of effect on child nutrition between the standard measure of community-level maternal literacy and a measure which takes account of the distribution of educated people in the community.

b) Study 2: the Knowledge and Networks study

3) To systematically examine the literature concerning the determinants of maternal health knowledge in India (q.1,) and the role of maternal health and nutrition knowledge in mediating the relationship between maternal education and child nutrition worldwide (q. 2)
• Q1: The literature search found no study that examined the role of maternal knowledge in mediating education effects on child nutrition in India. However, studies were found that had been conducted in other parts of the world. This research, all conducted in Africa, suggests that knowledge may mediate the effect of education, particularly among the wealthier households. The studies recognised the problem of endogeneity of knowledge in this relationship. • Q2: The literature provides no evidence for education being a determinant of health knowledge in India. Instead knowledge appears to be more strongly associated with household socio-economic status. • The review of the literature raised a number of key issues. Particularly interesting is the diffusion of knowledge through communication and media and the role of de-contextualized language skills. These issues were discussed with reference to other research.
4) To examine the role of mothers' education, their use of media, the characteristics of their communication networks and their communication ability in determining their health and nutrition knowledge
• Mother's education, size of communication network (especially the number of females living outside the household) and ability to communicate during the interview are strongly and positively associated with HN knowledge scores. General awareness scores are associated with education, communication ability, telephone use and reading newspapers. • Confounding by unknown factors is likely to be a problem in determining the effect of HN

knowledge on child nutrition. Unknown factors, such as health endowments, may be independently associated both with maternal HN knowledge and child nutrition leading to the problem of reverse causality. Ignoring endogeneity may therefore underestimate the effect of HN knowledge.
5) To examine the role of maternal health and nutrition knowledge in mediating the education effect on child nutrition, using both conventional and econometric methods.
• Both OLS and IV estimates suggest that health knowledge does not independently predict child nutrition, nor explain the effect of education on child nutrition. • Specification test results suggest that differences between the models were not statistically significant, either because health knowledge is exogenous or because the instrument is weak. The small sample size of this study relative to previous similar studies added to the difficulties of establishing robust effect estimates. • The potential weaknesses in the instruments are discussed, and the findings contribute to the wider debate about the application of the IV approach in epidemiology.
6) To examine the role of mothers' communication in mediating, modifying or confounding the effect of maternal education on child nutrition
• Mothers' communication was measured by their telephone use, size of networks and ability to communicate during the interview. Of the three indicators, only communication ability during the interview is a statistically significant determinant of child nutrition. • The results suggest that communication ability may confound or mediate the education effect, but statistically the evidence for this is weak. • Evidence was found of positive modification of the education effect by communication ability. • The problem of potential bias related to the communication ability variable was raised.

10.2 Methodological strengths, weaknesses and considerations

Before the findings summarised above are discussed it is important to consider the main strengths, weaknesses and methodological considerations of the thesis, which are given in Table 10.2 – 4.

Table 10.2 The strengths of the thesis

1) Combination of comparative analysis with in-depth context-specific exploration of mechanisms
The thesis combines cross-country analysis of YL data with an in-depth exploration of underlying mechanisms in India using KN data. It thereby provides both a general overview of the role of adult education in child nutrition (at the household and community level) while testing hypotheses and raising questions about underlying mechanisms. Most studies in this field have either been large cross-sectional analyses of survey data or in-depth, perhaps qualitative, examinations of potential underlying mechanisms within a specific culture. This study is exceptional because it combines the two approaches, thereby providing a rounded picture of the effect of adult education on child nutrition in India and Vietnam and informing, albeit to a limited degree, the discussion about the generalisability of findings.
2) Examination of multiple determinants
In general, studies examining the underlying mechanisms between adult education and child nutrition have focused on testing hypotheses about singular intervening variables. In this thesis, however, I have recognised the complexity of the issue and examined a large number of factors in order to attempt to disentangle effects and determine the relative importance of each.
3) Novel study population
The YL data contains educational information for several household members, including the fathers and grandmothers. The structure of the data has also enabled me to generate community-level education indicators. This is unique because most studies of adult education only examine parental education and have therefore overlooked any added independent effect of education at a higher group level. With this data-set I am able to assess education at the individual-, household- and community-level, and the statistical interactions between them. Furthermore, I study children aged 8 years. This is novel because most studies of child nutrition include only children of under 5. The fact that the association between adult education and child nutrition is evident at this older age suggests that the nutritional impact of education persists into later life.
4) Use of advanced statistical methods
The study addresses specific methodological criticisms of previous studies. To do this, I have used advanced statistical methods in epidemiology, such as multi-level modelling techniques and the IV approach. The latter is especially new to the discipline, and I have therefore appraised the advantages and disadvantages of its application in the current context and in epidemiology as a whole. The benefits of the multi-level technique compared with conventional single-level methods have been discussed.

Table 10.3 The weaknesses of the thesis

1) Measurement error and bias
It is likely that the key variables are measured with some unknown degree of error. If the error is random one would expect a dilution of effect. More concerning is systematic error or bias. Bias is likely to be a particular problem for mothers' communication ability, which was assessed by the interviewers and therefore subjective. I tried to overcome this by including the site variable in the regression models. However, the relationship between education and communication ability may nevertheless be biased because interviewers were aware of her education and knowledge before they classified her communication ability, which may have influenced their judgement. It is impossible to overcome this problem in the analysis.
2) Residual and unknown confounding
Confounding by known factors has been controlled by including certain variables in the models. Nevertheless, it is possible that these variables do not fully capture the effects for which they were designed, leading to residual confounding. Another problem is the confounding by unknown factors. The IV approach was used in an attempt to overcome this problem. However, this failed due to a lack of valid instruments. It was therefore not possible to assess the degree to which unknown factors confound the relationship between HN knowledge and child nutrition, or to adjust for it. Furthermore, the role of residual and unknown confounding is likely to be culturally-specific. The implications of this problem for the application of the IV approach in cross-sectional observational studies in epidemiology have been discussed.
3) Small sample size of KN study
Given that all the variables are likely to be measured with some degree of error, it is likely that the small sample size of the KN study (N=272) makes it harder to detect an effect than it would be in a larger study. The study design would have been improved if the number of sites was greater, enabling it to be specified as a random effect that would better adjust for the geographical clustering of observations. Sample size was constrained by the need to organise the fieldwork along the YL tracking exercise and by the limited time and funding available for the study. Despite sample size limitations, interesting findings have emerged that shed light on the mechanisms underlying the relationship between maternal education and child nutrition, and the role of HN knowledge specifically.
4) Weaknesses in the measurement of community-level education
Different methods were used in each country for defining 'community'. As a result any between-country differences in the role of community-level variables must be interpreted with caution. It is difficult to overcome this problem because the meaning and measurement of 'community' is rooted in the social structure of society. It is therefore important to consider underlying assumptions of comparative analysis when interpreting the results (Table 10.4). Furthermore, the community-level measures are not representative of the entire community because the data come from the YL study which had specific criteria for the inclusion of households, one of which was having a child present in the household that was 1 or 8 years old. It is possible that the use of a more representative sample of individuals within the community may have yielded a different result than the ones presented here.

Table 10.4 Methodological considerations

1) Assumptions in cross-country comparative analysis
A data-set that pools observations from different countries and contexts assumes that the confounding structure of the study populations are similar. An alternative option would be, for example, to stratify the analysis by country and urbanity and adjust for context-specific confounders. The drawback of this method, however, is a smaller sample size and the inability to ascertain the degree to which confounding has been controlled. In any comparative analysis the assumption is made that the meanings of the variables are comparable. Although the methods used to measure the variables were the same in India and Vietnam, the meaning of say 'primary education', in terms of the skills and knowledge it imparts, is likely to be different due to the different schooling systems. It is also likely that this argument can be applied to within-country comparisons, for example between urban and rural areas, unless a country has a strongly controlled curriculum content and teaching specifications like in the UK. It is also likely that the meaning of primary education undertaken by a grandmother is very different – in content and context – to the primary education undertaken a generation later by her children.
2) Causality cannot be established
The cross-sectional nature of the data, combined with the problem of confounding by unknown factors, means that firm conclusions cannot not be drawn about causal relations between variables. Nevertheless, the plausibility of findings have been assessed in the light of previous research. The IV approach was undertaken in an attempt to overcome the problem, but failed due to the lack of valid instruments. In this thesis I have discussed the difficulties in establishing causality, because it relies on the ability to disentangle the effect of women's skills and identity. The discussion has exemplified the importance of theorizing about the underlying causal structure and assessing methodological assumptions.
3) Education is a crude proxy
Education, whether measured according to grade or level completed, is a crude proxy for multiple processes that take place within a classroom and equip children with knowledge, skills, aspirations and identities that affect their future choices and capabilities. Furthermore, the YL indicator of education, the level of schooling completed, fails to distinguish between completely uneducated women and those who attended but did not complete primary education. This weakness was addressed in the KN study. The strength of the indicators used in this study is that they can be measured in the same way in different settings. This means that, unlike the underlying processes of interest to us, which are more culturally specific and difficult to observe, it is possible to detect cross-country benefits of education, in terms of the level completed or grade attained. From a policy perspective this is useful since it informs policy interventions across different countries. So although education is a crude proxy for a number of complex and largely unknown processes, processes that may vary from one country to the next, its simplicity is useful in the design of policy interventions to combat child malnutrition.

4) Proximal determinants of malnutrition not measured
In this thesis I have not measured the most proximal determinants of child malnutrition, which according to the conceptual framework presented in Figure 1.1 are diet and disease, themselves determined by food security, care and the health environment. None of these factors have been included in this analysis, first because the data were not all available and second because it is not considered necessary in order to address the objectives of the study. This view is supported by Greenland who has recently underscored the merits of descriptive risk-factor analysis which prevents researchers from over-interpreting associations in order to demonstrate scientific or policy relevance (Greenland, Gago-Dominguez et al. 2004). The aim of this thesis has therefore been to describe associations and raise hypotheses about more distant mechanisms, such as communication and knowledge, which have been studied to a lesser degree than the more proximal determinants of malnutrition.
5) Other causal pathways not examined
Causal pathways are likely to be multiple, inter-related and changeable. For this reason, it is useful to examine several potential pathways simultaneously [see for example (Frost, Forste et al. 2005)] in order to compare effect sizes. While this thesis has explored a number of causal pathways between maternal education and child nutrition, an even larger number of pathways have remained unexplored which (as illustrated in Figure 10.1d) include socio-economic status, reproductive behaviour, female autonomy, modern attitudes towards health care and community-level variables. Although I have not directly explored these factors, I have adjusted for socio-economic status in the regression models which suggests that any education effect observed operates independently of socio-economic status. Similarly, I have not directly measured modern attitudes towards health or female autonomy but instead I have focused on the role of women's communication patterns and their general awareness.

10.3 Contributions and recommendations

10.3. 1 HN knowledge does not mediate the education effect in AP

I have found no evidence of HN knowledge being a predictor of child nutrition or being on the causal pathway between maternal education and child nutrition, which contradicts the findings of previous studies aimed at exploring this question (Ruel, Habicht et al. 1992; Glewwe 1999; Kovsted, Pörtner et al. 2002). There are three possible reasons for this. First, previous research has all been conducted in Africa so it is possible that underlying mechanisms are different in India. This is supported by the literature on India which provides no evidence for education being a determinant of health knowledge.

Second, the lack of effect of health knowledge on child nutrition may be due to an inadequate measurement of HN knowledge. If I am not capturing the relevant type of knowledge, then I am unlikely to observe an effect. Finally, it may be explained by the fact that I was unable to adjust for endogeneity due to invalid instruments. Not adjusting for endogeneity may underestimate the true effect of knowledge which remains hidden by the confounding of unknown factors.

In recent years, studies of women's health knowledge have often measured knowledge in terms of mothers' ability to assess child growth (Black and Krishnakumar 1999; Glewwe 1999; Christiansen and Alderman 2001). A positive association between this type of knowledge and child health outcomes has been interpreted as representing a causal relationship, which has led to the advocacy for interventions aimed to improve mothers' awareness of growth faltering and their ability to identifying it. The claim has been made that 'strategies are likely to be most successful when caregivers do not deny the child's growth deficiency, have accurate perceptions of the child's health and temperament, and are nurturing and responsive to the child' (Black and Krishnakumar 1999). However, the effectiveness of growth monitoring at combating malnutrition has repeatedly come under scrutiny and is still hotly debated within the development field (Nabarro and Chinnock 1988; The Save the Children Fund 2003). I wish to draw attention to two issues with reference to growth monitoring interventions, first the issue of causality and secondly the issue of an exclusive focus on mothers, both of which have been repeatedly raised in this thesis.

The ineffectiveness of many growth monitoring interventions may, I suspect, be rooted in its non-causal relationship between child nutrition and the knowledge and understanding of growth monitoring among mothers. The association observed in cross-sectional studies between mothers' ability to follow growth charts and their own children's height and weight is not necessary a causal one, but explained instead by unknown factors related to women's innate abilities, such as intelligence. The understanding of growth charts is a proxy for something else which forms part of a woman's skill-set or identity, a 'something' which simultaneously enables her to better care well for her child. For these

reasons it is necessary that further research is conducted to explore this hypothesis. Growth monitoring, and the role of mothers' health knowledge in general, is featured highly on the development agenda. It would be timely for further research to identify the contexts in which this type of knowledge is important for child nutrition and to attempt to disentangle its role from that of existing positive personal attributes.

My second argument relates to the targeting of mothers. While it cannot be denied that women's care-giving capabilities are important for children's well-being and growth, an excessive focus on growth monitoring, as a type of care-giving capability to be positively modified by training, may in my opinion distract from other more effective interventions to reduce malnutrition, interventions which put less responsibility on the individual mother. It has been strongly highlighted in this thesis that it is not the mother alone who is responsible for a child's growth, a finding which supports a less individualistic approach.

Throughout the thesis I have repeatedly raised the issue of women's innate capabilities in determining child malnutrition. I have shown that a mother's general awareness and communication skills are strong positive determinants of child nutrition and that together they explain the effect of maternal education (Table 9.2 Model E). Thus it seems that education benefits child nutrition through the enhancement of existing capabilities and attributes, though the extent to which they are existing or taught remains unknown. Further research is needed to explore the role of these attributes in explaining the clustering of malnutrition and mortality within families, which has been frequently noted in the literature (Das Gupta 1990; Griffiths, Matthews et al. 2002; Griffiths, Madise et al. 2004).

10.3.2 The complementary relationship between education and communication ability

The results show that mothers' communication ability is a strong predictor of child nutrition. Although the mechanism by which mothers' conversational, interactive and

interpersonal skills benefit child nutrition is not fully understood, it is possible to put forward some hypotheses. One should consider the globalisation-driven transition of societies which in recent decades has transformed the provision and purpose of education in the developing world (Mebrahtu, Grossley et al. 2000). Globalisation has brought changes to the relationships between people, away from tight kinship systems towards more geographically spread networks and a growing dependency on strangers (Weinstein-Shr 1993). A modern and urban world is developing where a new mode of communication is needed to access educational and social service bureaucracies. In this new world, oral and written literacy has become a tool for negotiating with new institutions and for mediating between culture groups which are increasingly becoming exposed to each other as people migrate to the cities.

In cities women need confidence, fluency and competence when interacting with modern health institutions. Studies have shown that these skills can be obtained or enhanced by going to school (Caldwell and Caldwell 1985; Mechanic 1992; Joshi 1994). Additionally I propose that these skills are also used to cultivate informal social support networks, simply a network of family, friends and neighbours. In my study the interviewers were better able to communicate with mothers who had been to school. That suggests that educated women are more accustomed and keen to interact with strangers and people in authority. I have also shown that education has a stronger effect on nutrition in urban areas than rural areas. It is plausible, therefore, that in the light of recent research (see Section 5.4.5), education enhances women's ability to manipulate critical aspects of the modern world, such as bureaucratic institutions which play a more dominant role in urban life. Health services in particular are likely to be more available in urban areas. Dealing with modern health services can be intimidating and complex for most of us, let alone for poor illiterate women unfamiliar with modern medicine and bureaucracy in general. If educated women are better able to communicate with professionals – by effectively explaining symptoms, having the confidence to ask for clarification and the ability to follow advice and prescriptions – then they can take advantage of health services more effectively than uneducated women.

It is also plausible that education enhances women's ability to generate a large, spatially-spread and heterogeneous network of 'influential others'. My findings have shown that women tend to have larger communication networks in urban than rural areas (Table 9.2). There are several likely reasons for this. First, in cities women are likely to come into contact with a greater number and variety of people than women living in less populated rural areas. Second, they may deliberately develop a wider support network in response to being more distant from traditional kinship ties. Third, the urban environment can be new and daunting to first-generation migrants who need as much help as they can in order to safeguard a livelihood and the health of their family. Finally, urban women are more likely to take up outside employment and thereby foster new links with people they would otherwise not have met. It is therefore conceivable that women's interpersonal skills and connectedness are potential mediators of the education effect which, furthermore, may explain the greater impact of education in urban areas than rural.

I can do little more than speculate that communication abilities benefit child nutrition through the use of health services and the development of wider support networks. This is because I have not directly assessed the nature of the support offered by network members nor assessed women's access to health services in relation to their communication abilities. The communication variable may also suffer from bias (as explained in Table 10.2). Further research, preferably longitudinal, is therefore needed to explore these questions while attempting to overcome the methodological weaknesses identified in this study. A theoretical model has been proposed by LeVine in which academic literacy skills serve as a pathway between formal schooling and maternal health-related behaviours (LeVine, Dexter et al. 1994). This model needs to be applied in a variety of different settings in order to assess its applicability and uncover the micro-social processes by which oral and written literacy skills are connected with patterns of maternal health behaviour, and to examine how communication skills interact with intelligence and motivational factors such as aspirations, identity and empowerment. Furthermore, research is needed to explore the role of informal support networks in urban areas as a mediator of the maternal education effect.

10.3.3 Implications for policy

The exploration of policy implications of the findings has not been an outright aim of the thesis. I would generally support the view of Rothman that policy implications are better assessed by others who can synthesize evidence in a balanced fashion, along with costs and benefits of proposed interventions (Rothman 1993). Others, however, have taken the view that it is the responsibility of epidemiologists to consider the consequences and contexts of their work and findings, thereby helping to bridge the age-long gap between research and policy (Teret 2001). As I have justified the thesis on the basis of its public health policy significance (Chapter 1), it would be inappropriate not to consider some key policy questions in its conclusion. I will do this by focusing on India, the location of the KN study, because my experience of undertaking fieldwork there has given me a thorough understanding of policy related issues in that country.

The Education for All initiative, along with other international education proposals (see Section 1.3), have all emphasized the important role of universal 'basic' or primary education. Recent studies have also shown that even a small amount of education can have important benefits for the health of the next generation (LeVine, Dexter et al. 1994; Basu and Stephenson 2005). Basu used 1992/3 data from the Indian NFHS to show that even low levels of education increase child survival prospects and health-related behaviours, except for neonatal mortality and the effective management of diarrhoea. The results presented in this thesis do not, however, support this finding. In fact, it was shown in Section 8.4.2 that, for reasons that are unknown, maternal education of less than grade 5 had a statistically significant negative effect on child nutrition (compared with having no education). It is possible that the negative connotations associated with early drop-out outweigh the benefit of some schooling in my sample – a sample which concentrates on the poor. Nevertheless, if primary schooling is having a negative effect on child nutrition among the poor, then naturally the next question to ask is: what type of primary schooling are Indian children receiving? The question directs our attention to the issue of 'education quality'. Is it possible that poor quality education explains the lack of effect observed among women who has only completed grades 1-4? Recent studies have

suggested that primary education is viewed as irrelevant and inadequate by even the poorest of the poor, being a principle cause of premature drop-out (PROBE team 1999; Govinda 2002; Ramachandran 2003). Yet educational quality is notoriously difficult to measure. UNESCO defines educational quality according to learners' cognitive development along with the promotion of values and attitudes of responsible citizenship and the nurturing and creation of emotional development (UNESCO 2004). However, none of these indicators of educational quality were measured in this study, so it is impossible for me to comment on the extent to which educational quality can explain the lack of an education effect among the mothers who attended school for less than 5 years. It would be beneficial, however, to refer to a recent study in India which concluded that children in a typical primary school learn the virtues of obedience, authority, discipline and routine (PROBE team 1999). The report identifies that certain values are being transmitted within the classroom, deliberately or not. One is the respect for authority figures, which is supplemented by learning tools such as memorization, regurgitation and cramming. Basu links these 'skills' – the taught respect for authority and the ability to follow instructions and a time table of routine – to the capacity with which an educated woman may be more able to seek modern health care and follow the advice given to her by health care providers (Basu and Stephenson 2005). Viewed in this light, she claims that the 'hidden curriculum' of poor quality education is well suited to the improvement of childcare. This argument does not support the view of others that schooling increases women's autonomy, self-confidence and decision-making power (see Section 1.3.2).

Clearly there is a need to venture into the classroom to better understand which skills and messages are being transmitted and how. Such an understanding would enable us to speculate, like Basu has done, about the mechanisms behind the relationship between adult education and child nutrition which varies in its size and direction according to the level of education completed, social-strata and geography. In my opinion further research is particularly needed to explore women's networks and networking skills as potential mediators of the education effect on child nutrition. It is possible that schoolchildren are trained at a young age to respect authority as a source of knowledge and, at the same time, to make friends and interact with children whom they would otherwise not mix with

– children of a different sex, religion or ethnic background. These social skills, I suspect, may lead a girl to broaden her networks for social support and communication as she grows older, which in turn enables her to better care for herself and her family through a variety of mechanisms like the sharing of knowledge, practical help or social influence. It also encourages her to seek professional help outside her network should she need to.

10.3.4 Widening the focus from mothers to 'influential others'

I have shown that the education of adults other than the mother is important for child nutrition. Particularly interesting, given the lack of previous evidence, is the role of grandmother education in AP and community-level education in Vietnam.

The positive impact of grandmothers' education in AP is expected – because there is overwhelming evidence of health benefits of female education in general and because grandmothers are known to play an important role in childcare (Section 1.4.1). Particularly interesting is the stronger positive effect observed for boys of grandmother education in India, which may reflect the traditional preference for sons. The absence of a sex-difference in the maternal education effect suggests that this tradition is today much weaker than before.

In the YL study I only explored the role of the grandmother present in the household, thereby overlooking any benefit of the education of grandmothers living elsewhere. This concern was addressed in the KN study where I also examined the role of grandmothers located in a different household as part of the mothers' communication network. The results demonstrated that the number and education of female network members outside the household – the majority of whom tend to be maternal grandmothers – were important in determining mothers' HN knowledge and general awareness. Overall the results suggest that both maternal and paternal grandmothers are likely to play an important role, either in determining child nutrition directly or influencing the HN knowledge of the mother, which in turn may affect her care behaviour.

The findings in this thesis have repeatedly highlighted the important role of 'influential others' in determining mothers' HN knowledge and child nutritional status. For example, the education of parents and grandmothers, along with the education of other community-members, have independent effects on child nutrition; the effect of maternal education is positively modified by the education of the people around her; and the size and literacy of the women's communication networks was a strong predictor of her HN knowledge and general awareness. Overall, the findings suggest that the education of these individuals is likely to have important influences upon both mothers and children, although the mechanisms through which these influences operate is still not fully understood.

There are two important implications of these findings: first, it calls for a less individualistic approach to research on child malnutrition; and second, it highlights the need for further research into the nature of the externality of education. The results support the claim made by other studies that targeting solely women of reproductive age, which is common for many mother-and-child health programmes, may overlook other actors who influence health-related decision-making and practices (Wachs 1995; Bishai 1996). As women in India and Vietnam are increasingly taking up employment outside the household, the role of other carers such as grandmothers and siblings is likely to be important in determining child nutrition in the future (Bishai 1996). A less individualistic approach would demonstrate a recognition of the role of poverty as an underlying determinant of malnutrition (see the conceptual framework for malnutrition in Figure 1.1). Studies have shown that mothers are often too poor to act on their newly acquired knowledge about nutrition and that maternal education only benefits child health once basic needs have been satisfied (Ruel, Habicht et al. 1992; Reed, Habicht et al. 1996; The Save the Children Fund 2003). These and my own studies suggest than an over-reliance on poor mothers to alter their care behaviour may not be the most efficient way of combating child malnutrition.

10.3.5 Recognizing the role of community-level education and services

The externalities of education, its patterns and determinants, operate beyond the mother-child pair. I have shown that community-level education has a stronger impact on child nutrition if measured in terms of prevalence of maternal literacy rather than prevalence of highly educated adults. This may suggest that literacy among women is a channel through which the externality of education operates. However, because literacy among fathers was not collected it has not been possible to directly assess the sex differences in the role of community-level education. There was also a lack of difference in effect between the standard indicator of community-level maternal literacy and a measure that adjusts for the distribution of educated adults. Therefore, further research is needed to explore the mechanisms by which community-education impacts upon child growth, and whether the distribution of educated individuals matters. This would help policy-makers in targeting education resources to maximise the externalities of education so that the whole community benefits. While I showed that neither community-level education nor its distribution was important in determining child nutrition in AP, this may be due to an inappropriate definition of 'community' – based on geographical criteria rather than say caste or wider communication networks, which may been more culturally appropriate.

Moreover, research is needed to explore the relative importance of environmental and maternal factors, in particular the role of community-level services in determining child nutrition and in modifying the effect of adult education on child nutrition (Folasade 2000; Escobal and Torero 2002; Griffiths, Madise et al. 2004). Community-level factors may also mediate the individual-level education effect (Alderman, Hentschel et al. 2003) as educated people create demand for services and infrastructure and tend to have more political clout than less educated populations.

10.3.6 Advancing methodological discussions

In this thesis I have attempted to address the problem of confounding by unknown factors. While a handful of studies in the past have attempted to account for confounding by women's genetic endowments, intelligence or other factors which are typically unobservable, further research is needed to assess the extent of the problem. This is particularly important given that characteristics such as a willingness to learn, self-confidence, interpersonal skills and the ability to communicate with strangers may explain the association between education, health knowledge, general awareness, communication ability and child nutrition. The potential of education to enhance these innate abilities needs to be assessed through longitudinal research.

One suggestion for a future study would be the follow-up of children whose intelligence, communication abilities and self-confidence are measured before, during and after receiving primary education for a range of years and at schools of different quality. The potential of education to receive to improve particular traits can then be established – traits which are already known to be useful in later life to access health services, such as communicating with decontextualized language. Ignoring the role of innate capabilities can lead to a misinterpretation of associations – as I have argued with reference to growth monitoring – which may in turn support the design of interventions that ultimately fail because a causal relationship was falsely assumed.

Further research is also needed to address the potential problems of using the IV approach in epidemiology. I have used this approach in an attempt to address the concern of endogeneity of HN knowledge. Two problems have become apparent which cast doubt on whether the IV methodology is superior to conventional methods. The first relates to the selection and defence of suitable instruments; the second, to the interpretation of specification test results that are statistically non-significant, thereby providing no evidence that the IV methodology is superior to conventional methods. The implication is

that it becomes impossible to know whether the non-significant test results are due to a lack of endogeneity or to weaknesses in the instruments.

There is a need to improve our understanding of the potential of the IV approach to explore causal effects in cross-sectional observational data and of how to cope with untested assumptions (Greenland and Brumback 2002; Cox and Wermuth 2004; Hogan and Lancaster 2004). Particularly useful would be the identification of study designs or epidemiological subjects for which the IV approach is suitable, such as longitudinal studies or genetic epidemiology. It would also be worthwhile considering alternative statistical approaches that can overcome the problem of endogeneity caused by unobserved confounding, for example by including parental height in the model as an indicator of genetic health endowments like Glewwe has done (Glewwe 1999), or by channelling research funding into longitudinal studies which are better suited than cross-sectional studies to establishing causality. A recent longitudinal study of child immunization in China revealed substantial bias from standard cross-sectional models in contrast to panel data approaches because of unobserved confounders at the household or community-level (Xie and Dow 2005).

Another methodological issue which has come to the fore in this thesis is the need to develop new education indicators. As was mentioned earlier, a measure of the years of schooling or level of education is a rough proxy for the complex and multifaceted processes that take place within the classroom. More exploratory research is needed to develop culturally-specific education indicators that more successfully capture education quality, and to establish the role of educational quality in determining maternal reproductive and health behaviour and (Basu 1994; Joshi 1994; Carter 1999; Engle, Bentley et al. 2000).

10.3.7 Summary of recommendations for future research

The findings from this thesis led me to make the following recommendations for future research:

A The role of mothers' health and nutritional knowledge (especially related to growth monitoring) in mediating the effect of education on child nutrition.

B The role of mothers' communication skills and connectedness for improving child nutrition: the degree to which such skills and attributes may be enhanced through education and applied in adult life to improve access to health care and develop informal social support networks.

C The mechanisms that underlie the relationship between child nutrition and the education of adults, other than the mother, in the households and community, and the reasons behind the complementary relationship between maternal education and the education of other adults.

D The effect of community-level education on child nutrition over and above household-level education, especially potential differences between male and female education in its effect on child nutrition, as well as the role of education distribution.

E The role of community services in modifying the effect of adult education on child nutrition.

F The relative importance of women's acquired skills and innate capabilities in determining care behaviour, and the potential of education to enhance these to the benefit of child nutrition.

G The identification of research questions and study designs in epidemiology for which the IV approach is appropriate.

H The development of culturally-specific indicators of education quality for child health outcomes to complement existing education and literacy measures.

10.3.8 Final words

Child malnutrition contributes to half of all young children's deaths in the developing world. Education is a recognised strategy for combating malnutrition and yet questions remain about the underlying causal mechanisms as well as about the role of education among non-parental actors.

Using Young Lives data from India and Vietnam, I have shown that child nutrition is positively associated with the education of mothers, fathers and grandmothers. I have also shown that child height is associated with the level of education in the community as a whole, although the distribution of educated individuals does not appear to have an added impact. There were strong social and spatial variations in the strength of these relationships.

I used data from the Knowledge and Networks study in Andhra Pradesh to explore, applying different statistical methods, the mediating role of mothers' health and nutrition knowledge and communication ability. The findings contribute to recent debates, by challenging the emphasis on mothers' HN knowledge and by supporting studies that highlight the role of mothers' communication and interpersonal skills in mediating the education effect.

The matters dealt with in this thesis are of considerable public health importance. I have therefore set out recommendations intended to guide researchers within the field of Education and Nutrition exploring the symbiotic and inter-generational links between education, health, nutrition and well-being in developing countries. Furthermore, the thesis contributes to the discipline of Social Epidemiology by bringing to the fore key methodological challenges and raising new hypotheses to be tested through future research.

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Appendix A Copy of information sheet and consent form used in the KN study

The Young Lives Study: Schooling and Health in Andhra Pradesh

CESS (Centre for Social & Economic Studies)
Nizamiah Observatory Campus, Begumpet
Hyderabad -500016

Investigator: Helen Moestue

We wish to explain who we are and what we are doing, and to ask whether or not we can interview you today.

We are doing a study which is part of the Young Lives Project. You may recollect that in September 2002 people from the Young Lives Project came to your house to ask questions about you and your child/one of your children. We are very grateful that you are taking part in the Young Lives Project. The interview which we would like to conduct with you today is specifically about schooling in Andhra Pradesh. We are interviewing approximately 300 women in the local area. What you and other women tell us will help us learn more about how schooling affects people's lives, especially the lives of women.

We would like to interview you, if you want to. Taking part is entirely voluntary.

If you decide to participate, we will ask you some questions about your family and your life here in this community. You can withdraw from the interview whenever you want without having to give a reason, and you do not have to answer any questions if you do not want to. If you don't know the answer to a question, or do not wish to answer it, then please let us know. We appreciate your honesty and your cooperation with us.

The interview will take about 30 minutes.

All the information we collect will be entirely confidential. We will store the paper questionnaires in a secure place in the CESS office in Hyderabad, where only authorised people from the Young Lives Project will be able to access them.

This study has been given approval by the Ethics Committee of The London School of Hygiene and Tropical Medicine.

Thank you for listening.

The Young Lives Study: Schooling in Andhra Pradesh
Investigator: Helen Moestue

I have understood the verbal explanation concerning this study and I understand what will be required of me and what will happen to me if I take part in it.

My questions concerning this study have been answered by Young Lives Project staff.

I understand that at any time I may with draw from this study without giving a reason and without affecting my normal care and management.

I agree to take part in this study.

Signed……. Date…….

Appendix B Copy of questionnaire (English version) used in the KN study

DATE: __ __/__ __/__ __ STAFF ID: __ __ COMMUNITY ID: __ __ __ CHILD ID: __ __ __ __ __ __

Young Lives

Schooling and Health in Andhra Pradesh

SECTION 1: BACKGROUND AND NETWORKS CODE NAMES

1.1 What is your name? ▯ _____ NAMEMO

1.2 How old are you?
Completed years __ __
DK [ ] 88 MAGE

1.3 Can you read and write?
neither [ ] 0
sign name only [ ] 1
read only [ ] 2
write only [ ] 3
read and write [ ] 4

1.4 What grade did you complete at school?
grade completed __ __ MGRADE
not been to school **=> *skip to 1.6*** [ ] 00
functional school **=> *skip to 1.6*** [ ] 22 MLIT
night school/ adult ed **=> *skip to 1.6*** [ ] 33
DK **=> *skip to 1.6*** [ ] 88

1.5 Was it a government or private school? Gov [ ]1 Priv [ ]2 NA [ ]9 SCHTYPE

1.6 What is the name of the YL index child? ▯ _____ NAMECH

1.7 What is the sex of NAME? Boy [ ]1 Girl [ ]2 SEX

1.8 What is the age of NAME? (DK=99) Yrs:__ __ Mts:__ __ CHILDYRS CHILDMON

1.9 Which family members do you live with? TICK IF LIVES WITH MIL [ ] MIL

1.10 Can you name the people you talk to the most, either members of your family or others?
ENTER "NAME" + "SEX" OF 0-6 PEOPLE IN TABLE 1
1.11 Where do these people live? ENTER "LIVE" CODE IN TABLE 1
1.12 What is your relationship with these peop ENTER "RELATE" CODE IN TABLE 1
1.13 What grade did these people complete at school? ENTER "GRADE" CODE IN TABLE 1
1.14 Are these people literate? ENTER "LIT" CODE IN TABLE 1

TABLE 1: SOCIAL NETWORK

ID	NAME	SEX	LVE	RELATE	GRADE	LIT
01	▯ _____	__	__	__	__ __	__
02	▯ _____	__	__	__	__ __	__
03	▯ _____	__	__	__	__ __	__
04	▯ _____	__	__	__	__ __	__
05	▯ _____	__	__	__	__ __	__
06	▯ _____	__	__	__	__ __	__

TABLE 2: OTHER PEOPLE WHO GIVE ADVICE

ID	NAME	SEX	LVE	RELATE	GRADE	LIT
07	▯ _____	__	__	__	__ __	__
08	▯ _____	__	__	__	__ __	__
09	▯ _____	__	__	__	__ __	__
10	▯ _____	__	__	__	__ __	__
11	▯ _____	__	__	__	__ __	__

LIVE:
1=same hh 2=different hh, same locality 3= diff hh, diff locality
SEX:
1=male 2=female
RELATE:
1=husband 2=parent 3=brother/ sister 4=parent in law 5=sibling in law 6=son/ daughter 7=other family 8=friend/ neighbour 9=Other (specify)
GRADE:
00=no education 77=health proff. 99=DK
LIT:
1=literate 2=illiterate 9=DK

SECTION 2: KNOWLEDGE

EXPLAIN THAT ONLY THE RESPONDENT CAN ANSWER

Pregnancy:

2.1 Where did you give birth to NAME?

Govt hospital	[ ] 1	
Private hospital	[ ] 2	
Home by trained BA **=> *skip to 2.3***	[ ] 3	DELIV
Home by untrained BA/ alone **=> *skip to 2.3***	[ ] 5	
Other ➢_____	[ ] 7	

2.2 **TABLE:** Did anyone advise you to give birth here? ASK FOR MAIN PERSON

No one in particular advised	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	DELWHO
Teacher/ anganwadi teacher	[ ] 13	
Other ➢_____	[ ] 77	
NA	[ ] 99	

2.3 Did you go to the doctor for check-ups during your pregnancy with NAME?

Yes	[ ] 1	CARE
No **=> *skip to 2.5***	[ ] 2	

2.4 Where did you go?

Public health centre/community health centre/ sub sentre	[ ] 1	
Govt hospital	[ ] 2	
Private clinic	[ ] 3	CARWHERE
Private hospital	[ ] 4	
Other ➢_____	[ ] 7	
NA	[ ] 9	

2.5 **TABLE:** Who advised you to go there? ASK FOR MAIN PERSON

No one in particular advised	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	CAREWHO
Teacher/ anganwadi teacher	[ ] 13	
Other ➢_____	[ ] 77	
NA	[ ] 99	

2.6 What did you get at the check-up? DO NOT PROMPT, YOU CAN TICK >1 BOX

"injection"	[ ]	CHECKINJ
"tetanus injection"	[ ]	CHECKTET
"tablet(s)"	[ ]	CHECKTAB
"iron/ folic acid/ calcium/ vitamin C tablets"	[ ]	CHECKVIT
Weighing	[ ]	CHECKWT
Other ➢_____	[ ]	CHECKOTH
DK	[ ]	CHECKDK
NA	[ ]	CHECKNA

2.7 If mentions "injection" or "tetanus injection": why were you given this injection? ASK FOR MAIN REASON; TICK ONE BOX ONLY

for general health/ safety of mother/child	[ ] 1	
specifically to prevent tetanus for mother/child	[ ] 2	INJECWHY
Other ➢_____	[ ] 7	
DK	[ ] 8	
NA	[ ] 9	

Child immunization:

2.8 Has NAME received any vaccinations?

Yes	[ ] 1	VAC
No **=> *skip to 2.10***	[ ] 2	

2.9 **TABLE:** Who advised you get NAME vaccinated? [ASK FOR MAIN PERSON]

No one in particular advised	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	VACWHO
Teacher/ anganwadi teacher	[ ] 13	
Other ➢_____	[ ] 77	
NA	[ ] 99	

2.10 Do you know why babies receive an injection in the shoulder?

Mentions BCG or TB	[ ] 1	VACBIRTH
Does not mention BCG or TB	[ ] 2	

2.11 At what age should a baby get a measles vaccine?

9 months	[ ] 1	
Other age	[ ] 2	MEASLES
DK	[ ] 8	

Breastfeeding:

2.12 Did you breastfeed NAME?

Yes	[ ] 1	BRFEED
No	[ ] 2	

2.13 Did you sqeeze out the milk before you first breastfed NAME?

Yes	[ ] 1	COL
No	[ ] 2	

2.14 Why did you give/ not give *[colustrum]* ?

Gave, because good for baby's health/ nutrition/ growth	[ ] 1	
Did not give, because not clean	[ ] 2	
Did not give, because of previous miscarriage	[ ] 3	COLWHY
Did not give, because it is a "belief"	[ ] 4	
Because advised by someone	[ ] 5	
Other ➢_____	[ ] 7	
DK	[ ] 8	

2.15 **TABLE:** Who advised you to give/not give *[colustrum]?* ASK FOR MAIN PERSON

No one in particular advised	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	COLWHO
Teacher/ anganwadi teacher	[ ] 13	
Other ➢_____	[ ] 77	
NA	[ ] 99	

Complemetary feeding:

2.16 At what age did you start giving solid/ mushy foods to NAME?

ENTER AGE IN MONTHS:	__ __	WEANAGE

2.17 **TABLE:** Who advised you to do this? [ASK FOR MAIN PERSON]

No one in particular advised	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	WEANWHO
Teacher/ anganwadi teacher	[ ] 13	
Other ➢_____	[ ] 77	
NA	[ ] 99	

2.18 What is the ideal age for introducing solid foods into a child's diet?

ENTER AGE IN MONTHS:	__ __	WEANIDEAL
DK	[ ] 88	

2.19 Do you know what Cerelac is?

Yes	[ ] 1	CERELAC
No ***=> skip to 2.27***	[ ] 2	

2.20 **TABLE:** If yes, how did you get to know about it?

No one in particular	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	
Teacher/ anganwadi teacher	[ ] 13	CEREWHO
TV	[ ] 14	
Other ➢_____	[ ] 77	
NA	[ ] 99	

Feeding:

2.21 How many times did you feed NAME yesterday (meals and snacks)?

ENTER NUMBER OF MEALS:	___	MEALS
ENTER NUMBER OF SNACKS:	___	SNACKS

2.22 In general, how many times should a child should be fed (main meals) each day?

< 3 times per day	[ ] 1	
3 times per day	[ ] 2	FEDTIMES
> 3 times per day	[ ] 3	

2.23 The last time NAME had diarhhoea, did you give more/less/same amount of food?

More	[ ] 1	
Less	[ ] 2	DIAF
Same	[ ] 3	
Child has not had diarhhoea ***=> skip to 2.25***	[ ] 4	

2.24 **TABLE:** Who advised you to give this amount of food? ASK FOR MAIN PERSON

No one in particular advised	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	DIAFWHO
Teacher/ anganwadi teacher	[ ] 13	
Other ➢_____	[ ] 77	
NA	[ ] 99	

2.25 Should a child be given more/less same amount of food when he/she has diarrhoea?

Less	[ ] 1	
Same	[ ] 2	DIAFBEST
More	[ ] 3	
DK	[ ] 8	

Treatment of diarhhoea:

2.26 The last time NAME had diarhhoea: how did you treat her/him in your home?

Did nothing ***=> skip to 2.28***	[ ] 1	
Gave fluids (homemade drink, tea, coconut milk etc.)	[ ] 2	
Gave packet ORS	[ ] 3	DIAT
Gave homemade ORS	[ ] 4	
Child has not had diarrhoea ***=> skip to 2.28***	[ ] 5	
Other ➢_____	[ ] 7	

2.27 **TABLE:** Who advised you to do this? ASK FOR MAIN PERSON

No one in particular advised	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	DIATWHO
Teacher/ anganwadi teacher	[ ] 13	
Other ➢_____	[ ] 77	
NA	[ ] 99	

2.28 How do you prepare ORS?

Mentions mixing water with salt and sugar	[ ] 1	
Mentions mixing water with salt and sugar + added ingredients	[ ] 2	ORS
Other ➢_____ ***=> skip to 3.1 +explain ORS***	[ ] 7	
DK ***=> skip to 3.1 +explain ORS***	[ ] 8	

2.29 **TABLE:** Who taught you this? ASK FOR MAIN PERSON

No one in particular	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	ORSWHO
Teacher/ anganwadi teacher	[ ] 13	
Other ➢_____	[ ] 77	
NA	[ ] 99	

SECTION 3: HYPOTHETICAL SITUATIONS

EXPLAIN THAT YOU WILL TELL SOME STORIES ABOUT RAJITHA AND HER CHILD

3.1 Rajitha has a small baby boy. It is her first child. They live with her husband and his parents in a small house. One day the baby gets diarrhoea. She doesn't know if she should continue giving breastmilk or not. What do you think she should do?

Stop breastfeeding	[ ] 1	
Continue breastfeeding	[ ] 2	RBFED
DK	[ ] 8	

3.2 Rajitha's friend is called Lalita. Lalita also has a baby boy, one month younger than Rajitha's baby. Rajitha has noticed that her baby can barely sit unsupported, while Lalita's baby can already walk. Is this a problem?

Yes definitely it is a problem	[ ] 1	
Yes, it may be a problem	[ ] 2	RCDEV
No, it is not a problem	[ ] 3	
DK	[ ] 8	

3.3 Rajitha'a baby is now 10 months old. Rajitha has always breastfed the baby because she has had good milk. Therefore she has only given very small amounts of cerelac and rice to the baby. What do you think will happen to Rajitha's baby if she doesn't start to given more solids? YOU CAN TICK >1 BOX

Mentions growth	[ ] 1	
Mentions sickness/ weakness	[ ] 2	RWEAN
Other ➢_____	[ ] 7	
DK	[ ] 8	

3.4 In Rajitha's neighbourhood there are some children who are very short in height for their age. Other children are both short and thin. Do you know what is the reason for children not growing? YOU CAN TICK >1 BOX

Children eat bad/dirty food	[ ] 01	RNUT
Children eat small quantity of food	[ ] 02	
Children are sick/ lack of medical attention	[ ] 03	
Mother's milk is not good	[ ] 04	
Mother's health is not good	[ ] 05	
Mother's diet/ nutrition	[ ] 06	
Poor sanitation/ cleanliness in the home or outside	[ ] 07	
Genetic reason	[ ] 08	
Other ➢_____	[ ] 77	
DK	[ ] 88	

3.5 Rajitha's child falls sick often, with diarrhoea, cough, cold and fever. Rajitha doesn't know what the reason for this is. Do you know what the reason is? YOU CAN TICK >1 BOX

Child plays in dirty water		RSANIT
Poor sanitation/ cleanliness in the home or outside	[ ] 1	
Children eat little/bad/dirty food	[ ] 2	
Child does not get enough care/ attention	[ ] 3	
Mother has poor diet/ nutrition	[ ] 5	
Other ➢_____	[ ] 7	
DK	[ ] 8	

3.6 TICK IF YOU THINK MOTHER-IN-LAW IS NEARBY DURING INTERVIEW: [ ] MILRAJ

3.7 Rajitha's is living with her child, husband and mother-in-law. Her friend Sonya lives nearby. Rajitha has never been to school but her friend has completed 5th grade. One day Rajitha's child gets diarrhoea. Rajitha doesn't know what to do. Her illiterate mother-in-law gives some advice, but Sonya gives different advice - Whose advice should Rajitha follow?

Sonya's	[ ] 1	SONYA
Mother-in-laws's	[ ] 2	
Both	[ ] 3	
Other ➢_____	[ ] 7	
DK	[ ] 8	
Don't want to say/ cannot ask question	[ ] 9	

3.8 Rajitha is visited by a health worker when her child is 6 months old. The health worker examines the baby and gives some advice about what foods to start feeding the baby. When the health worker leaves, Rajitha explains the advice to her mother-in-law. The mother-in-law says that the health worker is wrong - Who should Rajitha listen to?

Health worker	[ ] 1	HW
Mother-in-law	[ ] 2	
Both	[ ] 3	
Other ➢_____	[ ] 7	
DK	[ ] 8	
Don't want to say/ cannot ask question	[ ] 9	

SECTION 4: ADVICE FROM OTHERS

4.1 Do you sometimes receive conflicting advice about how to care and feed your child, e.g. from the elders in your family and health proffessionals?

Yes	[ ] 1	CONFLICT
No	[ ] 2	
DK	[ ] 8	
Don't want to say/ cannot ask question	[ ] 9	

4.2 What do you do in those situations?

Follow health proffessionals	[ ] 1	
Follow family members	[ ] 2	WHATDO
Try to accommodate both	[ ] 3	
Other ▯ _____	[ ] 7	
DK	[ ] 8	
Don't want to say/ cannot ask question	[ ] 9	

4.3 **TABLE:** If your child falls sick, and the nurse/health worker is not available, who would you (actively) seek advice from? ASK FOR MAIN PERSON TICK ONE BOX ONLY

No one in particular	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	SEEK
Teacher/ anganwadi teacher	[ ] 13	
Other ▯ _____	[ ] 77	

4.4 **TABLE:** If your child falls sick, and the nurse/health worker is not available for 3 days. Who would you (passively) receive advice from? ASK FOR MAIN PERSON; TICK ONE BOX ONLY

No one in particular	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	
Doctor/ nurse/ other health professional	[ ] 12	RECEIVE
Teacher/ anganwadi teacher	[ ] 13	
Other ▯ _____	[ ] 77	

4.5 Do you get advice from anyone else? PROMPT, YOU CAN TICK >1 BOX

- Mother-in-law	yes [ ]	no [ ]	ADMIL
- Mother	yes [ ]	no [ ]	ADVMOT
- Other female relative	yes [ ]	no [ ]	ADVFEM
- ANM	yes [ ]	no [ ]	ADVANM
- Doctor/ nurse/ other health proffessional	yes [ ]	no [ ]	ADVDOC
- Anganwadi worker	yes [ ]	no [ ]	ADANG
- Other ▯ _____	yes [ ]	no [ ]	ADOTH

4.6 Do you belong to a self-help group?

Yes	[ ] 1	WGRP
No ***=> skip to 4.9***	[ ] 2	

4.7 What is your role?

Member	[ ] 1	
Leader	[ ] 2	WGRPROLE
Other ▯ _____	[ ] 7	
NA	[ ] 9	

4.8 What are the things you discuss at meetings?

TICK IF MENTIONS HEALTH/ CARE/ FEEDING	[ ]	
NA	[ ] 9	WGCARE

4.9 Apart from work in the house, what else do you do? ASK FOR CURRENT MAIN ACTIVITY

Nothing ***=> skip to 4.11***	[ ] 0	
Work as domestic servant	[ ] 1	
Farm activity	[ ] 2	JOB
Non-farm rural activity outside own home	[ ] 3	
Non-farm rural activity inside own home	[ ] 4	
Other ▯ _____	[ ] 7	

4.10 By doing this, can you gain knowledge about child care/ food preparation/ cleanliness or health care?

Yes	[ ] 1	
No	[ ] 2	JOBHELP
NA	[ ] 9	

4.11 Within the last year, have you migrated away for work?

Yes	[ ] 1	MIG
No **=> *skip to 5.1***	[ ] 2	

4.12 By doing this, can you gain knowledge about child care/ food preparation/ cleanliness or health care?

Yes	[ ] 1	
No	[ ] 2	MIGHELP
NA	[ ] 9	

SECTION 5: MEDIA AND LITERACY

5.1 In your daily life, do you ...READ LIST?

Listen to the radio	yes [ ]	no [ ]	RAD
Watch/ listen to TV	yes [ ]	no [ ]	TV
Use telephone	yes [ ]	no [ ]	TEL
Read newspaper	yes [ ]	no [ ]	NEW

5.2 IF USES MEDIA: Do you use these either inside or outside your home? READ LIST

	inside:		outside:		
Listen to the radio	yes [ ]	no [ ]	yes [ ]	no [ ]	RADIN/RADOUT
Watch/ listen to TV	yes [ ]	no [ ]	yes [ ]	no [ ]	TVIN/TVOUT
Use telephone	yes [ ]	no [ ]	yes [ ]	no [ ]	TELIN/TELOUT
Read newspaper	yes [ ]	no [ ]	yes [ ]	no [ ]	NEWIN/NEWOUT

5.3 What is this picture advertising? SHOW POLIO POSTER (NO TEXT)

Polio drops	[ ] 1	
Drops	[ ] 2	AD1
Other ▯ _____	[ ] 7	
DK	[ ] 8	

5.4 Can you read this? SHOW POLIO POSTER WITH TEXT

The respondent is not a Telugu speaker	[ ] 0	
Reads correctly and fast	[ ] 1	
Reads correctly but slow	[ ] 2	AD2
Reads a little only	[ ] 3	
Cannot read	[ ] 4	

5.5 When you go outside, do you face difficulty because you cannot read something?

Yes	[ ] 1	
No	[ ] 2	READDIFF

5.6 **TABLE:** Do you regularly ask a friend or family member for help to read something? ASK FOR MAIN PERSON

Nobody	[ ] 00	
ENTER ID (from Tbl 1, otherwise add details to Tbl 2 and enter new ID)	__ __	READWHO

5.7 Do you regularly ask somebody else for help to read/write? PROMPT

- Doctor	yes [ ]	no [ ]	RDYES/RDNO
- Teacher	yes [ ]	no [ ]	RTYES/RTNO
- Local leader	yes [ ]	no [ ]	RLNO/RLYES
- Shop keeper	yes [ ]	no [ ]	RSHYES/RSHNO
- Stranger (e.g. at bus stand)	yes [ ]	no [ ]	RSTYES/RSTNO
- Other ▯ _____	yes [ ]	no [ ]	ROYES/RONO

5.8 What do you feel if you need to ask somebody for help to read something?

Nothing, asking for help is no problem	[ ] 0	READHELP
Frustration/ embarrassment	[ ] 1	
Other ▯ _____	[ ] 7	
DK	[ ] 8	
NA/ rarely asks for help	[ ] 9	

SECTION 6: GENERAL AWARENESS

6.1 Is there a school nearby?

She answers	[ ] 1	SCHOOL
She cannot answer	[ ] 2	

6.2 Who is the local ward member/ Sar panch?

She answers	[ ] 1	LEADER
She cannot answer	[ ] 2	

6.3 What is the name of the chief minister of AP?

YS Rajasekhar Reddy is current chief minister	[ ] 1	APCHIEF
Chandra Badu Naidu is current chief minister	[ ] 2	
Chandra Badu Naidu is old chief minister, but don't know current	[ ] 3	
Wrong name	[ ] 4	
DK	[ ] 8	

6.4 What is the name of the Prime Minister of India?

Singh is current prime minister	[ ] 1	PRIM
Vajpayee is current prime minister	[ ] 2	
Vajpayee is old prime minister, but don't know current	[ ] 3	
Wrong name	[ ] 4	
DK	[ ] 8	

6.5 Who is the captain of the Indian cricket team?

Ganguly	[ ] 1	CRICKET
Sachin	[ ] 2	
Other name	[ ] 3	
DK	[ ] 8	

6.6 Other than Telugu and Hindi (and Urdu) what languages are spoken in India?

Names 1 language	[ ] 1	LANG
Names 2 languages	[ ] 2	
Names 3 or more languages	[ ] 3	
DK	[ ] 8	

6.7 Which district does your village/ urban area belong to?

Correct	[ ] 1	DISTRICT
Incorrect	[ ] 2	
DK	[ ] 8	

6.8 Where can you obtain a birth certificate?

MCH/ panchayat/ MDO/ MRO	[ ] 1	CERT
Other place	[ ] 2	
DK	[ ] 8	

SECTION 7: FIELD INVESTIGATORS' OBSERVATION

7.1 PLEASE CLASSIFY THE BEHAVIOUR OF RESPONDENT ACCORDING TO YOUR OBSERVATION DURING THE INTERVIEW:

Passive	[ ] 1	
Active	[ ] 2	BEHAVIOR
Inquisitive	[ ] 3	

7.2 PLEASE CLASSIFY THE COMMUNICATION SKILLS OF THE RESPONDENT ACCORDING TO YOUR OBSERVATION DURING THE INTERVIEW:

Communicates fluently and clearly, very little clarification needed	[ ] 1	
Communicates with some difficulty, some clarification needed	[ ] 2	COMMUNIC
Communicates with much difficulty, much clarification needed	[ ] 3	

7.3 PLEASE NOTE THE LANGUAGE USED DURING THE INTERVIEW:

Telugu	[ ] 1	
Hindi	[ ] 2	
Urdu	[ ] 3	LANGINT
English	[ ] 4	
Other □ _____	[ ] 7	

7.4 ANY OTHER NOTE: NOTE

SIGNATURES:
Field Investigator: □ _____ Field co-ordinator: □ _____