

Durham E-Theses

Growth, morbidity and serum protein markers of immunostimulation in nepali children

Nicola Alison Parkin

How to cite:

Parkin, Nicola Alison (2000) Growth, morbidity and serum protein markers of immunostimulation in nepali children. Masters thesis, Durham University.

Use policy

The full-text may be used and/or reproduced, and given to third parties in any format or medium, without prior permission or charge, for personal research or study, educational, or not-for-profit purposes provided that:

- a full bibliographic reference is made to the original source
- a <https://etheses.durham.ac.uk/id/eprint/4413/> is made to the metadata record in Durham E-Theses
- the full-text is not changed in any way

The full-text must not be sold in any format or medium without the formal permission of the copyright holders.

Please consult the [full Durham E-Theses policy](#) for further details.

**GROWTH, MORBIDITY AND SERUM PROTEIN MARKERS OF
IMMUNOSTIMULATION IN NEPALI CHILDREN**

by

Nicola Alison Parkin, B.Sc.

A thesis submitted for the degree of Master of Philosophy

University of Durham

Department of Anthropology

2000

The copyright of this thesis rests with the author.
No quotation from it should be published without
his prior written consent and information derived
from it should be acknowledged.



27 JAN 2003

ABSTRACT

This study investigated the health and well-being of children aged five to twelve years living in two villages in Nepal. The research took a biocultural perspective, combining qualitative anthropological techniques with traditional and innovative quantitative measures: anthropometric status, morbidity reports and serum markers.

The proportion of children in the sample classified as stunted and wasted was similar to the findings of other studies in Nepal, with much stunting, but little wasting. Median ACT values were low compared with other studies of children in developing countries, but fall within the normal range. Albumin values were lower than the normal UK range, but similar to other findings in developing countries.

Statistical analysis of the anthropometric data in a multivariate model showed that there was significant seasonal variation for height-for-age, weight-for-height and weight-for-age. There was a village difference in weight-for-height and weight-for-age, but not height-for-age. A child's age and *jat* were also associated with variation in weight-for-height, but not other measures. Surprisingly, there were no significant sex differences for any measure. Age and *jat* had a significant impact on reported morbidity levels, with younger children and high caste children reporting a greater frequency of morbidity. Morbidity, village and *jat* all had a significant impact on ACT levels; ill children had greater ACT than well children, Marpha children greater than Thini children, and high caste children greater than Tibeto-Burman and low caste children.

The key findings of this thesis make connections between growth, serum markers of inflammation and morbidity. Firstly, levels of ACT were raised in conjunction with reported morbidity. This confirmed the value of ACT as an objective measure of infection and inflammation, permitting comparison between populations. Secondly, subsequent linear growth was negatively related to both ACT and reported morbidity. Several authors have hypothesised that a heavy infection burden in children may lead to impaired growth, possibly due to the development of mucosal enteropathy.

TABLE OF CONTENTS

CHAPTER ONE - INTRODUCTION	9
THE METHODOLOGICAL AND THEORETICAL APPROACH.....	14
THE SETTING: MUSTANG, NEPAL.....	15
THE PARTICIPANTS: SCHOOL-AGE CHILDREN.....	17
OBJECTIVES OF THE DISSERTATION.....	18
PRESENTATION OF THE DISSERTATION.....	18
CHAPTER TWO : LOCATION AND PARTICIPANTS MUSTANG DISTRICT AND ITS POPULATION	20
2.1. THE KINGDOM OF NEPAL.....	20
2.2. MUSTANG DISTRICT.....	26
2.2.1. <i>Physical geography and climate</i>	26
2.2.2. <i>Historical importance of trade</i>	29
2.2.3. <i>“Making a living” in Mustang: the importance of agriculture, animal husbandry and trade in the 1990’s</i>	30
2.2.4. <i>A brief history and ethnography of the Thakali</i>	33
2.3. TOURISM IN MUSTANG.....	36
2.3.1. <i>The emerging impact of tourism</i>	36
2.3.2. <i>The nature of tourism in Mustang: who are the tourists and what do they do?</i>	38
2.3.3. <i>The Annapurna Conservation Area Project (ACAP)</i>	40
2.4. THE VILLAGES OF MARPHA AND THINI.....	41
2.5. MY EXPERIENCE OF FIELDWORK IN MUSTANG.....	45
2.6. DAILY LIFE IN MUSTANG.....	49
2.6.1. <i>Dress</i>	49
2.6.2. <i>Diet</i>	50
2.6.3. <i>Children’s activities: school, work and play</i>	52
CHAPTER THREE : METHODS	54
3.1. PARTICIPANTS.....	54
3.1.1. <i>Recruitment of participants and sample validity</i>	54
3.1.2. <i>The participating children- age, sex and caste distribution</i>	55
3.2. NOTES ON THE GENERAL APPROACH TO STATISTICAL ANALYSES.....	56
3.3. ANTHROPOMETRY.....	57
3.3.1. <i>Overview</i>	57
3.3.2. <i>Measurement techniques</i>	57
3.3.3. <i>Reliability of measures</i>	58
3.3.4. <i>Statistical treatment of raw height and weight data</i>	58
3.3.5. <i>Note on the determination of children’s age</i>	62
3.4. BLOOD SPOT MEASURES OF INFLAMMATION AND IMMUNE FUNCTION.....	64
3.4.1. <i>Methods available for assessing immune function and response to infection, and their suitability under fieldwork conditions</i>	64
3.4.2. <i>Rationale for the choice of methods</i>	67
3.4.3. <i>Technique of blood spot collection</i>	69
3.4.4. <i>Laboratory analysis of samples</i>	69
3.5. COLLECTING DATA ON MORBIDITY: THE CHOICE OF SELF-REPORTS OVER CLINICAL EXAMINATION.....	71

3.6.	STRUCTURED INTERVIEW ON FAMILY, LIFESTYLE AND EFFECTS OF TOURISM	74
3.7.	STUDY OF TYPICAL CHILDREN'S DIET	76
3.8.	ETHICAL CONCERNS: INFORMED CONSENT, SAFETY MEASURES AND DISSEMINATION OF RESULTS	78
CHAPTER FOUR : VARIATION IN CHILDREN'S GROWTH STATUS		80
4.1.	INTRODUCTION: WHY MEASURE CHILDREN'S GROWTH STATUS?	80
4.2.	RESULTS	82
4.2.1	<i>Statistical considerations</i>	82
4.2.2	<i>Description of children's growth status</i>	83
4.2.3	<i>General linear model testing the impact of seasonality and socio-economic factors on variation in growth status</i>	84
4.2.4	<i>Seasonality</i>	86
4.2.5	<i>Variation with age</i>	88
4.2.6	<i>Village differences</i>	89
4.2.7	<i>Jat differences</i>	91
4.2.8	<i>Variation with sex</i>	93
4.3.	DISCUSSION	94
4.3.1	<i>Growth status of children in this sample, and a comparison with the findings from other studies in Nepal</i>	94
4.3.2	<i>Association of age with variation in growth status</i>	95
4.3.3	<i>Seasonal differences</i>	95
4.3.4	<i>Village differences</i>	97
4.3.5	<i>Jat: ethnicity and socio-economic status</i>	98
4.3.6	<i>Sex differences</i>	100
4.3.7	<i>The effect of altitude on linear growth in children</i>	102
CHAPTER FIVE : MORBIDITY AND PLASMA PROTEIN LEVELS		103
5.1.	RESULTS	103
5.1.1	<i>Descriptive statistics of plasma marker values</i>	103
5.1.2	<i>Point prevalence rates of reported morbidity, with variation by season, village, age and caste</i>	109
5.2.	DISCUSSION	113
5.2.1	<i>Serum protein values</i>	113
5.2.2	<i>Reported morbidity</i>	114
CHAPTER SIX : CONCLUSIONS- THE RELATIONSHIP BETWEEN GROWTH, MORBIDITY AND SERUM MARKERS		117
6.1.	RESULTS	117
6.1.1	<i>Factors associated with variation in ACT</i>	117
6.1.2	<i>Association between growth status and markers of morbidity</i>	122
6.1.3	<i>Factors associated with variation in growth increments</i>	124
6.2.	INTERPRETING THE RESULTS	130
APPENDIX 1. REPEATED ANTHROPOMETRIC MEASUREMENTS ON 10 CHILDREN AGED 5 TO 12 YEARS		139
APPENDIX 2. TYPICAL QUESTIONS USED WHEN OBTAINING CHILD MORBIDITY REPORTS, WITH NEPALI TRANSLATION		140
APPENDIX 3. QUESTIONS USED FOR CHILD STRUCTURED INTERVIEW, WITH NEPALI TRANSLATION		141
APPENDIX 4. TOPICS OF INTEREST IN HOUSEHOLD SOCIO-ECONOMIC SURVEY		144

APPENDIX 5. COMMUNITY FOOD USE SURVEY (WEINER & LOURIE, 1981).....	145
APPENDIX 6. ARM CIRCUMFERENCE AND SKINFOLD DATA.....	146
APPENDIX 7. MARPHA HEATH POST RECORDS.....	147
APPENDIX 8. QUARTILES OF ANTHROPOMETRIC DATA.....	149

TABLE OF FIGURES

FIGURE 2.1 MAP OF NEPAL SHOWING INTERNATIONAL BORDERS, AND LOCATION OF MAJOR CITIES AND MUSTANG DISTRICT.....	21
FIGURE 2.2 MAP OF THE KALI GANDAKI AND SUBSIDIARY VALLEYS, SHOWING THE MAJOR VILLAGES AND MOUNTAINS DISCUSSED IN THIS THESIS, AND THE TREKKING ROUTE TO POKHARA.....	25
TABLE 2.1 AVERAGE DAILY TEMPERATURES AND RAINFALL OF MUSTANG, JUNE 1996 TO MAY 1997.....	27
TABLE 2.2 NUMBERS OF TOURISTS IN JOMSOM, 1996 (ACAP FIGURES).....	28
TABLE 2.3 POPULATION DISTRIBUTION OF MARPHA AND THINI, BY JAT (1997, FIGURES FROM ACAP SURVEY).....	41
TABLE 3.1 NUMBER OF CHILDREN BELONGING TO EACH JAT.....	55
EQUATION 3.1 WHCz, AN INDEX OF WEIGHT FOR HEIGHT IN OLDER CHILDREN.....	59
EQUATION 3.2 R, THE COEFFICIENT OF RELIABILITY.....	59
TABLE 3.2 STANDARD DEVIATION, TECHNICAL ERROR OF MEASUREMENT, AND COEFFICIENT OF RELIABILITY FOR REPEATED ANTHROPOMETRIC MEASUREMENTS ON 10 CHILDREN AGED 5 TO 11 YEARS.....	59
EQUATION 3.3 WHCz, AN INDEX OF WEIGHT FOR HEIGHT IN OLDER CHILDREN.....	59
TABLE 3.3 CLASSIFICATION OF MILD, MODERATE AND SEVERE GROWTH RETARDATION, ACCORDING TO THE METHODS OF GOMEZ (1956), WATERLOW (1972) AND WATERLOW ET AL. (1977).....	61
TABLE 4.1 MEDIAN, MEAN, STANDARD DEVIATION AND RANGE OF Z-SCORES BASED ON NCHS GROWTH CURVE FOR 125 CHILDREN AGED FIVE TO TWELVE YEARS.....	83
TABLE 4.2 PERCENTAGE OF SAMPLE CHILDREN (N=125) WITH MODERATE OR SEVERE GROWTH DEFICIT.....	83
TABLE 4.3 RESULTS OF REPEATED MEASURES GLM MODEL (85 CHILDREN).....	85
FIGURE 4.1 VARIATION IN GROWTH STATUS BY SEASON (N=85).....	87
TABLE 4.4 VARIATION IN GROWTH STATUS BY AGE GROUP, MARCH 1997.....	88
TABLE 4.5 VARIATION IN GROWTH STATUS BETWEEN MARPHA AND THINI CHILDREN, MARCH 1997.....	89
FIGURE 4.2 VARIATION IN GROWTH STATUS BY VILLAGE AND SEASON.....	90
TABLE 4.6 VARIATION IN GROWTH STATUS BY JAT FOR 51 MARPHA CHILDREN, MARCH 1997.....	91
FIGURE 4.3 VARIATION IN GROWTH STATUS BY JAT, MARCH 1997.....	92
TABLE 4.7 VARIATION IN GROWTH STATUS BY SEX, MARCH 1997.....	93
TABLE 4.8 COMPARISON OF THE PERCENTAGE OF STUNTED AND UNDERWEIGHT CHILDREN IN TOURIST AND NON-TOURIST VILLAGES IN MUSTANG IN TWO STUDIES.....	97
TABLE 5.1 N, RANGE, MEDIAN, MEAN AND SD FOR PLASMA MARKERS MEASURED DURING THREE ROUNDS OF SAMPLES ON MARPHA AND THINI CHILDREN.....	104
FIGURE 5.1 HISTOGRAMS OF ACT VALUES FOR MARPHA AND THINI CHILDREN.....	106
FIGURE 5.2 HISTOGRAMS OF ALBUMIN VALUES FOR MARPHA AND THINI CHILDREN.....	107
FIGURE 5.3 HISTOGRAMS OF IGG VALUES FOR MARPHA AND THINI CHILDREN.....	108
TABLE 5.2. NUMBER AND PERCENTAGE OF CHILDREN REPORTING DIFFERENT NUMBERS AND TYPES OF SYMPTOMS (285 REPORTS FROM 125 CHILDREN OVER THREE ROUNDS OF REPORTING).....	109
TABLE 5.3 PERCENTAGE OF REPORTED MORBIDITY BY JAT (285 REPORTS FROM 125 CHILDREN OVER THREE ROUNDS OF REPORTING).....	111
TABLE 5.4. PERCENTAGE FREQUENCY OF REPORTED MORBIDITY OVER THREE ROUNDS OF MORBIDITY (285 REPORTS FROM 125 CHILDREN).....	111
FIGURE 5.4 SEASONAL DIFFERENCE IN REPORTED RATE OF FEVER, DIARRHOEA AND RESPIRATORY INFECTIONS (BASED ON 285 REPORTS FROM 125 CHILDREN AGED 5 TO 12 YEARS FROM BOTH MARPHA AND THINI).....	112
TABLE 5.3 COMPARISON OF ACT AND ALBUMIN VALUES OBTAINED IN STUDIES OF DIFFERENT POPULATIONS.....	113
TABLE 6.1 LINEAR REGRESSION OF MARCH 1997 ACT VALUES ONTO MORBIDITY AND DEMOGRAPHIC VARIABLES (N=94).....	118
TABLE 6.2 SERUM MARKERS FOR CHILDREN REPORTING AS ILL OR WELL, POOLED OVER THREE ROUNDS OF REPORTING.....	119
FIGURE 6.1 MEDIAN ACT LEVELS FOR CHILDREN REPORTING SICK AND WELL.....	120
FIGURE 6.2 MEDIAN ACT, ALBUMIN AND IGG LEVELS IN CHILDREN REPORTING SICK AND WELL (ALL SYMPTOMS) AT THREE SEASONS.....	121
TABLE 6.3 SERUM MARKERS VALUES FOR CHILDREN REPORTING DIFFERENT NUMBERS OF SYMPTOMS.....	122
FIGURE 6.3 ANTHROPOMETRIC MEASUREMENTS BETWEEN CHILDREN REPORTING AS SICK (N=113) AND WELL (N=166).....	123
TABLE 6.4 MONTHLY HEIGHT AND WEIGHT GAIN OVER 2 TO 12 MONTH PERIODS.....	125
TABLE 6.5 FACTORS ASSOCIATED WITH HEIGHT GAIN FROM MARCH TO SEPTEMBER (N= 90 CHILDREN).....	126

TABLE 6.6 FACTORS ASSOCIATED WITH WEIGHT GAIN FROM MARCH TO SEPTEMBER (N= 90 CHILDREN)	126
TABLE 6.7 FACTORS ASSOCIATED WITH HEIGHT GAIN FROM SEPTEMBER 1997 TO MARCH 1998 (N= 87 CHILDREN)	128
TABLE 6.8 FACTORS ASSOCIATED WITH WEIGHT GAIN FROM SEPTEMBER 1997 TO MARCH 1998 (N=87 CHILDREN)	128
FIGURE 6.5 ASSOCIATIONS BETWEEN VARIABLES	129
MEDIAN, MEAN, STANDARD DEVIATION AND RANGE OF ARM CIRCUMFERENCE AND SKINFOLD MEASUREMENTS FOR 125 CHILDREN AGED FIVE TO TWELVE YEARS	146
HEALTH POST RECORDS BY DIAGNOSIS	147
HEALTH POST RECORDS BY MONTH, JULY 1996 TO AUGUST 1997	148

The copyright of this thesis rests with the author. No quotation from it should be published without their prior written consent and information derived from it should be acknowledged.

The research on which this thesis is based was supported financially by:

The Wenner-Gren Foundation for Anthropological Research Pre-Doctoral Award
University of Durham Alumni Postgraduate Award
British Foundation for Women Graduates Charitable Foundation
Parkes Foundation Small Grants Fund
University of Durham Council Fund for Students Travelling Abroad
Mr & Mrs W. Sharpe
Van Mildert College Bursary Fund

I would like to thank the following people for their assistance, support and other contributions:

my supervisor Dr Catherine Panter-Brick
Dr Peter Lunn for his assistance with the analysis of blood and saliva samples
Neeru Lalchun
Bhakti and Puspa Hirachan
Suryaman and Shijan Lalchun
Raj Kumar Bista
Narayan Poudhal
all the staff of Marpha school
Dr Shyam Thapa
Dr Thom McDade for performing EBV antibody assays

Most importantly, I would like to thank the children of Marpha and Thini for their willing and cheerful co-operation with my research. This thesis is dedicated to all of them.

CHAPTER ONE - INTRODUCTION

Infectious diseases and poor nutrition are major causes of morbidity and mortality amongst children in developing countries. The WHO World Health Report (1998) estimates that 10.4 million children under five died in these countries in 1995. Infectious diseases were a contributory cause in the majority of these deaths, with acute respiratory infections such as bronchitis and pneumonia, diarrhoeal diseases, and measles reported as the cause of over five million child deaths. Whilst only 3% of deaths were attributed solely to malnutrition, malnutrition was associated with 44% of the over two million deaths from respiratory infections, 70% of the further two million deaths from diarrhoeal disease, and 65% of over a million deaths from measles. Over the last thirty years, there has been great interest in unravelling the processes by which growth, nutrition and infection are linked (Scrimshaw et al., 1968). More recently, the emphasis has been on understanding more about the effect of nutrition on immune function, and thus on infectious disease (Chandra, 1991). The impact of infections, rather than simply nutrition, on poor growth has also been stressed (Lunn, 2000).

In some developing countries, the extent of malnutrition may be such that the majority of young children show significant growth deficit. Many studies have confirmed that this is the case in Nepal, with findings that between 40 and 80% of children have significant chronic growth failure (Nepal Nutrition Status Survey, 1975; Martorell et al, 1984; Panter-Brick, 1997). The proportion of stunted children varies with age, season and geographical terrain, but is extremely high for all but the most elite urban groups. It is also certain that children in poor communities suffer a very heavy morbidity load. This affects the quality of life of both the child and their family, may incur a great financial burden, and impairs cognitive and emotional well-being and development. Various studies estimate that a young child suffers from on average 5 to 8 episodes each year of both respiratory infection and diarrhoea (WHO, 1984; Rowland et al., 1988; Mata, 1978; Guerrant et al., 1983). The impact of repeated bouts of morbidity on children, and the value of a greater understanding of the relationship between malnutrition and infection, is beyond debate. However, the mechanisms by which morbidity, growth and immune response are associated have not yet been well elucidated.

The incidence of many infectious diseases can be very dramatically reduced by effective vaccination programmes, as in developed countries where diseases such as measles, whooping cough and tetanus, which were once common in young children, are now rare. Many diseases can also be simply and effectively treated with drugs. Antibiotics are effective against most acute respiratory infections, and can reduce the death rate from meningitis, septicaemia and

bacterial complications of measles. Oral rehydration therapy (ORT) dramatically reduces deaths from diarrhoea, and can be administered in the home at very low cost. However, a key factor in reducing childhood deaths associated with infectious disease is better nutrition. The impact of many infections is much reduced in well-nourished children.

Associations between children's growth status and the incidence, severity and duration of infectious disease

Many studies report that children with severe protein-energy malnutrition are both more susceptible to infections, and more seriously affected by infections; these have been comprehensively reviewed elsewhere (Ulijaszek, 1997). Quantitative data evaluating mild-to-moderate malnutrition as a risk factor for infectious morbidity are scarcer, and studies have, to some extent, reported conflicting results. Several community-based longitudinal studies have found increased duration of diarrhoea in malnourished children (Black et al, 1984; Chen et al, 1981), some studies also find evidence of increased incidence rates (Black et al., 1989; Bhandari et al., 1989; Tomkins, 1981; Trowbridge, 1981). James (1972) found that malnutrition was associated with both higher incidence and longer duration of acute lower respiratory infections, but had no effect on mild upper respiratory infections. Suggested explanations for the increased risk of diarrhoea and other infections in malnourished children include reduced gastric acid secretion (Gracey et al, 1977), reduced antibody synthesis and impaired cell-mediated immunity (Mata et al, 1972). There is ample evidence that severely malnourished children have impaired immunity, particularly cellular immunity. More recently, there has been great interest in measuring immune response in otherwise healthy children with mild-to-moderate malnutrition, and evaluating this as a risk factor for disease.

Malnutrition and infections together are the leading causal factors in growth failure. There are several mechanisms by which infections may adversely affect children's nutritional status. Mata et al. (1977) emphasised the importance of reduced food intake in determining the nutritional outcome of a bout of infection. This may be caused both by anorexia during episodes of illness, and caretakers withholding food or liquids from the child for either cultural or compassionate reasons. Some foods may be withheld from sick children, due to beliefs about the causation of disease. As well, food that is eaten may be lost through vomiting or through intestinal malabsorption. Fever during infections increases the child's energy requirements above the normal level, at a time when their nutritional intake may be substantially reduced. Thus, a sick child, suffering from an infection that may cause anorexia, will actually receive less food although the infection may raise energy demands and a spiralling situation of weight loss and increased susceptibility to infection may begin. Similarly, Gittelsohn (1991) suggested an important factor in explaining differences in growth status between siblings living in the same

household is the frequent failure of mothers to coerce reluctant children to eat.

A range of studies worldwide has documented the impact of repeated bouts of infection on children's growth. Diarrhoea, in particular, leads to acute weight loss in the short term, and impaired linear growth over a longer period. Nabarro (1985) used longitudinal data to show that Nepali children suffering from an episode of diarrhoea lost an average of 0.37 kg during the subsequent month, compared with an average gain of 0.11 kg experienced by children who did not have diarrhoea. The difference for children who suffered from measles was even more marked. Black et al. (1984) found that for Bangladeshi children each episode of diarrhoea was associated with a 0.56 cm reduction in linear growth. Guerrant et al (1983) report a 41% reduction in linear growth over a three month period for young Brazilian children who had suffered from diarrhoea compared to those who had no diarrhoea. Their study also demonstrated that, "diarrhoea remained a significant contributory cause of stunting even when age, socio-economic status, and initial nutritional status were taken into account" (Nabarro et al, 1988:177).

Recently, there has been great interest amongst workers in child health in applying new methods for measuring markers of inflammatory response to understanding the relationship between growth and infectious disease. One such marker is α -1-antichymotrypsin (ACT), an acute phase protein, which forms part of the body's response to tissue damage caused by infection or injury.

The acute phase response (APR) is the increase in the concentration of some liver-synthesised proteins in blood and tissue. It is part of a variety of systemic responses to tissue damage and inflammation, including fever. The presence of inflammation is indicated by this response, and measurement of acute phase proteins (APPs) can be used as a measure of the severity or extent of the inflammation. At present, the sequence of biochemical events involved in the acute phase response is not well understood, due to the complexity of the processes of inflammation. However, it is probably mediated by the release of cytokines from activated macrophages. Bacterial endotoxins are also known to be potent stimuli of the APR, resulting in rapid and large increases in APP concentrations.

Acute phase proteins are defined as those plasma proteins which increase in concentration by 25% or more in the seven days following tissue damage. Many of these proteins are integral to the process of inflammation and recovery, and are actively consumed by the body. Thompson et al. (1992) group them into several categories: mediators, modulators, inhibitors, scavengers, immuno-modulators, and substances involved in repair and resolution. There are many APPs, but the most easily measured, and well documented, as indicators of inflammation, are C-reactive protein (CRP) and α -1-antichymotrypsin (ACT). CRP is a mediator, and also acts as a

scavenger, opsonizing DNA and cell membrane debris. ACT is a protease inhibitor, inhibiting enzymes released from leucocytes during phagocytosis that could otherwise potentiate inflammation and induce further tissue damage. It has also been shown to be deposited on the surface of newly formed elastic fibres, aiding tissue repair.

Calvin et al. (1988) report a study on the value of five different APPs in the assessment of patients suffering from inflammatory conditions. The most important characteristics for a successful marker of the APR are the specificity of the test (i.e. that levels of the protein are not affected by factors other than the presence of inflammation), and the period of elevation of the protein following the onset of inflammation. The sensitivity and specificity was calculated for each protein, and ACT was found to be the most sensitive test (95%), with specificity (81%) similar to that of the other acute phase proteins measured. The values of some other APPs are known to be affected by factors such as oestrogens, renal failure and genetic variants.

Levels of ACT and CRP both rise sharply within ten hours of the onset of inflammation; the half-life of ACT is significantly longer than that of CRP, so levels remain elevated for longer. Levels of ACT in healthy individuals vary from around 0.2 to 0.6 g/L, and typically increase two to four fold with intense inflammation (Calvin & Price, 1986). CRP has a very variable reference range (68 to 8000 µg/l, with median of 580 µg/l) and can increase up to 1000 fold, so studies must be well controlled for individual variation. Thus, in a situation where samples are taken infrequently, it is difficult to monitor individual baseline values, or chronic disease is the focus, ACT has strong advantages over other proteins. For monitoring acute disease, with regular samples taken under clinical conditions, CRP is likely to be preferable. Calvin et al. (1988) suggest the combined measurement of both proteins as the most useful screen for inflammation in samples obtained from a wide range of patients.

To date, most studies of APP values have taken place in clinical settings, in western countries, using adult subjects. Relatively little is known about the variation in normal values, and the response to moderate levels of inflammation, for children of different ages from different ethnic groups. A few recent studies have begun to tackle this problem, and comparative data are available of APP values in ill and healthy children in the Gambia (Sullivan et al., 1991; Lunn & Northrop-Clewes, 1991), Bangladesh (Rousham et al., 1998) and Nepal (Panter-Brick et al., 2001).

Rousham et al. (1998) established that raised ACT levels were associated with maternal reports of diarrhoea and fever in Bangladeshi children, validating the use of maternal or self reports of morbidity, and demonstrate the usefulness of biochemical measures as a marker of infection. Filteau et al. (1993) suggested that even sub-clinical levels of infection might significantly raise

levels of some acute-phase proteins. However, Panter-Brick et al. (2001) found that a sample of Nepali village boys simultaneously had extremely high ACT levels and reported low morbidity compared to samples of homeless, squatter and middle class school boys living in Kathmandu. They also showed that ACT levels were inversely associated with height-for-age status across the four samples of Nepali boys. Lunn et al. (1991) found that for young Gambian children, ACT and other serum proteins were significantly associated with individual variation in growth. It seems that examining levels of ACT and other aspects of biochemical status, such as albumin, haemoglobin, immunoglobulins, and intestinal permeability, may prove to be the way forward in understanding more about the physiological relationship between growth and infections.

The methodological and theoretical approach

This is an interdisciplinary study of children's health, drawing techniques from cultural and biological anthropology, and biomedical sciences. It is set within the broad theoretical frameworks of human adaptation and ecology, and the biocultural paradigm of medical anthropology, which are detailed below. I hope that this approach will lead to a greater understanding of both the physiological processes and the social behaviour that mediate the effects of poor environments on health outcomes at an individual level.

Human adaptation, or human ecology, is concerned with the interaction between humans and their environment; it has been written about extensively (Harrison, 1982; Harrison et al., 1988; Waterlow, 1988; Ulijaszek & Strickland, 1993). Over the last two decades, the adaptive approach has become the dominant paradigm within biological anthropology. Human ecologists focus on the ways in which populations adapt culturally, as well as evolve physically, to survive in harsh environments, and the costs as well as the benefits of changes in behaviour. Behavioural adaptations that have a short-term benefit, perhaps in promoting survival, may well have a longer term cost to health and well-being of the individual. The 'small but healthy' debate surrounding the significance of poor growth in childhood is an excellent illustration of how both the costs and the benefits of biological and social responses to environmental constraints may be considered within the adaptive paradigm (Gopalam, 1983; Waterlow, 1985; Scrimshaw & Young, 1989). In this thesis, I describe the social and economic strategies adopted by the population of Mustang that enable them to survive within their particular environmental niche, and also consider biological phenomena from an ecological perspective.

The biocultural approach to human health involves, as the name suggests, the consideration of both biological and cultural variables and perspectives (Johnston & Low, 1984; McElroy, 1990). This approach is essential for many of the topics studied by biological anthropologists where health and well-being are affected both by human cultural behaviour and mammalian physiology. It emphasises the importance of understanding the processes of poor health, not simply the outcomes- death, morbidity or poor growth (Panter-Brick, 1998). Mosley and Chen's seminal paper on child survival (1984) proposed that we should look beyond the simplistic view of infectious diseases as the cause of most child deaths, and consider also the role of poor nutrition, and in particular the complex synergism between infection and nutrition. They suggested an analytical framework where socio-economic factors impact on the 'proximate determinants' of child survival: the mother's behaviour, environmental contamination, nutrient deficiency and injury, which in turn affect the likelihood of a child becoming sick. The model also shows how the cultural behaviour associated with preventing or treating illness can mediate

the biological mechanisms leading to growth faltering or death. A similar approach was employed by Shell-Duncan (1997) to model the morbidity rate amongst nomadic Turkana children, and McDade & Worthman (1998) to describe child weaning.

The background data for this study were collected using well-established qualitative anthropological techniques, such as participant observation and interviews. I aimed to obtain ethnographic data of the two communities, and contextual data on the daily lives of individual children. I describe the social and cultural primarily where it is of relevance to children's health and well-being, and some areas of social life are covered only briefly or not at all. Other anthropologists have written more extensively on the Thakali, in particular their economic success historically and within the present day (von Furer-Haimendorf, 1966; Parker, 1988, 1991; Parker & Patterson, 1993). To provide simple indicators of children's health, I performed anthropometric measurements to assess growth status, and collected morbidity data. Growth monitoring has been used for several decades to provide a relatively simple and cheap, yet effective method of appraising a child's health and well-being, reflecting the outcome of nutrition, infections, and activity level on growth potential. In comparison to clinical and biochemical techniques, anthropometric measurements are quickly performed, can be evaluated under field conditions, and are non-invasive. Also, vast amounts of comparable data exist from studies of different populations. There are methodological problems associated with the collection of morbidity data by self reports, particularly with regard to comparison between different populations, but the method is still of great value (Kroeger, 1983; Ross & Vaughan, 1986). To this sound base of known methods, I added more innovative techniques, recently developed for use in the field, which enable the measurement of markers of immune function and inflammation in blood spots.

The setting: Mustang, Nepal

The villages of Marpha and Thini lie in the upper Kali Gandaki valley, in the remote district of Mustang in Western Nepal. The valley has long been a major trans-Himalayan trade route; more recently, it has developed into a major trekking location for western tourists. Historically, Thakalis, an ethnic group of Tibeto-Burman origin, populated the area; they now comprise only about half the population, but remain the dominant *jat*¹. Thakalis have a monopoly on local

¹ I have used the Nepali word *jat*, which is usually translated into English as caste. However, "the use of the word *jat* is ambiguous in this multi-ethnic society and is used variously by different groups" (Parker, 1988). For highland Nepali populations of Tibeto-Burman origin, often Buddhists, *jat* is analogous to ethnic group, as defined by language, culture and descent. For Hindu groups of Indo-Aryan origin, including the rulers of Nepal and the majority of Kathmandu inhabitants, *jat* is caste, encompassing status and inherited occupation, in the Indian sense. In Mustang, the presence of groups of people who simultaneously display marked ethnic and status differences has led me to prefer the use of *jat* as descriptive of both these concepts.

politics, administering a complex system of social rules, with fines for transgressions; they run all the tourist-oriented businesses in the area, and maintain a visible and distinctive culture. There are also a number of Gurung and Magar, two other Tibeto-Burman groups. In recent years, many Indo-Aryan families have migrated into the area, particularly to villages on the main tourist trail. Economically, the increase in tourism is assumed to benefit local populations, but the effects of tourism on the physical and psychological well-being of the region's population may be more mixed, and have yet to be comprehensively studied. Previous research in the Annapurna area has indicated that there may be both 'good' and 'bad' effects on children's health. Children in villages on the main tourist route were found to have improved growth status compared to those living in villages not visited by tourists (Bennett & Panter-Brick, 1996; Bennett, 1996). However, the children in the tourist villages also had significantly higher blood pressure than the children living in villages off the trail; this could not be explained solely by their greater height and weight (Pollard et al., 1997; 2000).

Biological anthropologists have always been interested in the health and well-being of isolated communities, living in a harsh physical environment. This definition has gradually been extended to include groups, which are socially, as well as physically, isolated, and to encompass the difficulties of modernisation and the associated rapid changes in lifestyle. It was these factors, which initially drew me to fieldwork in Mustang: the apparent isolation and harsh physical environment, and the differences that were rapidly developing in lifestyle, wealth, and perhaps health, between the villages on and off the main tourist trail. Once I began work in Marpha and Thini, I developed an interest in the great social and economic inequality between the different *jati* living in Mustang.

Marpha and Thini are certainly physically isolated by Western standards, being accessible only by air, or by walking for approximately five days from the nearest road. However, the constant traffic of traders and goods along the valley means that the people of Mustang have always maintained social and intellectual connections to the surrounding communities in Tibet, Nepal and India. More recently, the growing numbers of international tourists, combined with television and other media, have given the population glimpses of life in Europe and North America. The physical environment of Mustang is undeniably harsh: the altitude, arid climate and a scarcity of cultivable land make subsistence farming extremely difficult. The Thakali have adapted very successfully to this environment, many of them have grown rich through monopolising the trade up and down the valley, running inns for traders, and more recently businesses aimed at tourists. For the Indo-Aryan low caste migrants to Mustang, life is indeed very harsh; these people lack land and capital, and do not profit from the influx of tourists.

The participants: school-age children

Children under 5 years, and pregnant and lactating women, are considered by health workers to be particularly at risk in harsh environments, and likely to be most vulnerable to malnutrition. This is due to their relatively high demands for energy and micro-nutrients, and in some societies, the low priority of women and children in intra-household food distribution (Prentice & Prentice, 1988; Dettwyler, 1992). Morbidity and mortality rates, and anthropometric data, for mothers and young children under five years, are often used as sensitive indicators of community health, well-being and development. The maternal-child dyad has also been a topic of interest for anthropologists, particularly with regard to breast-feeding and the process of weaning. However, the period of childhood is generally considered to continue well into the teenage years. Panter-Brick (1998: 66) draws attention to the fact that “in academic circles, relatively little attention, however, has been paid to the health and behaviour of 5- to 15-year-olds, except by workers linked to non-governmental organisations...”

The period from five to fifteen years is still a time of rapid growth and development when children are becoming increasingly independent of their parents, but may yet be severely affected by a poor environment. The value of studying later childhood is only now being acknowledged, as children of this age are increasingly recognised as valuable members of society, with the right to reach their full potential as adults. Improvements in public health care mean that almost 90% of the world’s children now survive beyond their fifth birthday (WHO, 1998). Increasing numbers of children in developing countries are now enrolled in primary school. Although child mortality rates have dropped dramatically in many countries in recent decades, levels of morbidity and malnutrition have not declined so rapidly, so these surviving children may not be well enough to benefit from educational opportunities. Bundy & Guyatt (1996:1) write that,

“many children still face health problems that compromise their physical development, their attendance at school and their ability to learn. The children have survived, but if their quality of life is compromised by ill health, they may be unable to take full advantage of what, in most developing countries, is the only educational opportunity they will ever be offered.”

Bundy and Guyatt suggest that programmes aimed at school-age children, and even implemented through schools, are the way forward, and that many of the most prevalent health problems in this age group can actually be alleviated simply and effectively, yet at low cost. They claim that the very success of earlier child-survival programmes has created a new challenge for the 1990’s and beyond, “to improve the quality of life of the survivors and to help children to realise their full potential through a reduction in their burden of disease.” (1996:1). It is well known that chronic ill health and malnutrition at school age leads to growth retardation and stunting which persists into adult life. There are also long term consequences for mental

well-being, which in turn can contribute to lifelong socio-economic disadvantages. It is clear that improving the health of school age children is a vital step in promoting both physical and intellectual development, breaking the cycle of poverty, deprivation and ill health, which may otherwise persist through the generations.

I chose to study children aged between five and twelve years, as I felt this had both a social and biological rationale, coinciding roughly with the period of primary schooling in Nepal and most other countries, and preceding the onset of puberty for most children.

Objectives of the dissertation

This dissertation is concerned with the health and well being of a group of children aged five to twelve years of age, living in two villages in Mustang, Nepal. The foci of interest are: the relationship between growth status and infectious diseases, and the associations between different lifestyles and discrepancies in health between groups living in the area. The specific aims of the dissertation are as follows.

- 1) To present an account of children's lives in Mustang, focusing on the impact of seasonality, and the variation between households by ethnic groups, and socio-economic status.
- 2) To present data describing:
 - a) children's growth status,
 - b) morbidity experienced by children, obtained from their own reports,
 and
 - c) levels of α -1-antichymotrypsin and other serum markers in blood samples.
- 3a) To analyse the variation in these biological measures according to demographic and seasonal factors;
- b) To relate these findings to the information on children's lives.
- 4) To investigate the possible relationships between measures of growth, morbidity and serum proteins, and discuss possible mechanisms to explain the complex nature of the relationship between growth status and infectious diseases.

Presentation of the dissertation

Chapter 2 summarises the physical environment, historical events, and present way of life in Mustang district, and discusses the impact of the burgeoning tourist industry. The villages of

Marpha and Thini are introduced, and I give an account of my experiences conducting fieldwork in Mustang. The variation in lifestyle for children belonging to different sectors of the population in Mustang is described.

Chapter 3 details the sample of children, study design, and the various quantitative and qualitative methodologies employed. Both the theoretical background, and the practical effectiveness of the chosen techniques in this field setting, are discussed.

Chapter 4 presents the anthropometric data; chapter 5 contains the morbidity and serum protein data. An interpretation of the findings is offered at the end of each of these chapters, and a comparison is made with the results of previous studies in Nepal and other developing countries. Chapter 6 examines the association between growth status, growth increments, inflammation and morbidity, and gives a final evaluation of the methods and findings.

CHAPTER TWO : LOCATION AND PARTICIPANTS

MUSTANG DISTRICT AND ITS POPULATION

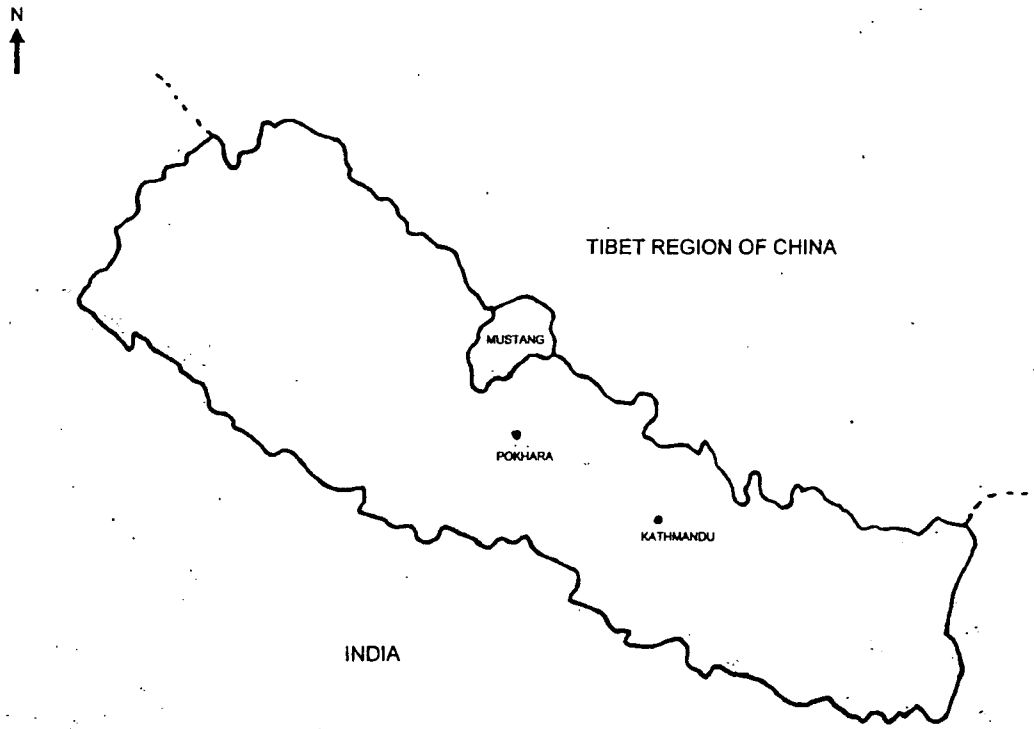
2.1. The kingdom of Nepal

Nepal is a small, landlocked kingdom, bordered by India to the south, east and west, and Chinese-occupied Tibet to the north (figure 2.1). Nepal was never colonised, so it avoided the overt European influence exerted on other parts of the Indian subcontinent, although the British army has long had a presence and impact through the Gurkha regiments. However, the country is now dominated economically, and strongly influenced politically and culturally, by its two powerful neighbours. Nepal is about 800 kilometres long from east to west, and only 200 kilometres from south to north, with three major geographical divisions: the Terai, the Middle Hills, and the Himalaya.

According to government figures, the population of Nepal increased from 15 million at the time of the 1981 census to 18.5 million in the 1991 census, an annual growth rate of 2.1%. A 1999 estimate put the population at 24.3 million, with a 3% annual growth rate (US Bureau of Census). Nepal is an extremely poor country, with an estimated gross domestic product of only US\$156 in 1994. More than 90% of the population are basically subsistence farmers, and operate largely outside the cash economy.

The south of the country is a narrow strip of land, lying almost at sea level, known as the Terai. Geographically, this region is an extension of the Gangetic plains of India, and it contains most of the country's cultivable land. Until the 1950's, the Terai was mostly malarial jungle, inhabited by only a few tribal groups. Successful eradication programmes have dramatically reduced the incidence of the disease, and the region is now home to 47% of Nepal's population.

Figure 2.1 Map of Nepal showing international borders, and location of major cities and Mustang district



The Middle Hills range up to about 2500 metres in height, and cover a band of the country some 60 kilometres wide; the hills are home to 45% of Nepal's population. The capital city, Kathmandu, lies in a large central valley at 1350 metres. Pokhara, the second largest city, lies about 200 kilometres northwest, in another large valley, at the lower altitude of 700 metres. These two valleys are the only substantial areas of flat land in the hills region, where most food is grown on steeply terraced slopes.

Along the northern border of Nepal, the country rises to the Himalayan mountains. The altitude makes this region inhospitable, and only 8 % of the population live here. Mustang district lies in the Himalaya in the Western region of Nepal, bordering Tibet.

A few motor roads run through the Terai and the hills, linking major towns and cities, but the majority of Nepali villages are accessible only on foot, along narrow trails. During the annual summer monsoon, transport is even more difficult as roads and trails may become impassable as a result of floods and landslides. In the mountains, there are no motor roads, and transport is on foot, by animal or by air.

Nepal has enormous cultural, ethnic and linguistic diversity. Over the last two centuries, the Rana rulers, and the present royal family have tried to unite the country, and impose the culture of the Kathmandu valley on the whole population. Almost all the population now speaks Nepali, an Indo-European language closely related to Hindi, and written in Devanagiri script, although only 58% have it as their first language. Nepali is the official language for business and education, although English is increasingly being used. Nepal is officially a Hindu country, but there are also a large number of Buddhists, and small numbers of Muslims and Christians. Hinduism, Buddhism and elements of early tantric and animistic religions have intermingled to a great extent.

Until the nineteenth century, Nepal was ruled by a succession of dynasties: the Kiratis, Licchavis, Thakuris, Mallas and Shahs. In 1846, Jung Bahadur Rana engineered a massacre of nobles and courtiers and seized power, giving himself the hereditary title of prime minister and Maharajah. Over the next century, the Rana family lived as a second royal family in Nepal, keeping the power within the family, and maintaining the Shah kings as mere figurehead monarchs. During this period, there was little development in Nepal and almost no contact with the outside world. Very few foreigners were permitted to enter the kingdom.

In 1951, under increasing pressure from the newly formed Nepali Congress Party (NCP) and the government of India, King Tribhuvan set up a new government, comprising both Ranas and members of the NCP. The first general election was held in 1959, under his son, King

Mahendra, and the Nepali Congress won a clear victory. However, in 1960, the King took control, banning political parties and arresting the cabinet. A partyless system of government was set up in 1962, with locally elected panchayats (councils) choosing representatives to district panchayats, which were in turn represented in the National Panchayat. The King still retained power, appointing the prime minister and cabinet, and a proportion of the National Panchayat members. In 1972, Mahendra died and was succeeded by his son Birendra who still rules.

During the 1970's, there was increasing disillusionment and discontent with the Panchayat system, culminating in violent riots in 1979. A referendum in 1980 showed 55% of the votes in favour of retaining the Panchayat system, as opposed to a fully democratic system with political parties. In 1981, elections were held, although political parties were still banned. This apparently democratic system was in reality heavily controlled by the military and police; there was strict censorship, and suspected political activists risked arrest and torture. The King retained the right to appoint 20% of the country's legislature, who were in turn responsible for electing the prime minister.

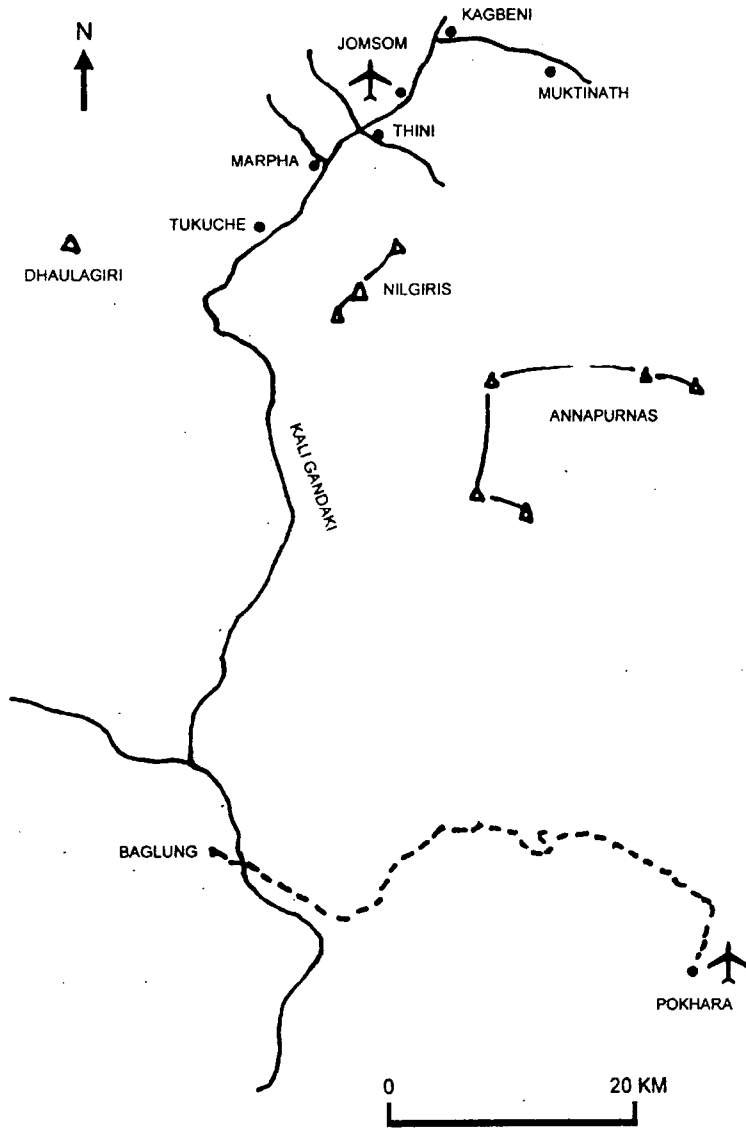
The *Jana Andolan* ("People's Movement") of 1990 forced the Panchayat system to be abandoned, and a new constitution was adopted. This made Nepal a constitutional monarchy with universal adult franchise and a multi-party parliamentary democracy. Elections are held every five years, but the system is presently very unstable. Since the May 1996 elections, the various political parties have formed and reformed coalitions, and the government has changed with astonishing rapidity. There were so many changes of power both during the months I spent in Nepal during 1997 and 1998, and the time I was out of the country, that attempting to follow national politics became increasingly farcical. At the time of writing in 2000, there are continuing outbreaks of violent unrest and terrorism in Kathmandu, and towns throughout the country; these are reported as being caused by communist activists. Democracy has, however, reduced government bureaucracy, achieved freedom of speech and of the press, and led to improved human rights.

The caste system is a central feature of life in Nepal, governing social relations, determining occupation and opportunity. There are several models used by anthropologists to describe the complex and flexible Nepali caste system, which encompasses all ethnic and social groupings. Bista (1991) states that there are five levels: Brahmin, Chettri, Matawan, which includes the majority of Tibeto-Burman groups such as Tamang, Gurung and Thakali, the occupational castes such as Kami and Damai, and untouchable groups who are without caste. The caste system that was originally part of Hindu cosmology, and was also central to the lives of the Newari people of the Kathmandu valley, has now been widely embraced by Tibeto-Burman groups. Some, such as the Thakalis, are keen to improve their caste ranking, and try to adopt Hindu practises as

a way to succeed, because, as Parker (1988) writes, “[they] must operate socially and politically in a nation dominated by the caste system (see section 2.2.4).

When writing about matters of caste in Mustang, I have tended to use the Nepali word *jat*, which is usually translated into English as caste. However, “the use of the word *jat* is ambiguous in this multi-ethnic society and is used variously by different groups” (Parker, 1988). For highland Nepali populations of Tibeto-Burman origin, often Buddhists, *jat* is analogous to ethnic group, as defined by language, culture and descent. For Hindu groups of Indo-Aryan origin, including the rulers of Nepal and the majority of Kathmandu inhabitants, *jat* is caste, encompassing status and inherited occupation, in the Indian sense. In Mustang, the presence of groups of people who simultaneously display marked ethnic and status differences has led me to prefer the use of *jat* as descriptive of both these concepts.

Figure 2.2 Map of the Kali Gandaki and subsidiary valleys, showing the major villages and mountains discussed in this thesis, and the trekking route to Pokhara



2.2. Mustang district

2.2.1. *Physical geography and climate*

Figure 2.2 is a map of the Kali Gandaki valley showing the location of major villages and mountains in Mustang region, and the trekking route to Pokhara. Mustang district lies along the Nepalese border with Chinese-occupied Tibet, and is geographically part of the Tibetan plateau. Since the Chinese invasion of Tibet, this border has been politically very sensitive, and upper Mustang (a remote and undeveloped area) is currently designated as a restricted zone. A small number of foreigners are granted 10-day entry permits to Upper Mustang each year, at a cost of US \$700, subject to the discretion of the Department of Immigration. Marpha and Thini lie in lower Mustang, which is open to tourists and other visitors with a trekking permit, available at a relatively low cost of US\$5 per week. This area is relatively prosperous, and has recently undergone some development, but retains a strong tradition of Tibetan Lamaic Buddhism.

Mustang is mountainous, ranging from about 2500 metres in altitude on the floor of the Kali Gandaki valley up to the Himalayan peaks of Dhaulagiri and Annapurna at over 8000 metres. The northern regions, including Marpha and Thini, are arid, and pressure differences above the land to north and south cause a fierce wind to blow up the valley each day. There are few villages, as little flat land or arable soil exists to support humans.

There are no motor roads in Mustang; transport within the district is overwhelmingly on foot, although some wealthier households own horses that can be ridden. A few young men in Marpha and Jomsom have pedal cycles that can be ridden along the main north-south trail, but other routes are too steep and rough. Even on the trail, cycling is so difficult and uncomfortable as to be restricted to a novel leisure activity, and symbol of status, rather than a practical mode of transport. The government airline, RNAC, and two private operators operate daily flights between Jomsom and Pokhara. Many tourists fly to or from Jomsom, but the air services are also used by the more affluent members of the local population, rather than walking to Pokhara. The motorable road from Pokhara currently ends at Baglung, from where it takes about four days walk up to Jomsom (three days back down) or longer if carrying a heavy load. For several decades, plans to extend the road up to Mustang have been discussed, and are vigorously opposed by environmental campaigners. In fact, the road is unlikely to be built in the foreseeable future due to the prohibitive cost of road building in the mountains. Because of relatively high costs, air freight tends to be limited to valuable imported goods for sale to tourists, or the few items that are considered too unwieldy or delicate to be carried by a porter. Most food and other goods for local consumption are brought up from Pokhara by porters or

pack animals.

Mean daily maximum and minimum temperatures, and total rainfall for each month from June 1996 to May 1997 are given in table 2.1 (ACAP figures). Seasonal temperature patterns are similar to the UK, with a greater magnitude of variation. December to February is bitterly cold winter; there is a warm and sunny summer from May to September. The Himalayan rain shadow means that the climate is generally dry; total annual rainfall in 1996/7 was 291 mm (in comparison, Kathmandu receives about five times as much rain each year, with an average of 380 mm of rain during July alone). There is no true monsoon as occurs elsewhere in Nepal at lower altitudes, but rainfall tends to be greatest during February to April and July to September.

Table 2.1 Average daily temperatures and rainfall of Mustang, June 1996 to May 1997

month	mean max. temp., °C	mean min. temp., °C	rainfall, mm
June	23.9	11.9	9
July	24.1	14.0	44
August	22.1	14.0	50
September	20.7	11.8	32
October	17.4	5.5	0
November	12.9	0.7	0
December	10.5	-0.9	0
January	6.6	-3.4	0
February	9.3	-0.2	74
March	13.2	2.3	63
April	15.1	3.9	11
May	19.8	9.9	8

Life in Mustang over winter is harsh, as supplies of locally grown crops may run out, and firewood is difficult to obtain. As all goods imported from lower altitudes have to be carried for several days, or flown in, prices of staple foods rise. During the snow of December 1997, there were no flights to Jomsom for almost a month, and little porter or pack animal traffic. Many families choose to leave their homes over winter, moving south to stay with relatives, often in Pokhara. They return to Mustang only when the weather improves and they can afford to do so. In some years, this may not be until late March, or even April, as poorer families are unable to afford inflated prices for essential food and fuel.

The number of tourists visiting Mustang shows sharp seasonal variation (see table 2.2); families who are wholly or partly dependent on tourists for their income must budget for this accordingly. Minor annual variation in weather patterns can also have major, and less predictable, effects on tourist numbers. During March 1998, numbers of visitors were

disappointingly low, after a very quiet winter. This was blamed on cancelled flights earlier in the year, and rumours abounding amongst potential trekkers of severe weather and snow closing the 5500 metres Thorung La pass (in fact, the weather in Mustang was not bad, and Thorung La passable from late February onwards).

Table 2.2 Numbers of tourists in Jomsom, 1996 (ACAP figures)

month	number	percentage
January	556	3.1
February	1140	6.4
March	2210	12.4
April	1911	10.7
May	672	3.8
June	247	1.4
July	593	3.3
August	629	3.5
September	2165	12.2
October	4379	24.6
November	2586	14.5
December	728	4.1
total	17816	100

2.2.2. Historical importance of trade

The Kali Gandaki valley has been a major trans-Himalayan trading route for centuries. Historically, Thakalis, an ethnic group of Tibeto-Burman origin, who are known throughout Nepal as traders and innkeepers, populated the area. Until 1959, Thakali traders exchanged salt collected from salt lakes in Tibet for rice and barley from the middle hills of Nepal. They also traded wool, livestock and butter, from Tibet, for sugar, tea and spices, from India, but the salt for grain trade dominated the economy. This trade has diminished, due to the political and economic changes brought about by the Chinese invasion of Tibet. Also, the demand for Tibetan salt has disappeared because Indian sea salt, containing iodine, is now available throughout Nepal at a much lower price than Tibetan salt, subsidised by foreign aid organisations. The use of iodised salt prevents goitre, which was previously common in many parts of Nepal (including Mustang) where the soil, and thus people's food supply, lacks iodine.

The Thakali had a total monopoly on the salt trade of the region; the people of Marpha had the privilege of exacting customs duty on all goods. Marpha was originally located an hour's walk to the north-west, and about a thousand feet higher, but three generations ago, the village shifted down to the valley, bringing the people closer to the prosperous trade route. Abandoned homes can still be seen; some are maintained and used as over night accommodation when people tend the gardens and orchards that are located on this site.

The closing of the Tibetan border in 1959 brought severe consequences for the people and land of the Kali Gandaki. As many Tibetan refugees fled across the border, bringing with them large herds of sheep, goats and yaks, high altitude pastures suffered catastrophic over grazing. As a consequence, many animals starved, and the grazing land was eroded into steep bare slopes, which have never recovered. Most of the refugees moved on to other parts of Nepal, but a Tibetan refugee camp was established on land near Marpha, and is now a permanent and thriving village. Its inhabitants make a living from agriculture, and the sale of locally produced handicrafts, including carpets and jewellery, to tourists.

After the trade with Tibet declined, many people emigrated from Mustang and the neighbouring district of Manang. The remaining families relied on agriculture and new forms of trade for a livelihood; during the 1980's, tourism became a major source of income for a minority of households. There was a decrease in the need for pack animals, and for horses, but some Thakali began to trade 'cash crop' animals, particularly yak, as an additional source of income.

2.2.3. "Making a living"² in Mustang: the importance of agriculture, animal husbandry and trade in the 1990's

The type of agriculture in Mustang is largely determined by the severe winters, and low rainfall. As precipitation decreases from south to north, irrigation becomes more necessary. In Marpha and Thini, about 70 % of fields are irrigated; farther south the proportion declines. In upper Mustang, successful agriculture is impossible without systematic irrigation, which few farmers can achieve. The scarcity and high price of cultivable land mean that agriculture, particularly of cereal crops requiring large land area, tends to be restricted to subsistence level rather than profit.

There are two types of field: irrigated fields (N: *khet*), and high forest fields (N: *ban*). The irrigated fields lie in the valley, close to the villages at around 2700 metres above sea level, and are harvested twice a year. The main winter crop is naked barley, which is planted at the end of November and harvested at the end of June. The main summer crop is sweet buckwheat, which is planted at the beginning of July and harvested at the end of October. Barley and buckwheat are the traditional carbohydrate staple foods in the area; barley is also used as animal fodder. Rice and maize will not grow at this altitude, and are brought in from Pokhara by pack animals. The non-irrigated forest fields lie 300 to 1000 metres above the villages, and are harvested once a year. The major crops grown in these fields are bitter buckwheat, potatoes and mustard. Most Thakali households grow enough cereals and potatoes to provide food for about six months of the year, but considerable amounts of food must also be bought in. Immigrant families, particularly the low caste Kami and Damai, have no land of their own to grow food. They obtain some food from Thakali households in exchange for labour; the remainder must be bought as imported goods from lower altitudes (see section 2.6.2 for detail of diet).

Many kinds of vegetables are grown, including cabbage, spinach, carrot, tomato, radish, onion and garlic, with new varieties constantly being introduced. Some households also produce vegetable seeds as a cash crop, under a programme started by the NTHRC (Nepal Temperate Horticultural Research Centre), in conjunction with the FAO (Food and Agricultural Organisation). Vegetables are produced mainly for the household's consumption, but any surplus may be sold or exchanged within the village. A few households intentionally produce excess, selling their vegetables to households without land, and to the hotels and lodges that cater for tourists.

² The title, and some of the information in this section, is from Michael Vinding's 1984 paper, 'Making a living in the Nepal Himalayas: the case of the Thakalis of Mustang district', which describes the various economic strategies of Thakali households. I will comment briefly on some of the factors which are important for understanding subsequent results, and also describe how non-Thakali households survive and make a living.

Vinding (1984) estimates that more than half the households in lower Mustang (the majority of Thakali households) had adopted the strategy of fruit cultivation, to various degrees. The trees were introduced in the late 1970's, with government and foreign aid, and were intended to improve the local diet, and yield a small surplus to be sold for profit. Measured in horticultural terms, this programme has been extremely successful; the trees thrive in the Mustang climate, and produce high yields. Economically, the results are more mixed, and there are problems with the storage and distribution of large quantities of perishable fruit. Apples are the most important fruit crop, then apricot, peach and plum. Three quarters of the orchards have less than 50 trees; only 9% contain more than 100 (but these orchards contain more than half of all trees). Fruit cultivation accounts for a substantial income for the owners of large orchards, and a small but useful extra income for small owners. Only small quantities are consumed locally, and mostly at harvest time, when there is glut of ripe and quickly spoiling fruit. Much of the fruit produced is processed into dried fruit, cider, brandy and jam, which is sold to tourists locally, and transported for sale in Pokhara and Kathmandu. Sale of fresh fruit is problematic as transportation costs to Pokhara reduce potential profits, but tourists and pilgrims are a steady, if relatively small, local market.

Animal husbandry does not have the same significance among Thakalis as for groups farther north where agriculture becomes still more difficult, and the pastoral nomadic lifestyle is more common. Still, the keeping of some species is economically important, both for agriculture and trade. Cattle and *dzo* (N: yak/cattle hybrid) are kept as a part of the subsistence economy, whilst goats, sheep, yaks and mules are 'cash crop' animals, primarily kept for producing and selling goods and services in the market. Only about 20% of households keep these 'cash crop' animals; the rest must buy meat and other animal products in the market. Meat consumption is relatively low, especially amongst the poor who can eat meat only on special occasions.

Tibetan dwarf cattle (N: *lulu*) are kept for milk, dung and reproductive purposes. Fresh milk is drunk very rarely; mostly powdered milk is used, and that only in tea. The Tibetan cow is a natural rubbish collector, eating anything, and surviving on a small diet, but yielding relatively little milk. Bulls are kept for reproduction and transportation. Cattle are kept in the village in winter and graze the high pastures in summer. Dung is highly prized, both as fertiliser and fuel, since deforestation means that there are strict rules governing the cutting of trees for firewood.

Dzo are kept primarily for traction power and transport. They pull ploughs, transport wood and other produce from the forest fields to the villages, and in winter occasionally transport goods to Tatopani and bring back rice. *Dzo* are much used in Mustang and are well adapted to the ecological conditions. Thakalis neither slaughter nor eat cattle and *dzo*, but sell their old animals

to Tibetans who kill and eat them.

Yaks usually live far above villages, above the tree line, at four to five thousand metres; they cannot survive for long at the lower altitude of the Kali Gandaki valley. They graze high altitude pastures where farming is difficult and only grass and herbs grow. The herders descend only every two to three months, and bring yak produce with them in the form of dried meat, hides, milk, butter and cheese. Yak milk is processed into butter for Tibetan tea, and demand exceeds supply in Thak Khola; traders from Dolpa exchange butter for locally grown barley. Yak slaughtered for meat are usually old. Some Thakali proclaim that they do not eat yak meat, but most people consider it a delicacy, and demand again exceeds supply.

The Tibetan border closure and subsequent decline in trade meant that there was less need for yak as pack animals. However, Von Furer-Haimendorf (1976) notes that yak numbers actually increased in Marpha, with animals being traded for additional income. Thak Khola suffers from a shortage of arable land, so it is impossible to increase agriculture for profit. High pasture ground is more plentiful, and the income from yak sales warrants the expense of renting high altitude pastures. Areas to the South do not have enough summer pasture, so many Thakali rent out pasture land as an additional source of income.

From sheep and goats, meat, skins and wool are obtained. The animals are grazed both around the villages and at higher altitude.

Donkeys, horses and especially mules are important in Mustang. Horses are primarily ridden and are status symbols, owned by only the wealthiest households, costing up to Rs 40,000. Mules and donkeys are used as pack animals during harvest and for transportation of goods to the north and south. Mules are cheaper than porters in Mustang, unlike the rest of Nepal. The number of horses in Marpha decreased after 1959, whilst mules increased. The switch from horses to mules was made because mules are more suitable pack animals and can also be rented out for construction purposes as an additional source of income. *Dzo* also decreased, as trade switched to southern low altitude routes; however, for going north in winter, *dzo* are used in preference to mules, as they are better adapted to conditions.

2.2.4. A brief history and ethnography of the Thakali

Lower Mustang is divided into two geographical areas: Panch Gaon (five towns) and Thak Satsae (the seven hundred houses). Thak Satsae is a collection of 13 settlements south of Marpha in the area of the Kali Gandaki valley known as Thak- thus Thakali. The Thakalis from this southern region consider themselves to be the true Thakalis, since Tukuche, for years the dominant town in the area, lies within their borders. The inhabitants of Thak Satsae refer to themselves as Tamang, and were probably using this name long before it came to designate the modern ethnic group of Tamangs who inhabit the middle hills farther east. The name Thakali is also used by, and for, the people of Panch Gaon. The inhabitants of Marpha form one group, and are known as Marphali. The villages of Thini, Syang and Chimang form another group, the Yhulkasummi Thakali. Each of these three groups is endogamous, and there are local variations in language and culture, but they share a great deal of common features. Each group has a number of exogamous patrilineal clans, each with its own animal deity and colour. The Marphali have four exogamous patrilineal clans, with the headship of the village rotating around the four clans in turn.

In the 1991 census, over 13,000 Thakali were recorded; the majority of these are Tamang Thakali, with around 1500 Marphali and a thousand Yhulkasummi. The Tamang Thakali have migrated to other areas of Nepal for several generations for business activities. More recently, over the last generation, many Marpha Thakali have also migrated, particularly to Pokhara and Kathmandu. Even now, few of the Yhulkasummi Thakali have migrated outside Mustang.

The Thakali have an extremely strong sense of identity as a cohesive ethnic group, and their behaviour is notably egalitarian within this group; although there are wide disparities in wealth, all Thakali are, theoretically at least, equal in status. Parker (1988) writes that:

“the Marphalis include themselves within the general ethnic designation, Thakali, but regard their own village endogamous group as a jat unto itself. Experience has taught them that it is the endogamous jat that receives (or does not receive) lucrative political favors, trade monopolies, economic domination of other groups, etc.”

Several anthropologists have studied the Thakali, particularly the Tamang Thakali, over three decades. Their political system is well documented, as are their economic strategies, and the continuing rise of many Thakali in business and entrepreneurial roles throughout Nepal. The Thakali have frequently been described as 'innovators' (Bista, 1971) and 'entrepreneurs' (Parker, 1988). Little has been written about the lives of the non-Thakali inhabitants of Mustang. In the last twenty to thirty years, large numbers of low caste Indo-Aryans, mostly *Kami* (blacksmiths) and *Damai* (tailors) have migrated to Mustang. These migrants are attracted by the area's relative prosperity, due to tourism in recent years, but historically because of trade links with Tibet. Many of the *Kami* and *Damai* families now living in Marpha are second-generation migrants, settled in Mustang, who consider it to be their home. More recently, there has been some migration of Tibeto-Burman families from Upper Mustang, a very poor and undeveloped area to the North. They are known as *Gurung*, but are not associated with the ethnic group of Gurung who inhabit the middle hills. There is never any intermarriage between these groups, and, as Parker (1988) writes, "caste-based concepts of hierarchy intrude into relations between local endogamous groups... and harden the boundaries of social co-operation and exclusion".

Parker & Patterson (1993) writing on the sexual division of labour amongst Marpha Thakali, comment "although the society maintains the conventional division of labour in broad outline, few tasks are actually forbidden to members of either sex". Mothers are usually the primary caretakers for small children, but childcare is shared among a large number of male and female kin, ranging from elder siblings, from the age of six or seven, to grandparents. Men will undertake many domestic chores, and tend to be particularly keen on cooking, whilst hotel businesses tend to be run chiefly by women. Thus, women are often kept busy cooking for, and attending to the needs of, tourists, and it is the man who will cook the family's meals. This involvement of women in commercial activities, which are prestigious amongst Thakali, seems to be important both in the high status enjoyed by Thakali women, and in the prosperity of most Thakali families. Equality of sexes is a general feature of Tibetan Buddhist societies, particularly accentuated in the Thakali because of women's successful involvement in commercial activities. Hindu migrants to Marpha tend to have much more marked sexual division of labour and low status of women.

Historically, Thakali leaders have several times attempted to modify the group's lifestyle and behaviour to improve their standing within the Nepali population; this is described in von Fürer-Haimendorf (1966) and Manzardo (1982). The Thakali originally followed a tribal animistic cult of ancestor worship. Many people in *Panch Gaon* continue to use the services of traditional shaman priests called *aya* or *dhom*, although this tends to be hidden from outsiders. From the seventeenth century, there is evidence that the Thakali had adopted Lamaic Buddhism, possibly

to promote trading links with Tibet (von Furer-Haimendorf, 1966). At the beginning of the twentieth century, Thakali leaders stage-managed a transition towards the trappings of a Hindu way of life, claiming descent from the Thakuris, a Hindu group of high caste. Neither strategy was overwhelmingly successful in changing outsiders' beliefs about the Thakali, but did cause some changes in lifestyle. An example is the abandoning of eating the meat of buffalo, cows, and *dzo*, in line with Hindu dietary restrictions. An English speaking Marpha Thakali informed me that the Thakali are now "mostly Buddhist, but a little Hindu". The Thakali occupy a high caste niche locally, with respect to the Kami and Damai population of the area. In the 1990's, influential Thakali were promoting education and travel as a way of improving outsiders' views, no doubt due to increasing contact with western tourists.

2.3. Tourism in Mustang

2.3.1. *The emerging impact of tourism*

Mustang lies in the Annapurna Conservation Area, which was first opened up to foreign trekkers in 1957. By the 1990s, Annapurna was the most popular of Nepal's trekking locations, and tourist numbers had increased dramatically, with over 47,000 visitors in 1995 (ACAP information leaflet, 1996). The rapid growth of tourism in Mustang region has enabled many Thakali families to extend their traditional business of running inns for Nepali travellers, to cater for foreign tourists with hotels, restaurants and shops. This supplements their earnings from agriculture and trade. There has also been considerable migration of Kami and Damai into the main tourist villages. Migrants are attracted by the prosperity of the Thakali villagers, and hope that they too can make what they perceive as easy money from rich tourists. This has not really been the case, as the Thakali control all commercial enterprise in the area, and prevent other groups from running businesses, thus maintaining their own local trade monopoly. Whilst Thakali men and women can be seen running hotels and shops throughout Mustang, and some men act as very highly paid guides to mountaineering expeditions, low caste men can only obtain occasional work as porters. However, there is some 'trickle-down' effect of wealth, as the Thakalis who are most involved in tourist businesses have employed low caste adults and children to work for them. They are engaged in menial tasks in hotels, and perform the agricultural and domestic tasks which are normally performed by the family members, who now lack either the time or inclination (see section 2.6.3. for children's work).

Government policy has been to direct tourists along a narrow trail of villages, and restrict access to other areas. This has led to villages on trekking routes undergoing radical change under an influx of Western tourists expecting food, shelter and entertainment, whilst villages just a few miles away may scarcely ever be visited by tourists, and the populations continue to live as subsistence farmers. The distinction between tourist and non-tourist villages is particularly marked in the Kali Gandaki valley because of local topography, and the trade route that historically lay along the valley. However, there is also what I call the "Lonely Planet effect", where travellers on a low budget all follow the advice of a particular guidebook, and all sleep and eat in the same few places. Marpha is one village to benefit from this approach, with most trekkers choosing to spend a night there, and only very few halting in the villages of Syang and Tukuche, immediately to the north and south.

Economically, the increase in tourism is assumed to benefit local populations, but the effects of tourism on the physical and psychological well-being of the region's population may be more

mixed, and have yet to be comprehensively studied. Previous research in the Annapurna area has indicated that there may be both good and bad effects on children's health.

Bennett and Panter-Brick (1996) showed that a sample of children from tourist villages in this region had greater height-for-age and weight-for-age than children from non-tourist villages. They concluded that this is probably due to improved economic circumstances in villages on the main tourist and trade route. Moderate increases in height and weight should be considered beneficial, as rural Nepali children tend to be severely stunted, although not usually wasted. The tourist village children, although taller and heavier than non-tourist village children, still had low height-for-age and weight-for-age, in comparison to the National Center for Health Statistics reference population.

Pollard et al. (2000) found that the children from on-trail villages had significantly higher blood pressure, which could not be explained solely by increased height and weight. The increase in blood pressure was particularly marked for girls living in tourist villages. Pollard et al. note that variables such as psychosocial stress, increased salt intake, earlier maturation and low birth weights causing early environmental programming of carbohydrate metabolism have all been proposed as possible factors associated with increased blood pressure in fast modernising populations. Smith (1997) has shown that hypertension is becoming a health problem in another Nepali population undergoing rapid lifestyle change, the Sherpa of Solu Khumbu region.

2.3.2. *The nature of tourism in Mustang: who are the tourists and what do they do?*

There are four main 'types' of tourists visiting Mustang, with different impact on the local economy.

- 1) Wealthy Asian tourists, often Nepali or Indian (many Japanese and Korean parties also visited during early 1997 and previous years, but by 1998, the economic crisis in southeast Asia was having a noticeable effect on tourist numbers from that region). These groups fly in, stay for one or two nights in the principal Jomsom hotel, maybe take a short horse ride or a very short walk, then fly out again. They pay high prices, but most of their money goes to the airline, the outside agent who arranged the trip, and one hotel owner.

- 2) Organised 'trekking groups', usually consisting of between four and ten Western tourists, accompanied by a very large entourage of Nepali guides, porters and cooks, carrying huge amounts of food, equipment and fuel. This enables both tourists and staff to be self-sufficient regarding meals, and often shelter, as many groups sleep in tents, by-passing the local hotels completely. Very little of the high prices (anything up to US\$200 per day) paid by these tourists goes into the local economy.

- 3) Independent 'backpackers', usually young and on a low budget, and mainly from Western Europe, North America and Australasia. They travel alone, or in small groups of friends, staying in the local hotels and lodges, and buying food along the way. This group spends considerably less money per day than the first two groups (I estimate between US\$5 and US\$10), but a much greater proportion of the money enters the local economy; they also tend to stay longer in Mustang. However, even this money is concentrated into only a few of the many local businesses (see 2.3.1 on the "Lonely Planet effect").

- 4) Indian and Nepali pilgrims to Muktinath. They are mostly Hindus who walk, often with inadequate food and clothing for winter and high altitude, with little money or food. The most noticeable of these are the *sadhu*, religious ascetics who walk barefoot and semi-naked, smeared with ash and carrying only a trident and begging bowl. Villagers frequently give food, shelter or money to pilgrims, and both Hindus and Buddhists consider this a meritorious act.

The main routes taken by either individual trekkers or organised groups are either the 'Annapurna circuit' or the 'Jomsom trek'. The Annapurna circuit is a long and quite challenging route, taking approximately three weeks to complete. It circles right around the Annapurna massif and crosses Thorung La, a 5500 metre pass which is often completely blocked with snow

in winter and spring. The route is usually walked anti-clockwise, making the crossing of the pass considerably easier; this means that walkers on the circuit descend through Mustang. The trek up or down the Kali Gandaki valley is much easier than the circuit, with no particularly high altitude sections, and is popular because it requires less equipment and exertion, and can be completed within a week. Trekkers usually walk between Jomsom and Baglung, where the road ends west of Pokhara. Trekkers may walk to Jomsom and fly back to Pokhara, fly to Jomsom and walk back, or more rarely walk both ways. The route is commonly extended as far as Muktinath (see figure 2.2), a further day's walk past Jomsom, but very rarely any further as upper Mustang is accessible only to those who have paid a hefty fee (US\$700) for a special permit.

2.3.3. The Annapurna Conservation Area Project (ACAP)

The Annapurna Conservation Area covers 2600 square kilometres from Pokhara north to the Tibetan border, including Mustang region and the famous 8000 metre peaks of Annapurna and Dhaulagiri. The conservation area is run by ACAP, a non-governmental organisation funded by the King Mahendra Trust for Nature Conservation. ACAP's primary objectives are to improve local standards of living, to protect the environment and to develop more sensitive forms of tourism. Unfortunately, my observations suggested that in Mustang anyway, they were considerably more successful with the first of these objectives than the other two. ACAP has channelled a great deal of funding into the area, and wealthy Thakali have been particularly adept at gaining their share of the money, but some of the key projects were noticeably failing.

The influx of visitors to this area has compounded the problem of scarce natural resources and a fragile mountain eco-system. Tourist demands for hot showers, warm rooms and a varied menu available throughout the day have increased demands for fuel, and accelerated the rate of deforestation. To combat this, ACAP have funded many well intentioned projects, ranging from community tree plantations, the introduction of more efficient back-burner stove designs, use of kerosene by trekking groups and attempts to modify tourist behaviour and demands. While these initiatives have been successfully implemented in some villages (notably Ghandruk, close to Pokhara, which is held up as a model example of a sustainable community development project for tourism), I was disappointed to see blatant ignoring of many of ACAP's guidelines throughout Mustang, both by hotel owners and trekkers. Deforestation is fast becoming a major problem in Mustang, and local people are only now realising the consequences as erosion follows the destruction of the forest.

More successfully, ACAP has built community latrines and rubbish tips, which appear to have largely eliminated the problems of litter and sanitation that were mentioned in many guidebooks to the region five to ten years ago. There is also a price-fixing scheme where all lodges in a particular village must charge the same price for accommodation and food. This also results in each lodge offering an almost identical menu, with few local dishes. This prevents rampant inflation of prices by the owners of currently popular lodges, but also prevents the owners of less popular businesses attempting to win favour by undercutting prices.

2.4. The villages of Marpha and Thini

Marpha (altitude, 2665 metres) lies 7 kilometres south of Jomsom on the main trail from Pokhara to Muktinath, a holy site and place of pilgrimage for both Hindus and Buddhists. Porters and pilgrims use the route throughout the year, and at the peak of the trekking season, during the months of October-November, and March-April, as many as 200 tourists pass through each day. The village has fourteen hotels and lodges where tourists eat and sleep. The official population figure stated is about 1400 people, in over 300 households, but this includes many family members who live and work elsewhere in Nepal, or overseas. My best estimate, based on a house to house survey I carried out in conjunction with ACAP during the summer of 1997, and discussion with village informants, suggests 900 as being a closer figure for the number of residents (see table 2.4 for *jat* breakdown). Many of the absentees are Thakali, as all Marpha Thakali are recorded in official censuses, despite the fact that many of them have long since moved away and rarely return to the village. The *jat* distribution of my sample is probably much closer to the genuine mix within Marpha (see 3.1.1).

The population is very much reduced over winter, as many families move south to avoid the coldest period, often staying with family in or around Pokhara. The winter of 1997/8 had been particularly severe, and consequently some families had not yet returned to Mustang in March 1998.

Table 2.3 Population distribution of Marpha and Thini, by *jat* (1997, figures from ACAP survey)

<i>jat</i>	Marpha		Thini	
	number	percentage	number	percentage
Thakali	71	42.5	67	80.7
Gurung and Magar	21	12.6	9	10.8
Damai	31	18.6	4	4.8
Kami	32	19.1	2	2.4
Brahmin and Chettri	12	7.2	1	1.2
total	167	100.0	83	100.0

Thini (altitude, 2800m) is about 3 km from Jomsom, but is not on the main trail, and is rarely visited by tourists. There are no hotels or lodges, and only villagers and local porters use the one teashop. Thini has a population of around 500, in 83 households. Most of these people are Yhulkasummi Thakali, with several Gurung migrants from upper Mustang, and a few Kami and

Damai from lower areas (see table 2.4 for *jat* breakdown). Almost all the population are farmers, growing barley and buckwheat in irrigated terraced fields. A few men have 'government' jobs in Jomsom, or are away from home in the Nepali army. The Kami work as blacksmiths, and also do some waged labour for wealthier Thakalis.

In Nepal, *jat* is a key variable affecting the aggregation of individuals and households into groups for common action. These groups can have considerable impact, politically and economically, in advancing the interests of their members. In Marpha, this is apparent with the "mother's groups", which were set up to improve standards of child health and education, and to promote women's interests in community development. There are separate groups for Thakali, Kami and Damai women, and each group has their own funds, collected through members' subscriptions and outside sources. The Thakali group is more organised and active, and much richer. The women frequently put on displays of singing and dancing and collect money from tourists, and money for village development projects also appears to go into funds administered by Thakali groups. The channelling of aid towards a particular ethnic group was also observed by Thomas-Slyter and Bhatt (1994), in their study of Lalitpur district, and found to be an important factor affecting household economic growth.

Several leading individuals in Marpha have been extremely successful in attracting foreign aid money for village projects. A major donor is the Canada Fund for local initiatives, administered by the Canadian consul to Kathmandu. Money has been used to build, stock and run a village library, and literacy classes for adult women have been run for the last two years. In April 1998, building was about to begin on an electrically powered agro-processing mill, to enable women to grind cereals, replacing the existing water powered mill, which is some distance from the village, and works erratically. A German project has built and maintains a solar drying facility, which is mainly used to prepare dried fruits for sale. All these projects could in theory benefit the entire village population, but in practise seem to be informally oriented towards Thakali needs.

The village school in Marpha goes from class one up to class ten, the end of secondary schooling in Nepal. In Thini, the school has only seven classes, and pupils wishing to complete their secondary education must transfer to the high school in Jomsom, about three kilometres away. The first five classes are free, after that parents pay for tuition and books. Marpha is wealthy enough for children from poorer families to receive prizes and scholarships covering school expenses, but there is still the loss of income or labour if a child would otherwise be working. Education is less prioritised by low caste families, even where money is available, and is not seen as desirable by many. In Thini, parents had to pay themselves for their children to continue in school, and this is probably one reason for the lower participation in secondary schooling

compared to Marpha. Also, Marphali village law³ requires that children are sent to school, and there are heavy fines, as well as social pressure, for families who do not educate their children, at least until they reach the age of fifteen or sixteen. In fact, almost all Thakali children finish school, and take the school-leaving certificate, regardless of academic inclinations or ability. All the Marpha Thakalis I spoke to considered educating their children to be of paramount importance, and several children are sent to expensive private “boarding” schools in Jomsom, Pokhara or Kathmandu.

Marpha has a health post, which was reputed to be staffed by seven workers, including a government trained health worker and his assistant. There is no health post in Thini, but people can go to the hospital in Jomsom. A consultation costs Rs 2, and medicines provided by the government are dispensed free of charge (including a range of antibiotics, analgesics, anti-allergics, vaccines, ORT and IV fluids). Unfortunately, whenever I visited the health post, I found many of these medicines were out of date, or had not been stored properly, and in the case of the potentially life-saving yet simple IV fluids, the staff did not know how to apply them. Child health clinics are held each month, where babies can be weighed and their growth checked against a reference curve on charts distributed by the Nepali government.

Health Posts aim to vaccinate all children against tuberculosis, diphtheria, pertussis, tetanus, measles and polio during their first year. Health workers visit each ward in the village on different days each month, to try and locate all children, and ensure they receive the full set of immunisations. Women of childbearing age may also receive tetanus vaccine, to prevent cases of neonatal tetanus. The World Health Organisation reported that in 1997, 96% of Nepali children had received the BCG vaccination, 78% DPT and polio vaccine, and 85% had been vaccinated against measles, before their first birthday (WHO, 1999). I was unable to calculate coverage in Marpha and Thini as records of vaccination were extremely patchy, some kept by parents, some by health workers. Parents were often confused about what vaccination their children had received, with several assuring me that their children (under 10 years) had received smallpox vaccine, which seems extremely unlikely. Most children certainly received some vaccinations, but it seems doubtful whether the majority were given a full set.

³ Marphali customary law (Thakali: *pem shel*) regulates many features of daily life in Marpha. Parker (1991) writes that “many village laws are concerned with enhancing the physical appearance of the village in order to improve the public prestige of the *jat*”. The application of these laws to the low caste inhabitants of Marpha seems to be patchy; they are expected to obey some rules, such as those proscribing the painting and maintenance of houses, or else pay a fine. The rule about education seemed to apply only to Thakali children, but as with so many matters concerning the issue of *jat*, it was difficult to find a definitive answer to this question.

There is a hospital in Jomsom, which is usually staffed by health workers, with Nepali and foreign doctors visiting from time to time to hold clinics or perform simple surgery (an eye surgery unit visited in 1998, performing cataract operations and other simple procedures). During the period of fieldwork, a doctor was supposed to be working at the hospital full time, but he was rarely seen in Jomsom. This is a problem with professionals assigned to work in Mustang - it is designated as a 'remote posting', and is unpopular with the majority of the city born, university-educated elite who fill most professions in Nepal. Doctors, teachers and other officials usually have to be compulsorily recruited for a two-year stint in Mustang, despite the payment of a 'hardship allowance' of between 50 and 100% on top of regular salary. As no doctor is present much of the time, medical emergencies need to be evacuated to Pokhara by air. This can be very expensive, as airfares for the patient and another family member are needed, as well as the costs of any treatment, and lodgings whilst away from home. If the family cannot afford this, money from communal village funds will be used if the sick person is Thakali, but this charity does not extend to members of other *jati*. Amongst the truly wealthy families in Marpha, many routinely travel to Pokhara or Kathmandu to consult doctors, and women to give birth in hospitals. Most women who lack the means to travel outside Mustang prefer to give birth in their homes, attended by other village women. In practise, the hospital in Jomsom seemed to be functioning largely as a hospice for the dying on several occasions when I visited.

A system of traditional medicine is practised by *jaggris*, or shamans, who carry out healing rituals and also administer herbal remedies. More westernised and educated individuals are keen to deny any involvement with traditional medicine, but it is still used by most families, either in preference to, or as well as, western medicine.

There are well-constructed drainage systems running through the streets of both villages, a clean water supply, and community toilets. Most homes have electric lights, with power provided by a locally managed hydroelectric system. Houses are built in the traditional style, of wood and stone, with flat mud roofs and a central courtyard surrounded by a veranda. All the family will usually sleep together in an inner room, but a few of the more modernised Thakali now have separate 'bedrooms' for children. Several of the wealthier Marpha families have installed taps within their homes, and a few have built their own toilets.

2.5. My experience of fieldwork in Mustang

I made three field trips to Nepal over a period of fifteen months, returning to live in Marpha each time. My first trip took place during March and April 1997, when I established contacts in Kathmandu and Mustang, chose field sites, recruited children to participate in my research, and carried out preliminary measurements. I returned from June to September 1997, and in March and April of 1998. On each visit to Nepal, I spent a short time in Kathmandu, establishing contacts with the Centre for Nepal and Asian Studies at Tribhuvan University, and obtaining official documents for travel and research.

I had studied the Nepali language before leaving Durham, and knew some basic grammar and a limited vocabulary, which enabled me to communicate. During fieldwork, I of course learnt much more of the language, both formally through lessons with the English teacher at Marpha school, and informally. Nepali is the national language of Nepal, spoken by almost everyone in the country. For many older inhabitants of Mustang, the first language spoken is Thakali, but all speak Nepali also. I did not attempt to learn Thakali, as few of the children and young people use the language, and it is spoken by only Thakali people, not other ethnic groups.

Most of my research was conducted alone, in very informal settings; measurements and sample collection were frequently performed in the street, or in the children's homes. I learnt enough Nepali to be generally able to communicate with the children and their parents, but for more complicated interviews, I was assisted by one of four individuals who interpreted for me. In Thini, the headmaster of the school, Narayan Poudhil, interpreted for me. He was a Brahmin from a village near Pokhara who had worked in Mustang for the last two years, but returned to his home frequently. His English was good, but his local knowledge and understanding were sometimes even more restricted than my own.

In Marpha, three individuals interpreted and assisted me at different times: Raj Kumar Bista, Bhakti Hirachan and Neeru Lalchun. Raj Kumar Bista is a young Marpha man whose family moved from Upper Mustang. He worked for the Annapurna Conservation Area Project (ACAP) in Jomsom, and we co-operated on carrying out a house-to-house demographic and economic survey in Marpha. The questions were based on a standard ACAP survey with a few additional questions I inserted, and the results were used both by ACAP and myself. Bhakti Hirachan is a very well respected and prominent member of the local community. He carries out social and development work, takes an active role in village politics and generally is involved in most happenings in Marpha. He has spent many years establishing highly effective contacts with foreign visitors and development agencies, to obtain funding for projects in Marpha. In the past,

these include the establishment of the village library, literacy lessons for women, the building of a 'community hall' and a youth group. In 1998, he was negotiating with a Canadian funding agency on the final plans for a hydro-powered mill. Neeru Lalchun is the daughter of a wealthy Marpha family who own a large and prospering hotel. She ran the hotel with the help of her younger sister, and a girl who lived with the family and worked in exchange for food, accommodation and a small wage. At the time of my first trip to Mustang, her father was the mayor, a position held in rotation by the married Thakali men of the village.

I was always aware of the status of my assistants in each community, and how this could potentially affect both the willingness of people to talk, and the truth of the answers people gave. I tried to work alone when possible, as I felt there was often a great deal of uneasiness from low caste children and their parents when Thakalis accompanied me. In Thini, there was also a natural reluctance for children to talk openly in front of the headmaster.

Manzardo (1982) writes:

"To the Thakalis, the anthropologist represents a member of the educational elite and thus is considered to be very important. The Thakalis, in trying to create a favorable impression with the anthropologist, will often try to second-guess him. Because of their good education and their own sensitivity to others, the Thakalis are able to quite rapidly figure out the anthropologist's interests and seeing where his questions are leading bias their answers in such a way as to help the anthropologist prove his point."

I came across this comment after completing my fieldwork, and was interested, because in part it reflected my experience very closely, and in part provided a contrast. I was aware, in listening to the answers of many Thakali, that they were trying to 'impress' me to some extent, for the good of the group image. This was manifested, sometimes as lies, but more often as subtle exaggerations or twisting of the actual situation. Thus, they certainly tried to create a 'favorable impression' for me. However, the corollary of this tended to be that in promoting the 'goodness' of Thakali behaviour, they emphasised the 'badness' of other groups, particularly the Kami and Damai. This was not, in Manzardo's terms, the 'point' I was trying to 'prove' - I was genuinely interested in differences in behaviour and lifestyle between *jati*, but obviously not to judge as better or worse. I was frequently surprised by the degree of caste prejudice shown by some well-educated Thakali who seemed liberal and open minded on a range of other subjects. In time, I developed a hidden agenda to see if certain individuals would put forward more egalitarian views on other castes, if I made my own position abundantly clear. I never found that my stated beliefs made any difference on this particular issue, and so I concluded that some (mainly, but not exclusively, older individuals) were inherently prejudiced against other castes, and it was not merely a question of image manipulation to me, the anthropologist, and the outsider.

Whilst conducting research, I lived with the family of one of the Marpha school-teachers, who ran a small lodge. I was well known to all the children in Marpha, and to most of their parents. I spent a lot of time observing and talking to children in the street, and around the village, and in this way I gradually got to know whole families, and was invited into their homes. I felt that this process of gradual introduction through the children was very important in enabling me to get to know, and to be accepted by, some of the low-caste families. My hosts were a wealthy and influential Thakali family, who introduced me to most other Thakali in Marpha, but not to low-caste households.

To examine the effects of tourism on village life, I needed to find another community to study, living off the main trail. My main criteria for choosing were: a similar population size and ethnic mix, located within three hours walking distance of Marpha with similar altitude and climate. There were several possible villages within that distance, but most off-trail villages were considerably smaller than Marpha, and any sample of children would have been very small. Thini was chosen as the largest village at a similar altitude; although the official population figure was considerably smaller than that of Marpha, the number of children enrolled in, and attending, the village school was remarkably similar. This was probably due to the fact that large numbers of Thakali who are officially described as living in Marpha for census purposes in fact live most of the time in Pokhara, Kathmandu or even overseas. It proved to be impossible to find an off-trail village as ethnically mixed as Marpha. The population of Thini was around 90% Thakali, with a few low caste Indo-Aryan families. This was typical of off-trail villages, as it seems only villages lying on the main trail are wealthy enough to support a large immigrant population of tradesmen and waged labourers.

I was not so well known to people in Thini, and worked almost entirely through the school, with the help of the headmaster. He was a pleasant and helpful man, and spoke good English, but as a Brahmin from Pokhara he was always outside of the true life of the community to some extent. I spent many days working in Thini, and on a few occasions stayed overnight in the home of one of the female teachers. By the end of my time in Mustang, I knew all the school children, but knew few of their families well.

The children's initial attitude was to treat me as just another tourist- after all, I looked much like many of the young western backpackers- and many of the younger children in both villages begged for sweets and pens when they first saw me walking around. Begging from tourists is discouraged by most adults (particularly Thakali), but as children spend a lot of their time working or playing unsupervised in the street, it is very common behaviour. Later, they seemed to regard me as a combination of teacher and doctor, as these were roles they could identify with, and my behaviour probably fitted to some extent with their perceptions of these jobs. I

found that I spent quite a lot of time repeatedly explaining to the children and their parents, as clearly as I could, my actual role and intentions; in particular, denying that I was in any way medically trained. In fact, after I had been in Marpha for a few weeks, I did teach a few English lessons in the school, although I preferred informal 'conversation' classes in other settings. I also assisted the Village Development Committee (VDC) in writing letters to individuals and organisations for aid money to fund local development projects. On a couple of occasions, I even found myself employed as speechwriter when important visitors (usually wealthy potential donors) came to the village.

The role of (social) anthropologist was well understood by many of the older men in Marpha, presumably because of previous studies of Thakali life. The major Thakali festival occurs during March, and I was twice present at this time, and also witnessed several other minor festivals. On each occasion, great care was taken to make sure I knew what would be happening and when. If I was missing from some event considered to be important or noteworthy, a child was often sent to fetch me (and my camera and tape recorder). In this way, I found I witnessed a great deal of ceremony which was not directly related to my work, but did enable me to understand more of what it means to be a Marpha Thakali, as well as enjoying some great celebrations. Inevitably, I was much more identified (by adults and children of all castes) with the Thakali population of Marpha, who regarded me as an honorary Thakali, although of that indeterminate gender typical of fieldworkers.

2.6. Daily life in Mustang

2.6.1. Dress

The clothing, and other aspects of personal appearance, of the people of Mustang, tends to be a fusion of traditional Tibetan culture, immigrant lowland Indo-Nepali, and increasingly the influences of western media and tourists.

Children wear western style clothes, bought on trips to Pokhara and Kathmandu or from travelling merchants. A uniform, of white shirt or blouse, and navy trousers, skirt or gymslip, is supposed to be worn for school, but some poorer children did not possess these clothes, and they were still allowed into school. Older children often rebelled and would not wear uniform, preferring to wear clothes of their own choice. Again, the teachers did not seem to be unduly concerned by this, and the uniform rule was certainly not strictly enforced. Girls adopt more traditional dress at puberty, but young men continue to wear western clothing. The only exception to this is young Thakali men who wear their traditional costume on formal village occasions and during festivities.

Older men of all *jat* generally wear traditional Nepali style dress: a *topi* (cap), trousers with a baggy low seat, then tight from the knee down, and a shirt, waistcoat and suit style jacket, or blazer. Younger men tend to wear assorted western garments; jeans, baseball caps and slogan emblazoned T-shirts are particularly sought after. A lot of high quality and expensive cast-off mountaineering gear finds its way to Marpha, often as gifts for helping climbing expeditions. The better connected men had excellent thermal and waterproof clothing, and were certainly better equipped for outdoor work in a Himalayan winter than I was.

Older Thakali women wear their traditional dress, which consists of a long divided skirt, several long cloths wrapped around the waist and hips, black velvet apron and blouse (*chulo*), and shawl. Young Thakali women have adopted the Punjabi style *salwar kameez*, a knee length tunic worn over baggy trousers, as every day wear, although a few more westernised young women in tourist villages (with liberal parents) sometimes wear jeans and T-shirts. However, like the men, they keep a set of traditional Thakali clothes for formal or ritual occasions. Women of other ethnic groups usually wear either the *lungi* (skirt made of a single wrapped and tied length of cloth) or *sari*, with a blouse. In cold weather, any outfit is liable to be topped by a variety of shawls, or western style cardigans and coats.

Married women of all *jat* wear jewellery, usually gold earrings and bangles, as a symbol of

wealth and status. Thakali women wear Tibetan style necklaces and rings made of large, roughly shaped pieces of turquoise and coral. Watches, particularly elaborate digital models, are extremely popular; many adults of both sexes, and some children from wealthier families wear them.

Both adults and children almost always wear some type of footwear; this is partly a response to health education about hookworm, also because of the harsh climate and terrain. Expensive boots and training shoes are particularly popular with young men. In summer, or all year round for the poorest families, footwear tends to be rubber thong sandals.

2.6.2 Diet

The most common meal consumed throughout Nepal is *dhal bhat tarkari* (literally, lentils, rice and vegetables). This consists of a large helping of rice, with *dhal*, vegetables, a pickle, and occasionally a little meat. Traditionally, the Thakali eat barley and buckwheat flour as staples, as they are grown in the area. The flour can be made either into *roti* (N: flat bread), or *dhero* (N: a kind of dough like porridge of boiled flour). Recently, many Thakali have started to eat rice as a staple, but this must be imported from lower altitudes. Children and young people tend to prefer rice, whilst older people, particularly men, like to eat *dhero*, at least for their main evening meal. *Dhero* is very heavy and filling, and it is difficult to eat a large quantity, so I suspect calorific value will be higher for a typical rice intake, although *dhero* will be superior in terms of fibre and micro-nutrients, as it is less refined. Flour is ground in a local water powered mill, and sieved to remove larger pieces of husk. Barley flour is sometimes roasted to produce *tsampa*, which is eaten traditionally with Tibetan butter tea, or now sometimes with milk and sugar in a kind of porridge, which is more popular with children. Hindu households always eat rice; a meal is considered inadequate without it. Rice is eaten plain boiled, with only a little salt added; leftover rice may be fried and eaten as a snack between meals, or for breakfast the following morning. During festivals, Thakali make special deep fried breads, from wheat and rice flour, as well as barley and buckwheat. *Roti* are also sometimes made from refined wheat flour, bought from travelling merchants, or on trips to Pokhara.

Dhal is made from a variety of pulses, some varieties of bean are grown locally, and others are brought in. Pulses are boiled, then fried with spices, and water added to make a kind of soup. The consistency varies, depending on the wealth of the family, from being like a thick soup, to very watery. Nutritionally, the combination of rice and *dhal*; or *dhero* and *dhal* is good, forming a complete protein.

Locally grown vegetables (*tarkari*), most often spinach, cabbage, carrots and potatoes are boiled, and then fried with spices into a kind of curry, and a small amount of this served with rice and *dhal*. Meat, when eaten, is served in the same way.

Traditionally, Nepalis eat two large meals, around ten in the morning, and then around eight in the evening, so work in the fields during the day is not interrupted. Tea, and some kind of cereal snack are usually consumed shortly after getting up, around six. Barley, rice or corn grains are all eaten roasted or beaten in this way. Snacks are eaten between meals, and now a lot of people eat 'lunch', particularly families with children, who feel hungry a long time before the evening meal is ready. However, not all families eat in the middle of the day, particularly poorer families, where both parents may be working all day at some distance to the home. Small children who are too heavy to carry to the fields may be left alone, or in the charge of an elder child, with only cold leftover food available. This is not appetising and is difficult for small children to eat, so if they are not coaxed and assisted, they may not eat all day. This has been noted as a significant nutritional problem of young children in rural Nepal.

Nepalis drink a lot of tea, most often made with large quantities of milk and sugar. Sometimes black tea is drunk, either through personal preference, or if the family cannot afford milk. Dried powdered milk is always used. Local cows seem to yield very little, but more importantly, people just do not drink fresh milk. Older people in particular sometimes drink Tibetan tea (*nun chiya*) made with yak butter and salt. This is consumed with *tsampa*, or *chura*, roasted or beaten rice, as breakfast.

Alcohol is consumed by most Thakali men (not infrequently to excess), but is very rarely drunk by women. Brahmin and Chettri do not drink, but Kami and Damai men and women both drink alcohol if they can afford to. Locally produced rice beer, *chang*, or rice wine, *raksi*, is common. Apple and apricot brandy is distilled in Marpha, but is mostly sold to tourists. Another spirit, *uwa*, rather like whisky is distilled from barley grain for local consumption. Commercially produced drinks such as bottled imported beers and Nepali made spirits are available, but are only occasionally drunk by the wealthy as a status symbol because of their extremely high cost.

The question of meat eating is a good example of the gap that may exist between what people say they do consistent with their religious or other cultural beliefs, and how they actually behave. According to strict Buddhist doctrine, animals should not be killed for any purpose; thus, the majority of Buddhist groups are vegetarian. I was told on several occasions that as Buddhists, the Thakali did not eat meat, but I never met a Thakali who refused meat if it was available, although some would claim otherwise when questioned! The Thakali will not themselves slaughter animals for meat, but pay others - usually Damai men - to do so for them. Brahmins

and some Chhettris also do not eat meat in theory, but often do in practise. Kami and Damai observe no dietary restrictions on meat, but can seldom afford to buy any. The only active taboo I encountered is on killing and eating cow or *dzo*, and these species are sold to Tibetans (who it seems will kill and eat anything, despite being Buddhists) when too old. This extends from the Hindu proscription on harming cows, and von Furer-Haimendorf (1966) claims that the eating of yak meat was similarly prohibited earlier in the twentieth century during the Thakali's bid for high caste status. The most commonly served meat is goat or mutton; chickens are kept to provide eggs, but their meat is expensive, and is mostly served to tourists. Yaks are also slaughtered and eaten during the late summer and autumn. Meat is hung in cooking smoke to dry and preserve it for several weeks, and the meat from one animal, particularly a yak, which provides a huge amount of meat, will usually be shared out amongst several families.

2.6.3. Children's activities: school, work and play

School takes place from 10 until 1, and 2 until 4, from Sunday to Thursday, and from 10 until 1 on Friday. Saturday is the weekly rest day in Nepal. School holidays occur frequently for national and local religious festivals, and at times of peak agricultural labour demand, although the central government are trying to impose the same structure on all schools, with a break during March and April for the Nepali New Year. Boys and girls seemed equally likely to be enrolled in school in both Marpha and Thini, although this is not true for Nepal as a whole.

Children usually begin school at five or six years of age, although some children were not sent until they reached seven, or even eight. There are ten grades, and children must pass each grade to progress; many children fail and have to repeat, so finishing school may take longer than ten years, and there was a wide variation in age within each class. All Thakali children attended school, either the village school, or boarding schools in Jomsom, Pokhara or Kathmandu. The sole exception to this was a mentally handicapped girl of twelve who remained at home all day and helped in the house. Most low caste children attend school for a few years, perhaps until they are eleven or twelve, but after that their attendance declines dramatically compared to Thakali children. Parents must pay fees and buy books for secondary schooling, also as children get older, they can be more usefully employed doing household jobs, or working outside the home for wages. Low caste children also tended to be older starting school, and were more often made to repeat classes, so there were several low caste eleven and twelve year olds in classes with children three or four years younger.

Girls are expected to work in the home more than boys, helping their mothers with food preparation, fetching water, washing and caring for younger siblings. Boys also look after

younger children, but more rarely help with other household chores. They are more likely to be sent up the mountain to the forest fields to fetch loads of firewood or crops. Both sexes may help in the family fields at certain times of year when more labour is required. This domestic work usually takes place outside school hours.

The amount of work children are expected to do in the home increases with age, especially for teenage girls. Poorer families also expect children to do more domestic work, as they cannot afford to pay servants, and parents may be engaged in waged labour outside the house. Children from the poorest families were often paid by Thakali lodge owners to work in the kitchen or on other tasks. The youngest child I was aware of regularly working full time outside the home (instead of, rather than in addition to, attending school) was a ten year old, and usually children were twelve or thirteen. Some girls worked as domestic servants in Thakali homes, cooking family meals, washing clothes and dishes, and generally taking over the drudge work, often allowing family member to work in more profitable tourist-related jobs. In this case, the girls often receive food and clothes from the family who employs them, though they continue to sleep and spend some time in their own family home.

Children in Mustang have few toys, and do not play a wide variety of games. Recreation tends to take the form of talking to, or teasing friends, and in the case of boys, running and chasing games. Football and volleyball are popular with teenage boys. Children's play in rural Nepal is well described by Anderson & Mitchell (1984). They found that chronically malnourished children in a rural village devote less time and energy to play than expected, and appear to pursue a spontaneous strategy of minimising energy expenditure, allowing them to maximise their physical growth potential. Anderson and Mitchell questioned whether this lack of play would lead to impairment of psychological, social and motor development, but conclude that the pattern and variety of play observed, and the enthusiasm for play, was similar to that of healthier peasant children in nineteenth century Europe.

CHAPTER THREE : METHODS

3.1. Participants

3.1.1. Recruitment of participants and sample validity

I aimed to include in the study all children aged five to twelve years normally living in Marpha and Thini at the time of my research. During my first visit, in March 1997, I tried to locate all children in this age range, in and out of school. During subsequent visits, I tried to follow up the same children, in order to get repeated growth measurements over the course of a whole year, and also included any children I had not seen before in the same age group. There is a lot of mobility in Mustang, as families regularly spend weeks or even months elsewhere, particularly during winter, so I inevitably lost a number of children from my study, and gained others, over the course of the year.

I do not claim that this is a complete, or even necessarily representative, sample of all children from the villages, for a number of reasons. Many children from the wealthier Marpha Thakali families were sent away to private “boarding” schools in Jomsom, Pokhara or Kathmandu, and returned to the village only for short holidays. I never knew of any Thini children or non-Thakali children from Marpha being sent away to school, but it is possible there were a few. Some children, most often from the poorest Kami and Damai families, did not attend school at all, or did so very erratically. I tried to include as many of these children out of school as possible, but this was often difficult. The children who consistently did not attend school usually worked each day, frequently outside their family home. Some children worked in lodges or in wealthy Marpha Thakali households, but there were also many children sent to work in other villages (and of course children from other villages employed in Marpha). These working children tend to be highly mobile, and I was often able to measure them only once, and found they had moved on by the next time I tried to see them. Thus, my study probably missed some children from both the richest and the poorest extremes.

3.1.2. The participating children- age, sex and caste distribution

101 children participated in the study in March 1997, and a further 24 children joined in July 1997, giving a total of 125 children participating at different stages. 67 of these children were from Marpha, and 58 from Thini. There were 67 boys and 58 girls. In March 1997, ages ranged from 5 years and 1 month, to 11 years and 6 months; the mean age was 8 years and 8 months (SD = 22.0 months). 2 of the Marpha children worked and did not attend school at all; the others attended at least some of the time. Children belonged to seven different *jat*: Thakali, Gurung, Magar, Kami, Damai, Brahmin and Chettri. Caste composition of the two villages is very different; the numbers of children belonging to each *jat*, in each village and overall, are given in table 3.1.1. Most of the population of Thini are Thakali or Gurung, with a few Indo-Aryan families (see table 2.4); the *jat* distribution of the sample reflects that of the population as a whole. There is a greater mix in Marpha, with about two fifths of the population Thakali, about one fifth each Kami and Damai, and the remainder made up of small numbers of other groups. Thakali children formed only a quarter of children in the Marpha sample; this is probably because many Thakali children are sent away to school.

Table 3.1 Number of children belonging to each *jat*

jat	Marpha number (%)	Thini number (%)	all children number (%)
Thakali	16 (23.9)	39 (67)	55 (44.0)
Gurung	6 (8.9)	16 (28)	22 (17.6)
Magar	5 (7.5)	0 (0)	5 (4.0)
Kami	15 (22.4)	2 (3)	17 (13.6)
Damai	18 (26.9)	0 (0)	18 (14.4)
Chettri	2 (2.9)	0 (0)	2 (1.6)
Brahmin	5 (7.5)	1 (2)	6 (4.8)
all	67 (100)	58 (100)	125 (100)

The population of Mustang is highly mobile; in particular, many families were absent during the winter, so it was impossible to measure all children at each season. 85 children were present for all four sets of measurements, 17 for 3 sets, 18 for 2, and 5 only once.

3.2. Notes on the general approach to statistical analyses

The range of quantitative and qualitative methods employed during the course of this project resulted in a large and complex data set. Broadly, the statistical methods used fall into two categories: longitudinal analysis of variation over time, and cross-sectional analysis of variation between individuals and groups.

Several repeated measures of physiological parameters such as anthropometric, immune markers and other blood proteins were taken, from many individuals. Time intervals between measurements were two, four, six and twelve months. It was possible to conduct powerful repeated measures analyses of variation over time, within individual children, using this longitudinal data. All statistical analyses are reported in chapters four, five and six as part of the results.

Much of the qualitative data collected served to describe the children's socio-economic backgrounds. There was a great deal of variation, with children coming from two very different villages, seven *jat*, and a wide range of household wealth. Cross-sectional comparisons were made between groups of children, to investigate the effects of *jat*, village, sex and age.

Z-scores of anthropometric data were generated using the Center for Disease Control Anthropometric Software Package (CASP 3.1). All other statistical procedures, including all tests of significance, were performed with the SPSS statistical package (SPSS for Windows version 8.0), using $p \leq 0.05$ as the accepted level of significance.

3.3. Anthropometry

3.3.1. Overview

Height, weight, mid-upper arm circumference and skinfolds at four sites were measured, using standard techniques and portable equipment. Three full sets of measurements were taken, at six-month intervals (during March 1997, September 1997, and March 1998), for all children participating in each phase of the research. I also measured height and weight in July 1997, so that growth increments could be calculated over shorter periods of time. Skinfold and arm circumference measures were omitted on this occasion, to save time and minimise invasive procedures.

3.3.2. Measurement techniques

Height was measured to the nearest 0.1 cm using a Harpenden portable anthropometer, according to the technique outlined by Weiner & Lourie (1981).

Weight was measured using a Salter electronic scale with 0.2 kg precision. Shoes and other heavy items of clothing were removed, but due to extremely cold weather on some occasions, and modesty constraints, children retained some garments. All clothing was noted; sample garments were later weighed and clothing weight subtracted from measurements.

Mid upper arm circumference was measured to the nearest 0.1 cm, using a 'lassoo' tape (supplied by Child Growth Foundation, London, UK), according to the technique outlined by Weiner & Lourie (1981).

Biceps, triceps, subscapular and suprailiac skinfolds were measured to the nearest 0.2 mm using a Holtain calliper, according to the technique outlined by Weiner & Lourie (1981), and Harrison et al. (1988). Three readings were taken at each site, and the median value retained. The sites were chosen to give an idea of distribution of subcutaneous fat on the trunk and limbs. Durmin and Womersley (1974) recommended the use of the same four skinfold thicknesses as the minimum required as representative of whole body fat.

3.3.3 Reliability of measures

I performed all anthropometry, and recorded the figures myself, on all occasions (assistance from one teacher in each school was required to measure height). Before beginning fieldwork, I had been trained in all techniques by Dr Catherine Panter-Brick (Department of Anthropology, University of Durham, Durham, UK), an experienced field worker. I practised the techniques on adults and children in the UK until we were both satisfied that I was confident with performing all techniques, and could do so easily and reliably.

Full sets of repeated measurements were obtained for ten children on two consecutive days in March 1997. The technical error of measurement (TEM, equation 3.3.1) and the coefficient of reliability (R, equation 3.3.2) were calculated for each measure, according to Ulijaszek & Lourie's recommendations (1994), and are reported in table 3.3.1. For all measures except the suprailiac skinfold, R was greater than or equal to 0.99, indicating good reliability and low intra-observer error. For suprailiac skinfold measurements, R was 0.96.

3.3.4 Statistical treatment of raw height and weight data

To allow statistical comparison of children of different sex and age, heights and weights were converted to z-scores (standard deviations from the mean) of height-for-age (HAz), weight-for-age (WAz) and weight-for-height (WHz), relative to a United States reference population. The data set used was compiled by the National Center for Health Statistics (Hamill et al., 1977; 1979). Z-scores were calculated using the Center for Disease Control Anthropometric Software Package (CASP 3.1).

The National Centre for Health Statistics (NCHS) growth reference curves are based on American data collected between 1963 and 1970. The NCHS data set is used as an international reference to enable easy and meaningful comparisons between data collected in different studies, from different populations. It does not necessarily imply that the NCHS data give an appropriate standard for growth of all children in all environments, or a target for all children to aim at. Children from different populations may have a genetically different growth potential, requiring different standards. There may also be differences in tempo of growth, particularly between bottle and breast fed children. Thus, the use of a universal standard is practically meaningless.

Equation 3.1 WHCz, an index of weight for height in older children

$$TEM = \sqrt{(\Sigma D^2/2N)}$$

where D is the difference between measurements, and N is the number of individuals measured

Equation 3.2 R, the coefficient of reliability

$$R = 1 - [(TEM)^2 / (SD)^2]$$

where SD is the total inter-subject variance, including measurement error

Table 3.2 Standard deviation, technical error of measurement, and coefficient of reliability for repeated anthropometric measurements on 10 children aged 5 to 11 years

measure	standard deviation	technical error of measurement	coefficient of reliability
height (cm)	16.79	0.446	≥ 0.99
weight (kg)	10.93	0.199	≥ 0.99
arm circumference (cm)	3.09	0.063	≥ 0.99
biceps skinfold (mm)	1.98	0.238	≥ 0.99
triceps skinfold (mm)	2.55	0.255	≥ 0.99
subscapular skinfold (mm)	3.68	0.241	≥ 0.99
suprailiac skinfold (mm)	2.33	0.458	0.96

Equation 3.3 WHCz, an index of weight for height in older children

$$WHCz = (WAZ - rHAz) / \sqrt{1 - r^2}$$

where r is the age and sex specific correlation coefficient of WAZ and HAZ (Cole, 1993).

Martorell (1985) argued however that all children under five years have the same genetic potential, and observed differences are due to environmental constraints. According to this argument, the NCHS curves could be used as a standard. However, others such as Eveleth & Tanner (1990) argue against this, and recommend that each country should generate its own standard curve based on healthy adequately nourished individuals in the population. Clearly, this is both expensive and time-consuming, and there is also a great difficulty in selecting a representative, and at the same time healthy, population from many developing countries.

Thus, it is currently preferable to use a single reference curve, whilst bearing in mind the genetic and environmental characteristics of the population on which the data set is based. Several sets of growth statistics are available, and, at times used as reference curves. Some older studies use the US National Academy of Sciences (NAS) data set as a reference, but this has been largely superseded by the NCHS data, which are based on a larger and more representative sample of American children. A reference based on the growth of British children is also available (Cole, 1993), but using the NCHS data facilitates comparison with a greater number of international studies.

Raw height and weight measurements must be adjusted for the child's age and sex. This allows comparisons between children, and the development of a classification system to define individual children suffering from degrees of growth failure or malnutrition. There are three methods of doing this: as z-scores (standard deviations from the median), as centiles, or as a percentage of the median. For statistical reasons, associated with the distribution of growth data, Waterlow et al. (1977) recommended the use of z-scores to describe growth status of children in undernourished populations; the WHO endorsed this in 1978. Since then, z-scores have been the preferred technique, and a cross-classification with cut-off points defined as z-scores of weight-for-height and height-for-age can be used to distinguish grades of growth deficit, both chronic and acute. Some of the results referred to in subsequent chapters are from older research papers, and are expressed in terms of centiles or percentage of the median. The definition of mild, moderate and severe growth failure according to Gomez et al. (1956), Waterlow (1972) and Waterlow et al. (1977) is given in table 3.3.2.

Gomez's 1956 classification used cut-off points defined as centiles of weight-for-age. The use of centiles may be problematic for relatively undernourished populations in developing countries, as it is inaccurate at the tails of the distribution (i.e. above the 95th centile and below the 5th centile), where many children from these populations fall. Also, the use of only weight-for-age suffers the drawback of ambiguity and potential misinterpretation, as it is impossible to

Table 3.3 Classification of mild, moderate and severe growth retardation, according to the methods of Gomez (1956), Waterlow (1972) and Waterlow et al. (1977)

	Gomez (1956), using centiles of reference population	Waterlow (1972), using percentage of reference median	Waterlow et al. (1977), using z-scores (S.D.s) of the reference median
acute growth failure (wasting) defined in terms of weight for height (WH)		<i>adequate:</i> WH > 80% of ref. median <i>wasting:</i> WH < 80% of ref. median <i>severe wasting:</i> WH < 75% of ref. median	<i>adequate:</i> -1 < WHz < +1 <i>mild:</i> -2 < WHz < -1 <i>moderate:</i> -3 < WHz < -2 <i>severe:</i> WHz < -3
chronic growth failure (stunting) defined in terms of height for age (HA)		<i>adequate:</i> HA > 90% of ref. median <i>stunting:</i> HA < 90% of ref. median <i>severe stunting:</i> HA < 85% of ref. median	<i>adequate:</i> -1 < HAz < +1 <i>mild:</i> -2 < HAz < -1 <i>moderate:</i> -3 < HAz < -2 <i>severe:</i> HAz < -3
acute on chronic growth failure (underweight) defined in terms of weight for age (WA)	<i>adequate:</i> WA above 90th centile <i>mild (Gomez 1):</i> WA between 75th & 90th centile <i>moderate (Gomez 2):</i> WA between 60th and 75th centile <i>severe (Gomez 3):</i> WA below 60th centile		<i>adequate:</i> -1 < WAz < +1 <i>mild:</i> -2 < WAz < -1 <i>moderate:</i> -3 < WAz < -2 <i>severe:</i> WAz < -3

distinguish between a child who is short for his age (stunted), with normal weight-for-height, and a child who has normal height-for-age, but is thin for her height (wasted). For this reason, Waterlow (1972) developed a method using weight-for-age, weight-for-height and height-for-age to improve the specificity of classification. When possible, all three criteria should be used, but as dates of birth are often difficult to determine in developing countries, it may only be possible to assess weight-for-height with any accuracy. Weight-for-height is an index of growth status based on the child's present condition, and can be used to diagnose acute growth failure, or wasting, but gives no indication of past conditions.

Onset of puberty is later for Nepali children, who have a slow rate of growth compared with the US reference population (Eveleth & Tanner, 1990). Due to growth spurts at puberty affecting American children of this age, the NCHS program cannot be used to generate WHz for girls over 10 years, and boys over 11.5 years. An alternative index of weight for height, WHCz (equation 3.3.3), was calculated for older children. This conditional index was developed by Cole (1993) from the correlation between log weight-for-age and log height-for-age measurements for American children. WHCz can similarly be expressed in terms of standard deviations, or z-scores.

The combined use of the NCHS WHz, and Cole's WHCz, allows comparison of weight-for-height (reflecting current nutritional conditions) for all children. The two measures have been treated as a single index of weight-for-height in the following analyses (after Panter-Brick et al., 1996). This measure is considered to be independent of age.

For each set of skinfold measurements, the mean of the three recorded readings was calculated. Sum of skinfolds was calculated for each child, as a measure of general 'fatness' (SSF = mean biceps + mean triceps + mean subscapular + mean suprailiac).

3.3.5. Note on the determination of children's age

To calculate height-for-age and weight-for-age z-scores accurately, it is necessary to know each child's age as precisely as possible. Dates of birth were known for many children, from village and school records. If parents could not give an exact date of birth, I tried to determine the year and month of birth, referring to the twelve year Tibetan calendar, or the Nepali Hindu calendar.

In about half the cases, not even this information was known, so the child and/or parents were asked for their opinion of the child's age in years. All responses were compared with age of

siblings to check for any obvious discrepancies. Age was then taken to be the number of completed years, plus six months. Nepalis commonly give age as age at next birthday, rather than age in completed years as in common in Britain. This assumption was checked by asking the age of children for whom I knew date of birth, and found to be valid for over 80% of cases. Thus, a child who responded eight years, in March 1997, would be considered seven years old by western reckoning. For analysis purposes, I would assume their age to be precisely seven years and six months (and four months later, in July 1997, I would assume they were precisely seven years and ten months old).

Whilst this method is not ideal, in that it cannot produce accurate ages for all children, it has no obvious bias in either direction, so should not affect the pattern of results.

3.4. Blood spot measures of inflammation and immune function

3.4.1. Methods available for assessing immune function and response to infection, and their suitability under fieldwork conditions

Serum markers of inflammatory response

The rationale for measuring acute phase proteins (APPs) is discussed in the introduction, along with a brief review of previous studies which used these methods. Measurement of APPs is often combined with the measurement of other plasma proteins, including immunoglobulins, albumin and haemoglobin. Plasma levels of a specific antibody can be used to monitor the immune response to infection with a specific antigen, or the total amount of a particular class of immunoglobulin can be measured as an indicator of present or past levels of infection. IgA exists in limited amounts in plasma, and in a different form, as secretory IgA in saliva, sweat, gastric secretions and milk. IgD is found on the surface of B cells, and acts as an antigen receptor, activating the cell. IgE is usually only found at trace levels in blood; elevated IgE is associated with severe allergic reaction, or chronic intestinal parasite infestation. IgG is approximately 80% of all antibody in plasma; levels are cumulative, so high IgG levels indicate a history of infection. IgM exists in two forms, one of which circulates in plasma. This is the first Ig class released by plasma cells during the primary immune response, thus high IgM levels to a specific antigen indicate a current infection (Marieb, 1992).

Albumin accounts for around 60% of plasma protein. It acts as a carrier of other molecules through the circulatory system, and is important as a buffer to maintain normal blood pH. It is also crucial, along with sodium ions, for the maintenance of plasma osmotic pressure, keeping the correct level of water in the blood stream. Low plasma albumin levels indicate hypoalbumaemia, suggesting gastro-intestinal protein loss through trichuriasis or hookworm disease (and may also indicate the level of protein in an individual's diet).

Haemoglobin is a red pigment contained in erythrocytes; its function is to transport oxygen to all body cells. Haemoglobin binds with oxygen in the lungs, forming oxy-haemoglobin which is carried in the blood throughout the body. Where oxygen is needed it dissociates from the haemoglobin and enters cells to be used for respiration. Low haemoglobin levels indicate anaemia, a reduction in the oxygen carrying capacity of an individual's blood. This can lead to fatigue, pallor and shortness of breath, when blood oxygen levels become inadequate to support normal metabolism. Anaemia may be caused by slight but persistent blood loss (due to conditions such as parasitic infestations, haemorrhoids, or bleeding ulcers) inadequate dietary

iron intake, or impaired iron absorption. It is rare for individuals to consume a diet deficient in iron over a long period of time, so anaemia is most commonly caused by a combination of these factors.

Epstein Barr virus antibody titres

Epstein-Barr virus (EBV) is a herpes virus that infects over 80% of individuals in developed countries by adulthood, and almost all children in developing countries by the age of five. Following EBV infection, individuals remain latently infected for life. The virus is maintained in its latent state by adequate functioning of the cell-mediated immune system (Glaser & Kiecolt-Glaser, 1994a). Immunosuppression allows reactivation of the virus and production of antigens, to which an antibody response may occur. Thus, counter-intuitively, higher antibody titres to EBV suggest suppression of the cellular immune system. Therefore, EBV antibody titres, although measuring the activity of the humoral immune response, also provide an indirect measure of cell-mediated immune function. This method is well validated, and has been widely used for research on western populations, showing reliable changes in response to a range of psychosomatic variables (e.g. Glaser et al. 1987, 1991; Kiecolt-Glaser et al., 1985, 1991). The measurement of EBV antibody by a bloodspot assay, and its use on children in developing countries has been pioneered by Dr Thom McDade (formerly at Department of Anthropology, University of Emory, Atlanta, GA). The results of more such studies are likely to be available soon, and should reveal more about between and within population variation in this measure, and the effects of poor nutrition and high rates of infection on the cell-mediated immune system, as well as the widely studied results of psychological stress (McDade et al, 1998; 2000).

Delayed-type hypersensitivity testing

Hypersensitivity, or allergy, is defined as an abnormally intense reaction to an allergen, after the initial immune response. Hypersensitivity may be immediate or delayed, mediated by antibodies or cells, and varies in severity. Anaphylaxis, most frequently seen in the UK as a response to bee and wasp stings, and peanut ingestion, is an extreme and sometimes life-threatening symptom. T-cell mediated hypersensitivity is called delayed-type hypersensitivity (DTH), and can be assessed by injecting antigens into the skin, and measuring the size of any subsequent reaction. If the person has been previously exposed to the antigen then small hard lesions form under the skin over a period of one to three days. The Heaf, or Mantoux, test has long been used clinically to detect immunity to tuberculosis. Kits are now available which use multiple antigens to assess an individual's cell-mediated immune function, and have the advantages of being less painful and yielding more reproducible results. One example is the Multitest CMIR (Institut Merieux, Lyon, France), which consists of a single applicator with eight

heads loaded with seven antigens (*Streptococcus*, tuberculin, *Candida*, *Trichophyton*, *Proteus*, tetanus and diphtheria) and a glycerine control. These were originally used clinically on populations known or suspected to be suffering from suppressed immune systems, particularly HIV positive individuals. More recently, the method has been appropriated by psychologists interested in the emotional correlates of immune function in a 'healthy' population.

Recent work indicates that delayed-type hypersensitivity testing (DTH), a measure of cellular immune function, is a significant predictor for the occurrence of diarrhoea and acute respiratory infections, and may be a more important risk factor than nutritional status. Black et al. (1989) found that both DTH response and length for age were negatively associated with incidence, but not duration, of diarrhoea episodes in young Peruvian children. Baqui et al. showed that for Bangladeshi children DTH response and nutritional status were both significant predictors of the incidence (1993a) and duration (1993b) of diarrhoeal disease. Koster et al. (1987) found that DTH response was a significant predictor of the incidence and severity of diarrhoeal disease, and nutritional status had no significant independent effect. Shell-Duncan & Wood (1996) showed that, for Turkana children, DTH response, but not nutritional status was a significant predictor of diarrhoea rates. Both nutritional status and DTH response were significant predictors for attack rates of ARI, but when these effects were tested in a single model, nutritional status was not a significant independent risk factor. They suggest that the effect of nutritional status on morbidity may be mediated primarily by suppression of cellular immune response. Shell-Duncan (1997) used these results in a new model of child morbidity, emphasising the importance of individual immunocompetence as a mediating factor between environment and health outcome.

Intestinal permeability test

Lunn et al. (1991) used serial measurements of an intestinal permeability test (based on urinary lactulose-mannitol ratio) to assess the status of the mucosa in the small intestine in young Gambian children. They showed that the mucosa deteriorated with increasing age, becoming more 'leaky'. This allows the loss of digestive enzymes from the gut leading to malabsorption of nutrients, and may also allow increased entry of antigens into the intestine, causing systemic inflammation. In statistical models, the results of this test predicted 43% of variation in height growth and 39% of variation in weight gain, suggesting that increased intestinal permeability may be an important factor associated with growth faltering. Lunn (2000) claims that this damage to the gut, and the resulting chronic systemic inflammation, may account for the very poor growth observed in Gambian children. Mucosal enteropathy was found in all of the more than 400 infants in the sample, and evidence of similar damage has been found in children in other developing countries. He concluded, "it seems likely that [mucosal enteropathy] will be

found wherever infant growth faltering occurs”, and that enteropathy is more likely to be a cause than a consequence of malnutrition (2000: 153). Panter-Brick et al. (2001) suggested that damage to the intestinal mucosa might be one explanation for the high ACT values and poor growth found in their sample of rural Nepali boys.

Secretory immunoglobulin A in saliva

Secretory immunoglobulin A (sIgA) is an index of humoral immune function, and is measurable by radioimmunoassay in saliva or dried blood spots. SIgA helps to prevent pathogens from attaching to, and invading, epithelial cell surfaces, such as the mucous membranes lining the respiratory and gastrointestinal tracts. It has been widely researched as a correlate of psychological stress in studies of western populations.

Stone et al. (1987) criticised the measurement of total sIgA as a method of assessing immune function, as there are potential confounding difficulties of measurement and interpretation. Concentration of salivary IgA is affected by saliva flow rate, which may be dramatically reduced under psychological stress, as well as certain physiological conditions, and they recommended that saliva samples be collected unstimulated. O’Leary (1990) recommended that IgA values be expressed as secretion rates per unit time, necessitating timed saliva collection. Both of these modifications can add considerably to the time and awkwardness of a saliva collection protocol, and are likely to reduce compliance in many participants, particularly if several repeated samples are required. Stone et al. also suggested measuring an individual’s ability to produce IgA to a specifically introduced novel antigen as a more useful test of immune function than assaying total sIgA.

Jemmott & McClelland (1989) present empirical observations to refute Stone et al.’s criticisms, and justify the use of sIgA as a measure of immune function. Their meta-analysis of studies linking psychological well-being with immune function showed that low levels of sIgA were a key risk factor for susceptibility to upper respiratory infections.

3.4.2. Rationale for the choice of methods

In deciding what methods to use in this study, I considered a range of factors including the reliability of each technique, possible interpretation of results, its feasibility under fieldwork conditions, and its acceptability to subjects.

All the acute phase proteins and other proteins mentioned above can be measured in either whole blood samples or, by using recently developed assay methods, from dried blood spots (techniques developed by Dr P. Lunn at the Dunn Nutrition Centre, Cambridge, UK). The latter method is particularly suitable for anthropologists, and others working in remote field situations, because of the simplicity of sample collection, transportation and storage. Only very small quantities of blood are needed for these assays, and several assays can be carried out on a single drop of blood. The blood spots can be collected through a simple minimally invasive finger prick procedure, and once the samples are dried, they are easily stored, and can survive transportation without refrigeration. Unfortunately, these assays have had limited validation for measurement in dried blood spots, so it is not yet certain whether results from this method can be compared with other results obtained using whole blood samples. Despite the uncertainty surrounding the assay methods, I decided to collect dried blood spots for assay of ACT, albumin and IgG, as it was not possible for me to collect and store fresh whole blood samples in Mustang.

When I was originally planning my study, the assay being used for EBV antibodies was performed on fresh whole blood samples. I could not preserve blood samples in the field, or arrange rapid transport to appropriate laboratory assay facilities from Mustang, so I reluctantly decided that it was impossible to include EBV antibody measurement. However, an enzyme-linked assay for EBV antibodies in dried blood spots has now been developed at Emory University, US (McDade et al., 1996; McDade, 2000). It has a blood spot-plasma correlation of 0.97, and has been validated for use in the field. The new blood spot assay is an exciting development as it will allow more anthropologists and other scientists working at remote field sites in developing countries to include this useful measure of immune function in future research projects.

I decided not to use DTH testing as I was concerned about the ethics of introducing possibly novel antigens into a population. There is also a very remote risk, made more significant because of the possible severity of the outcome in a remote setting, of stimulating a severe allergic reaction. Also, I feel that as an investigative technique, not associated with any prospect of medical treatment, DTH testing would almost certainly be poorly received. The method involves initial slight discomfort when antigens are injected, followed by the development of several raised, red, itchy lumps (in a positive reaction) that are visible for weeks. There was also the difficulty that to assess the results with any meaning, each child's immunisation status for the relevant antigens must be known. Neither the village health posts, nor children's parents, were able to give me reliable information about individual children, but some children had certainly received DPT and BCG vaccinations. Results obtained from an unvaccinated, or partially vaccinated, population would not be comparable to those available for reference populations of

healthy children who have all received vaccinations (Kniker et al., 1985; Corriel et al., 1985).

For biological anthropologists working in the field, the measurement of IgA in saliva seems promising once further research has been performed to fully validate the method. Due to the difficulties of interpretation mentioned above, I was reluctant to adopt the method in the present study, but there is certainly much potential for future work. Saliva may be preferable to blood sampling, as it is non-invasive and minimally disruptive to normal activities, thus allowing more frequent repetitions and measurement of variation over shorter time intervals. Samples are relatively easy to store and transport under remote or adverse field conditions, as are frequently faced by anthropologists, although the 'shelf-life' of IgA in samples stored under different environmental conditions has not been thoroughly investigated. There is also the possibility of a study combining the measurement of IgA, cortisol, and other substances, as a small (4 ml) saliva sample provides sufficient material for many assays.

The intestinal permeability test appears to be a powerful predictor of chronic growth failure, and will undoubtedly be of great value in future studies. It is non-invasive, but requires careful compliance from children and caretakers to obtain carefully timed urine samples over a period of hours. However, it requires adequate facilities for immediate and continuous freezing of urine samples at the field site to prevent degradation, which may be problematic at some field study sites.

3.4.3. Technique of blood spot collection

Blood spots were collected by finger prick with an auto-lancet device (Autolet II, Baxter Scientific Products, McGraw Park, IL). Drops of blood were allowed to reach maximal size on the fingertip (about 100 μ l, and then dropped onto pre-printed circles on standardised filter paper (Schleicher & Schuell, no. 2992, Keene, NH). Four to six drops were collected from each child, depending on the amount of bleeding. Blood spots were dried at room temperature for a day, and then placed in a ziplock bag with desiccant. Samples were refrigerated below 5°C for up to two weeks whilst in the field, and then stored in the laboratory at -23 °C until assay. Ethical and safety considerations are discussed in section 3.8.

3.4.4. Laboratory analysis of samples

ACT, albumin and IgG analyses were performed by Dr Peter Lunn at the Dunn Nutritional

Laboratories, Cambridge, UK (now at Department of Biological Anthropology, University of Cambridge, UK). Blood spots were eluted from the filter paper by soaking for 48 hours in a phosphate buffered saline solution. ACT, albumin and IgG were then measured using an automated immunoturbidimetric technique (after Calvin & Price, 1986) on a Cobas Bio. Antibodies and standards were supplied by DAKO Ltd, Cambridge, UK; the ACT antibody used was no. Q0367, albumin antibody was Q0328, and a standard preparation X0908.

There is currently a problem with standardising the ACT assay between laboratories and occasions, because the values obtained are dependent on both the antibody/standard pair, and the actual conversion of blood spot values to plasma equivalent. The international standard for ACT fell into disrepute several years ago, and the new standard gives values less than half those obtained with the old standard. A conversion factor ($\text{new ACT value} = (\text{old value} - 0.116) / 2.033$) calculated by Dr Lunn (pers. comm.) gives a good straight line fit between values obtained using the old and new standards, and I have used this equation to compare absolute values from older studies in the final chapter. Thus, absolute values of ACT may occasionally be uncertain, making comparisons with other studies problematic, but internal comparisons made between sample groups in the study should be valid.

When comparing absolute values of serum proteins measured in blood spots and in plasma, it is necessary to convert values. Concentrations are normally expressed as g/l of plasma if measured from plasma, whereas data from blood spots is most accurately expressed as grams of protein per litre of blood. Blood spot values were multiplied by a factor of 2.26 to obtain approximate plasma equivalent values (after Panter-Brick et al., 2001).

3.5. Collecting data on morbidity: the choice of self-reports over clinical examination

For any researcher interested in collecting population morbidity data, there is a basic choice of methodologies: clinical examination versus self (or caretaker) report. The usual reasons for using caretaker or self-reports are the much lower costs: in terms of time, staff expertise and equipment. However, there are two major problems with this method. Firstly, there is the qualitative difficulty, of establishing if, and how, subject reports of illness correspond with a western biomedical definition of disease. For anthropologists, with their particular interest in other systems of cognition and classification, this may be considered an interesting and worthwhile aspect of research. A clinician aiming to produce comparable epidemiological data from a range of populations is likely, however, to be frustrated by the ambiguity. Secondly, there is the quantitative problem of whether the reported prevalence of a disease represents the true prevalence rate.

Clinical examinations tend to identify a slightly different array of health problems to caretaker or self-reports. 'False negatives' occur, with patients reporting themselves well when a western medical practitioner might diagnose disease. In particular, chronic symptoms such as malnutrition, worms and anaemia are not commonly reported (Kroeger, 1983). This can be due to the problem being invisible, or undiagnosed, so that the respondent is not aware of it. Alternatively, a symptom may be so common within a particular population or sub-population (for example, children), that it is considered to be inevitable, and therefore normal. Some individuals may also yield apparent 'false positives', reporting acute illnesses at times when clinical examinations do not reveal symptoms. This may be due to variation in the definition and classification of illness between cultures causing a misunderstanding, or deliberate misinformation by the informant. The status of the interviewer, the sex of the interviewer, and the language spoken by the interviewer are all factors that may affect the quality of responses. The best data are obtained when the interviewer speaks the first language of the informant fluently, is the same sex as the informant, and is of similar status, ethnicity or caste (Ross & Vaughn, 1986). For these reasons, fieldworkers are frequently selected from the local community, and trained in the required interviewing techniques, rather than using experienced investigators from outside the community who may not be equally trusted and accepted.

The population being studied may resent clinical examinations as an intrusion on privacy, and time-consuming, particularly if frequently repeated. Alternatively, some people may welcome the attention, particularly if medical treatment is provided, or anticipated. The expectation of treatment associated with medical research is problematic, both ethically, and because of the

manner in which it may bias results. Clearly, a mother who believes the interviewer to be a doctor who will provide free treatment or medicine is more likely to report her child to be sick (and thus in need of drugs and attention), than one who understands that the study will not provide medical aid of any sort, or has an alternative and affordable source of medical treatment available. I discuss my personal approach to this problem in more detail in section 3.8 on ethical concerns, and section 2.5 on my experiences during fieldwork.

Even with well-motivated informants who do not wish to mislead in any way, accurate recall of morbidity over a set time period is problematic, particularly in non-literate populations, where calendars may be of less importance. If the interval is too long, respondents are likely to forget and under-report illness; a very short interval is more likely to lead to over-reporting as remembered instances of illness may have occurred prior to the time of interest. Following investigation of different recall periods, two weeks has been widely recommended as the optimum interval for accurate recall, compromising between under and over-reporting (Ross & Vaughan, 1986; Kroeger, 1983).

I intended to use the two-week period, but after a few initial attempts, it became clear that most children could not remember accurately over this time scale. Eventually, morbidity data were collected by asking children if they were currently ill, or had been ill in the last week, and what had been wrong with them. I had hoped to collect data on duration of illness, but this was probably optimistic given the quick and easy methods I used. Some children struggled to recall the entire week, and teachers or older siblings tended to supplement the answers of young children, but most children were well able to report their own acute illnesses, at least for the day in question. Thus, the morbidity data obtained in this way describe presence or absence of acute illness at the time of blood sample collection, or shortly before, but do not indicate the severity or duration of illness. Typical questions used with children are included in appendix 1, along with Nepali translations.

Occasionally, children would claim to be well, when clearly suffering, for example, from a bad cough. When this happened, I would repeat my question, asking specifically, "Do you have a cough?" This often led to children saying, 'yes', but if the child still claimed to be well, I recorded their response, whilst making a note of my own observation, but I have used the child's response in this analysis. Equally, if a child claimed to have many illnesses, but appeared to be well, I would also repeat the question. Teachers occasionally drew my attention to children who they believed were falsely claiming to be ill, but this was very rare. Again, I recorded the child's response, and merely noted my observations where different, but have used the child's response in this analysis. Clearly there are reasons why children may have been motivated to over or under report symptoms, particularly if being interviewed in the presence of parents, teachers or

friends. However, as these cases of discrepancy between the child's response and my observations occurred so infrequently, this does not appear to be a cause for concern with my data; numbers are certainly too small for any kind of analysis (fewer than ten cases over the entire study period).

Initially, in March 1997, I worked alongside a teacher to help with any language difficulties, but as a fairly limited vocabulary was involved, and my command of Nepali improved, I almost always worked alone with children. I preferred this, as it seemed that children were more likely to embroider the truth when a teacher, or other adult of high status in the community was around. Once it was apparent that I offered no incentive or disincentive for reports of illness, I believe that misinformation was not too much of a problem.

3.6. Structured interview on family, lifestyle and effects of tourism

A short structured interview (appendix 2) on family composition, work and schooling, migration, and exposure to tourism and other outside influences was given to each child participating in March 1997 (n=101), with an English-speaking teacher present to interpret when necessary. I had prepared the interview in English, and questions were printed in English, with my rough translation into Romanised Nepali. Teachers studied both versions, and discussed any ambiguous points with me, which were modified until we were satisfied that the translation was sufficiently close to the original English version.

The purpose of several of the questions was to establish whether there were genuine differences in lifestyle between Marpha and Thini, either as a result of tourism, wealth or other factors. Some questions included in the original list prepared prior to fieldwork turned out not to yield useful data, either through irrelevance in the context, or difficulties in getting answers from young children. Asking about consumption of foreign foods met with blank responses, or denials, in both villages from children and adults alike. This was certainly one instance of people not doing as they say they do, as I realised later. Some families certainly consume both imported foods, and foods cooked to foreign recipes, on a regular basis, particularly families with tourist lodges. A question about knowledge of foreign words yielded replies only in terms of how much English had been learnt in school (the subject is compulsory in all Nepali schools from class 4 onwards). Replies about the amount and type of work done out of school yielded only very general information. I later observed children to find out more about how both the amount of time spent on work, and the physical activity level required for tasks, varies by age, sex, caste and socio-economic status.

Some children were unable to give single meaningful answers on their parents' occupations. This is not necessarily a straightforward matter, because most families own or rent some land, and therefore do some farming, but may derive the major portion of their income from another trade. Information about visits to Kathmandu and Pokhara, and the location of previous homes was also difficult for some younger children to remember. During July 1997, I spoke with the parents of most of the children during the socio-economic survey, and I was able to repeat these questions, and check responses.

Use of a structured interview for this kind of research has definite limitations for the type and quality of data that can be collected. However, I feel it was a worthwhile approach to take initially, as I was able to amass a large amount of data on several topics and plan strategies for further data collection on specific points of interest. Many of the flaws in individual questions

were because this was my first contact with the children, during my first couple of weeks in Mustang. Some of the questions I had planned to ask turned out to be ridiculous, due to my ignorance. Other questions were problematic because my definition, i.e. 'foreign', did not always exactly match local definitions. Finally, there was the problem of image management; the Thakali in particular are anxious to give the best impression to outsiders, of whom I was definitely one at that stage.

This latter difficulty was to some extent compounded by using teachers as interpreters, at a time when my Nepali was very basic, and the motives of my research may not have been entirely clear. There was a tendency for the teacher to answer for children, especially younger and shyer children. More importantly, I sometimes thought that one teacher was pressing children into giving the answers he thought I wanted to hear, or mis-translating the answers they gave. Also the children themselves almost certainly lied on some points. They were clearly reluctant to admit to begging from tourists in front of the teachers, as this behaviour is frowned upon. A few children insisted their families owned TV or radio, but other children or teachers told me this was untrue.

Questioning all children in this way at the beginning of my research was very useful to gather the most basic facts: putting a name to each child, discovering age and date of birth, and identifying the number and order of their siblings. This was key information, which I used to calculate average number of children per family, and birth order for each child. As there were only a few surnames in each village and Nepalis use kinship terms (e.g. N: *didi*, older sister; N: *bahini*, younger sister) as polite greetings for non-relatives, untangling family relationships could sometimes be a laborious process.

In the final analysis, I did not make use of all of these data as quantitative statistics, but the children's answers essentially coloured my work from then on, giving me a picture of some key elements of lifestyle. I have incorporated some of the findings into chapter two, describing life in Mustang.

3.7. Study of typical children's diet

Previous researchers working in Nepal have produced very accurate and detailed observations of the amount and type of foods consumed by different ages and sexes (Gittelsohn, 1991; Strickland & Tuffrey, 1997)). Nutritional analyses of typical Nepali village diets are also available, showing probable deficiencies in energy and micronutrients at different seasons (Panter-Brick, 1997). Such detailed quantitative information was not the primary aim of this thesis; my interest in the diet of groups and individuals in Mustang was to provide an explanatory background to my observations of children's growth status. I aimed to describe the pattern of children's food intake, including seasonal variation, to allow me to deduce broad nutritional implications. Also, as this was by no means a homogeneous population, I wanted to consider variation in intake between the two villages, differences by sex and age, and how families of different caste, ethnicity and wealth fed their children.

To answer these questions, I concentrated very much on techniques of participant observation, watching and talking to children and adults. These were purely qualitative observations; I never attempted to weight, or even estimate, the amount of food consumed. I considered aspects such as the number of meals served each day, what foods were served, whether children were served as a priority, or last after adults had eaten, and whether children were given more food if they asked.

I also used the community food use survey (appendix 3) described by Weiner & Lourie (1981) as a starting point for discussions with a few adults. This is designed to be given to representatives of a community, as an interview or questionnaire, resulting in an account of the major foods used, by season and occasion. I did not systematically administer the interview to anyone; instead, I began by observing meals throughout the community, and informal conversations with adults and children. Once I had a clearer idea of what people ate, and when, I questioned several (approximately 6 to 8) key informants more systematically, and used the Weiner & Lourie survey as a reminder of some questions. This enabled me to check ambiguous points (sometimes a result of linguistic difficulties, sometimes of conflicting information), and to find out more about methods of food preparation. It also gave me interesting insights into a well-known problem of using informants- namely, that what people will tell you that they do may differ markedly from what they actually do! The fact that I observed more than fifty different families (of different *jat*) eating very many meals, as well as questioning a few individuals in greater detail, means that I have greater faith in the veracity of the information, as I could cross-check the two methods.

My description of the typical diet in Mustang, including methods of food preparation, and intra-population variation is given in chapter two. The approach used gave me sufficient information to fulfil my objectives, without being too time consuming or intrusive to participants. Many of my observations of meals were carried out as I made my 'rounds' of family homes for other purposes, such as interviews or sample collection. The family I lived with was also invaluable for teaching me about different methods of food preparation in the course of cooking our meals each day. This approach did not provide the precise quantitative data that can be obtained by recall or weighed observation methods. However, diet was not a primary focus of this study, and I required the information to give a context to biological data and perhaps to explain some results, rather than to analyse. The point I did try to study in detail was the nutritional variation between subdivisions of the Mustang population, including difference by caste, ethnicity and wealth. Weiner & Lourie (1981) mention this as an important aspect of any nutritional survey, which is often critically lacking, leading to over-simplification and inaccuracy of reported data.

3.8. Ethical concerns: informed consent, safety measures and dissemination of results

When I first arrived in Mustang, the purpose of my research and the procedures involved were explained to teachers and community leaders, and subsequently to anyone who asked, including many of the children's parents. There was a great deal of interest in, and support for, the idea of studying their children's health in any way. I was concerned that some people initially had unrealistic expectations of the outcome of my work, most often that they thought I would give their child medical treatment as a result of my investigations. I tried to always make as clear as possible the motivation for my research, my qualifications (that I was *not* medically trained), and the kind of results they could expect from my work. During the time I spent in Mustang, I frequently received requests for both medicines and diagnoses. I felt it was neither possible nor appropriate for me to meet these requests, beyond offering common sense advice and some very basic first aid treatment. I frequently advised patients to attend (and occasionally accompanied them to) the health post or hospital.

Whenever possible, I asked parents for permission before working with their child. However, I did not make this a prerequisite for including the child in the research, as it was difficult to track down parents. Also, many children were quite vociferous in offering their own consent. No child refused to participate in the study, and no parent refused permission for his or her child to take part in any component of the research. The only worries expressed were about blood sampling. Some adults asked about the 'cleanness' of the needles (presumably a response to HIV education), others were concerned that the blood sampling might frighten their children. I demonstrated blood collection on myself several times, to audiences of both adults and children, before I began working with any child. I emphasised safety and cleanliness factors (particularly the disposable lancets, and the impossibility of reusing a lancet), the very small amount of blood collected, and the minimal pain involved. A few of the younger children (four out of over a hundred and thirty) were frightened at the idea of blood sampling, so no blood was taken, although they participated in other elements of the research. The vast majority of children were happy to comply with all procedures, and seemed to enjoy the novelty of the situation, as well as my undivided attention.

I had planned to give a small cash reward to the parents of each child who participated, to compensate for the time taken for sampling and answering questions, and my intrusion into their homes. However, when I discussed this with my assistants, it proved difficult to settle on an appropriate sum, or even to decide if a financial reward was appropriate. There is such a range of wealth between families in Mustang that an amount such as Rs.100 (approximately £1) would

be a significant gain to poorer families, amounting to several days' earnings, but to the more wealthy families, it would be regarded as a joke or even seem patronising. In the end, I settled for rewarding each child with a sweet or piece of fruit after blood sampling, and presented each school with a cash donation of Rs.5000 (£50) to be used for scholarships for poorer children, plus some books, and sports and science equipment, which the teachers had requested.

Procedures for saliva and blood sampling complied with University of Durham Health and Safety guidelines, and were designed to ensure the safety of both researcher and participants. The study design and all protocols for sample collection were examined and approved by the University of Durham Research Ethics Committee.

Inevitably, I was not obtaining truly 'informed consent', due to communication difficulties that went far beyond the language barrier. I am not sure if anyone in either community really appreciated why I would undertake research purely for intellectual, rather than financial, reward. I explained what I intended to do with the data, and the samples I collected, in as much detail as I could. I am personally satisfied that I never carried out any procedure against the wishes of a child or their parents. I hope that nobody was left with any gross misunderstanding of what I was doing, or the type of feedback that I could give, and I believe this to be the case.

I have sent copies of my official reports and publications to both schools, and to the library in Marpha. Copies have also been sent to the Annapurna Conservation Area Project (ACAP), in Jomsom and Kathmandu, and to the Centre for Nepal and Asian Studies at Tribhuvan University. Teachers were interested in the anthropometric data, and I have sent them complete copies of all the measurements I collected over the year, for use in school, or to be given out to any parents who ask for their own child's measurements. I have also written (in English) to the four individuals who interpreted for me at different times, with a simple explanation of my major findings, and the request that they pass on this information to anyone who is interested.

CHAPTER FOUR : VARIATION IN CHILDREN'S GROWTH STATUS

4.1. Introduction: why measure children's growth status?

Growth monitoring has been used for several decades to provide a relatively simple and cheap, yet effective method of appraising a child's health and well-being, reflecting the outcome of nutrition, infections, and activity level on growth potential. In comparison to clinical and biochemical techniques, anthropometric measurements are quickly performed, can be evaluated under field conditions, and are non-invasive. However, the best interpretation of growth data, and in particular the significance of slow growth relative to the reference population, has been strongly debated.

Poor growth was once considered to be synonymous with malnutrition, but it has long been clear that other factors, particularly the incidence and severity of infectious disease, are equally as important as the quantity and quality of food consumed by a child. Seckler (1980) put forward the 'small but healthy' hypothesis. This suggests that slow growth may be an adaptive response for children where food is in short supply, and that stunting should be seen as normal for that environment, and may even be advantageous in reducing the likelihood of wasting, a more dangerous condition.

This argument is problematic, and has been widely criticised (Waterlow, 1985; Scrimshaw & Young, 1989) not least for its use of the evolutionary concept of adaptation, which implies progress. Waterlow suggests that accommodation is a more suitable term for stunting in response to food shortage, which may favour individual survival, but not without simultaneous significant loss of important function. Gopalan (1983) also condemns the idea, rephrasing the hypothesis as, "small is healthy for the poor". He states that, "to plead the virtues of 'smallness' is to acquiesce in the preservation of the status quo of poverty, ill health and under-nutrition, and socio-economic status"; acceptance also reduces the need for aid and political intervention from developed to developing countries. The key point of debate however, is on the costs and benefits of stunting. Martorell (1989) mentions two costs of smallness: small individuals have reduced physical work capacity (which may translate to reduced earning capacity in a cash labour situation), and small women are more likely to deliver small babies, with reduced chances of survival. There are also more obstetric problems, and higher mortality rates during birth for both

subsistence work in particular, individuals rarely work at maximum capacity, and it may be more energetically efficient to have a small body size. This can be demonstrated most clearly for tasks such as animal husbandry, where children are often used in preference to adults.

If we assume that slow growth and stunting are not adaptive, and should instead be considered an indicator of a sub-optimal childhood environment, it is clear that very many of Nepal's children are living in seriously adverse conditions. Adult Nepalis are short in stature, and studies of children's growth find extremely high prevalence of stunting, although little wasting. Nabarro et al (1988) report a mean height of 160 cm for adult men, and 148 cm for adult women in the rural Koshi Hills area of Nepal, with adults from poorer families tending to be shorter than adults from wealthier families. The 1975 Nepal Nutrition Status Survey (NNSS) reports on the growth status of a large sample of children aged 6 to 71 months throughout Nepal. 6.7% of children were classified as acutely undernourished (low weight-for-height), and 52% as chronically under-nourished (low height-for-age). Martorell et al. (1984) found that 65% of children were stunted, and 4% were wasted, in a sample of children aged 3 to 10 years from the Terai plains. They described this as, "among the highest extent of malnutrition... outside of extraordinary deprivations occurring during events such as wars and famines".

In contrast, studies of elite groups of children in Nepal and North India over several decades have shown that these children have similar anthropometric characteristics to British and American reference groups (Udani, 1963; Banik et al., 1972; Currimbhoy, 1963). The Nepal Nutrition Status Survey (1975) included a "special group" of privileged urban children in Kathmandu, chosen to represent the growth potential of reasonably well-nourished Nepali children. In this special group, only 1% of children were classified as acutely undernourished, and 18% as chronically undernourished. Farquharson (1976) prepared growth curves for a "well-to-do" group of Nepali children, who demonstrate a rate of growth far closer to that of western reference populations. Mean growth status for this privileged group fell between the 10th and 50th percentile of the British data, whilst the mean for the entire Nepali sample fell well below the British 10th percentile.

4.2. Results

4.2.1 *Statistical considerations*

The procedure and rationale for converting height and weight data into age and sex adjusted z-scores of the NCHS reference population are detailed in section 3.3.

Where one-way analysis of variance determined that differences existed between means, Tukey's honestly significant difference (HSD) test was used as to make Post Hoc pairwise multiple comparisons.

T-tests, analyses of variance methods, and Tukey's HSD test all assume that samples are drawn at random from a normally distributed population, although both methods are robust to slight departures from normality. Histograms of z-scores were plotted, and the distributions appeared normal. This was further checked by producing normal P-P plots, which verified the assumption of normality. There is also an assumption that the samples have equal variances. Either Levene's test for equality of variances (where there were two samples), or Levene's test for homogeneity of variances (where there were three or more samples), was performed to test that there was no statistically significant difference between the variances for the groups; this assumption was found to be valid in all cases. Thus, the basic assumptions underlying t-tests and analyses of variance are valid and these methods are appropriate for use on these data.

4.2.2. Description of children's growth status

All statistics and figures in this section are based on data from 434 measurements of height and weight made on 125 children aged 5 to 12 years, on four occasions over the period of one year. Z-scores of height-for-age, weight-for-age and weight-for-height were calculated for all children at each season, and children's growth status was categorised using Waterlow et al.'s 1977 classification (details in section 3.3). Arm circumference and skinfold thickness at four sites were also measured, and these data are presented in appendix 5. Table 4.1 shows the median, mean, standard deviation and range of values of height-for-age, weight-for-height and weight-for-age z-scores.

Table 4.1 Median, mean, standard deviation and range of z-scores based on NCHS growth curve for 125 children aged five to twelve years

	median	mean	SD	range
HAz	-1.46	-1.52	1.02	-4.59 to 1.17
WHz	-0.75	-0.77	0.66	-3.09 to 1.12
WAz	-1.55	-1.53	0.78	-3.48 to 0.92

On average, the children in the sample are only mildly stunted and underweight for age, with weight for height within adequate limits. However, the range of values is extremely wide for all measures, with many children showing significant growth retardation, particularly of linear growth. Table 4.2. shows the percentage of children classified as moderately and severely growth retarded (z- scores less than -2, or -3, respectively).

Table 4.2 Percentage of sample children (n=125) with moderate or severe growth deficit

	percentage of children moderately growth retarded ($-3 < z < -2$)	percentage of children severely growth retarded ($z < -3$)
height-for-age	20.4	9.4
weight-for-height	3.0	0.2
weight-for-age	24.1	2.3

4.2.3. General linear model testing the impact of seasonality and socio-economic factors on variation in growth status

A single statistical model was needed to simultaneously test the impact of several factors on variation in growth status and to investigate interactions between these factors. The SPSS general linear model (GLM) procedure was used to provide repeated measures analysis of variance. Season was entered as a within subject or repeated measures factor (4 levels). Village (2 levels), sex (2 levels) and *jat* (3 levels) were entered as between subjects factors. Age was entered in the model as a varying covariate (4 levels). The data were for the 85 children who were measured at all four time periods. This model was applied three times with HAZ, WAZ, and WHz entered as dependent variables in turn; the results are given in table 4.3.

For HAZ, season was significant as a repeated measures factor; age was not significant as a covariate; village, *jat* and sex were not significant as between-subjects factors. There was a significant interaction between village and season. For WHz, season, age, village and *jat* were significant variables; sex was not significant. There was a significant interaction between village and season. For WAZ, season and village were significant variables; age, *jat* and sex were not significant. There were significant interactions between village and season, and between sex and season.

Table 4.3 Results of repeated measures GLM model (85 children)

dependent variable	age	village	fat	sex	season	interactions
type of factor	covariate	between subjects	between subjects	between subjects	within subjects (rep. measures)	
number of levels	4	2	3	2	4	
HAz	df=1, f=0.28, ns	df=1, f=1.99, ns	df=2, f=0.35, ns	df=1, f=2.07, ns	df=3, f=2.83, p=0.039	village by season, df=3, f=6.37, p<0.001
WHz	df=1, f=9.30, p=0.003	df=1, f=9.51, p=0.003	df=2, f=5.84, p=0.004	df=1, f=0.38, ns	df=3, f=7.67, p<0.001	village by season, df=3, f=2.92, p=0.035
WAZ	df=1, f=3.01, ns	df=1, f=6.58, p=0.012	df=2, f=2.19, ns	df=1, f=1.84, ns	df=3, f=5.61, p=0.001	village by season, df=3, f=3.22, p=0.023; sex by season, df=3, f=3.00, p=0.031

4.2.4. Seasonality

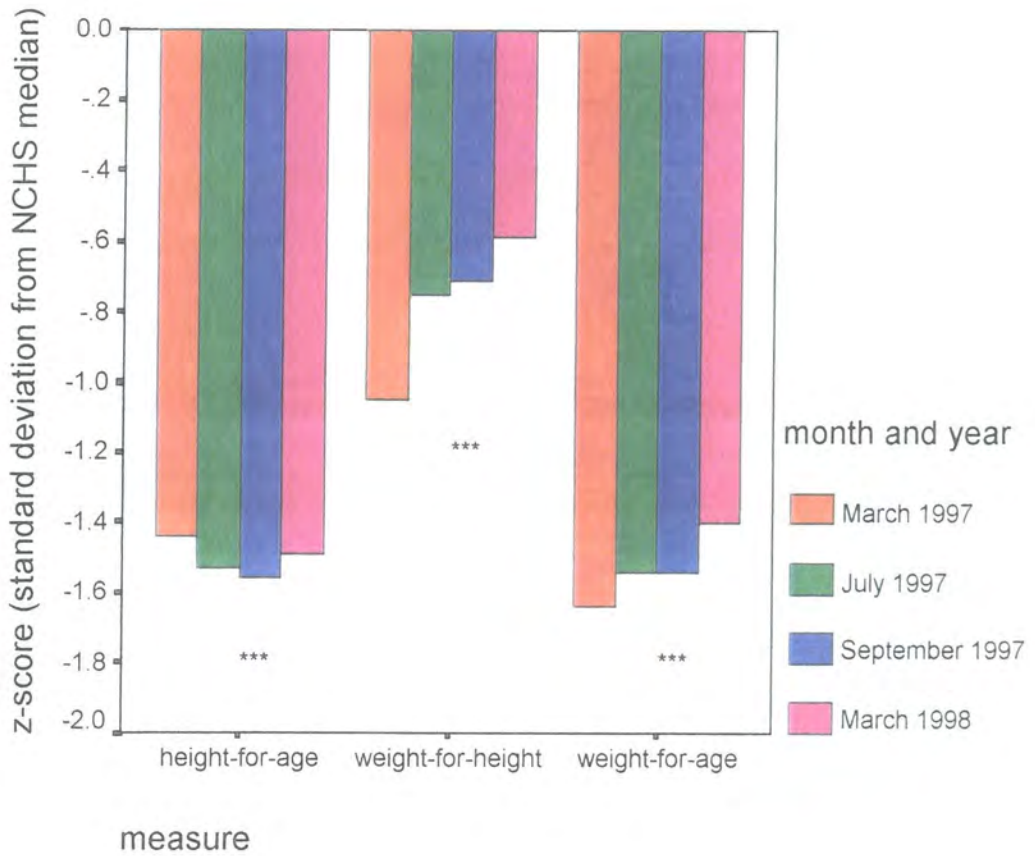
All results reported in this section are for only the 85 children who were measured at all four rounds of measurement, in March, July and September 1997, and March 1998. Figure 4.1. illustrates seasonal variation in growth status. For each measure, season had a highly significant impact on z-scores ($p < 0.001$). Tukey's HSD Post Hoc test was used to test for differences between means for each pair of seasons; results are reported below.

Mean height-for-age z-score varies from -1.44 in March 1997 to -1.56 in September 1997. At all seasons, children show mild stunting (HAz between -1 and -2) in comparison to the reference population. There were significant differences between pairs of means for March and July 1997 ($p < 0.001$), March and September 1997 ($p < 0.001$), and September 1997 and March 1998 ($p = 0.008$); differences between other pairs of seasons were not significantly different.

Mean weight-for-height z-score is lowest at -1.05 in March 1997, and increases at each season to a peak of -0.59 in March 1998. Children were mildly wasted (WHz between -1 and -2) in comparison to the reference population during March 1997, but within the adequately nourished category (WHz greater than -1) at all other seasons. Significant differences existed between mean WHz scores for all pairs of seasons except July and September 1997 ($p < 0.002$ in all cases).

Mean weight-for-age z-scores are also at their lowest in March 1997 at -1.64, increasing through July and September 1997 to -1.40 in March 1998. At all seasons, children are on average mildly underweight for their age compared to the reference population (WAZ between -1 and -2). There were significant differences between mean WAZ scores for all pairs of seasons except July and September 1997 ($p < 0.001$ in all cases).

Figure 4.1 Variation in growth status by season (n=85)



Significance of season in one-way analysis of variance: *** $p < 0.001$

4.2.5. Variation with age

Children's age ranged from 5 to 11 years during March 1997. Results in this section and the remainder of this chapter are based only on March 1997 measurements to avoid the problems of repeated measurements from each child. The GLM analysis of variance model showed that age was associated with significant variation in weight-for-height, but not with other measures. Table 4.4 gives the mean and standard deviation of height-for-age, weight-for-height and weight-for-age z-scores for children aged 5 to 7, 8 to 9, and 10 to 11 years. All three measures improve through the three age groups.

Table 4.4 Variation in growth status by age group, March 1997

age	sample size	HAz ^{n.s.}		WHz ^{**}		WAz [*]	
(years)	(n)	mean	SD	mean	SD	mean	SD
5-7.99	33	-1.56	1.03	-1.36	0.66	-1.90	0.79
8-9.99	38	-1.53	0.96	-0.96	0.69	-1.64	0.73
10-11.99	26	-1.22	1.01	-0.83	0.50	-1.38	0.76

Significance of age difference in one-way ANOVA:

n.s. df=97, F=1.023, not significant;

** df=97, F=5.838, p=0.004;

* df=97, F=3.516, p=0.034

4.2.6. Village differences

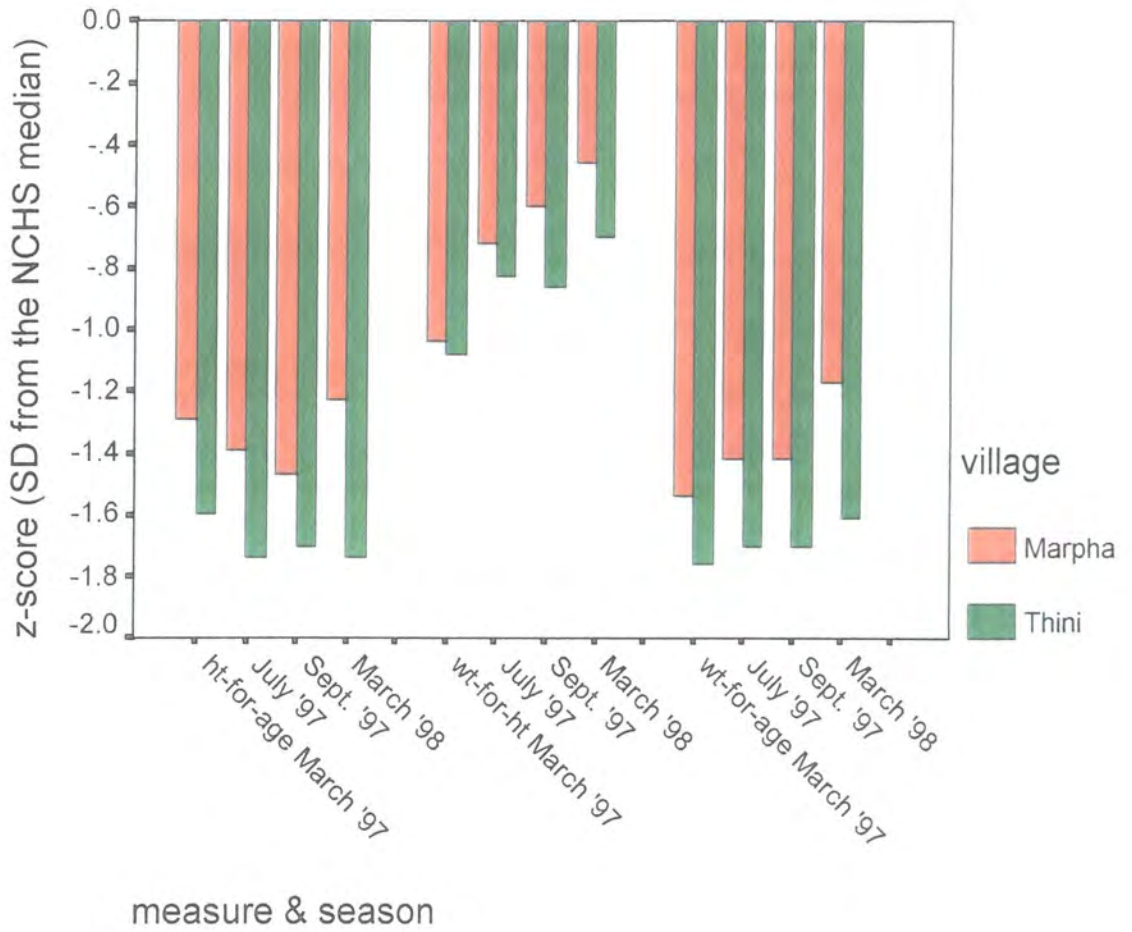
In the GLM analysis of variance model, village was associated with significant variation in weight-for-height, and weight-for-age, but not with height-for-age; there was also a significant interaction between village and season for all measures. Means and standard deviations of anthropometric measurements for children from each village during March 1997 are shown in table 4.5. There was no significant difference between village means for any measure. Figure 4.2 shows means of anthropometric measurements by village and season, to illustrate the interaction between the two variables

Table 4.5 Variation in growth status between Marpha and Thini children, March 1997

	Marpha (n=47)		Thini (n=50)	
	mean	SD	mean	SD
height-for-age	-1.29	0.99	-1.60	0.99
weight-for-height	-1.04	0.70	-1.08	0.64
weight-for-age	-1.54	0.77	-1.76	0.78

no significant difference between Marpha and Thini children in independent samples t-tests

Figure 4.2 Variation in growth status by village and season



4.2.7. *Jat* differences

The GLM analysis of variance model showed that *jat* was significantly associated with variation in weight-for-height, but not other measures. A comparison of the data for children from each *jat* is given here for Marpha children only, as almost all of the Thini children were Tibeto-Burman. Children belonged to seven different *jati*, but because the relatively small sample size meant that numbers of children from some *jati* were extremely low, they were divided into three groups. Researchers commonly classify Nepal's many ethnic groups in this way for analysis purposes. The 51 children whose results are reported below consisted of: 20 Tibeto-Burman children (Thakali, Gurung and Magar), 24 Indo-Aryan low caste children (Kami and Damai) and 7 Indo-Aryan high caste children (Brahmin and Chettri). The number of high caste children is very low, as few high caste families stayed in Mustang all year round. Means and standard deviations of anthropometric measurements for the three groups are shown in table 4.6; the means for each *jat* are illustrated in figure 4.3.

Table 4.6 Variation in growth status by *jat* for 51 Marpha children, March 1997

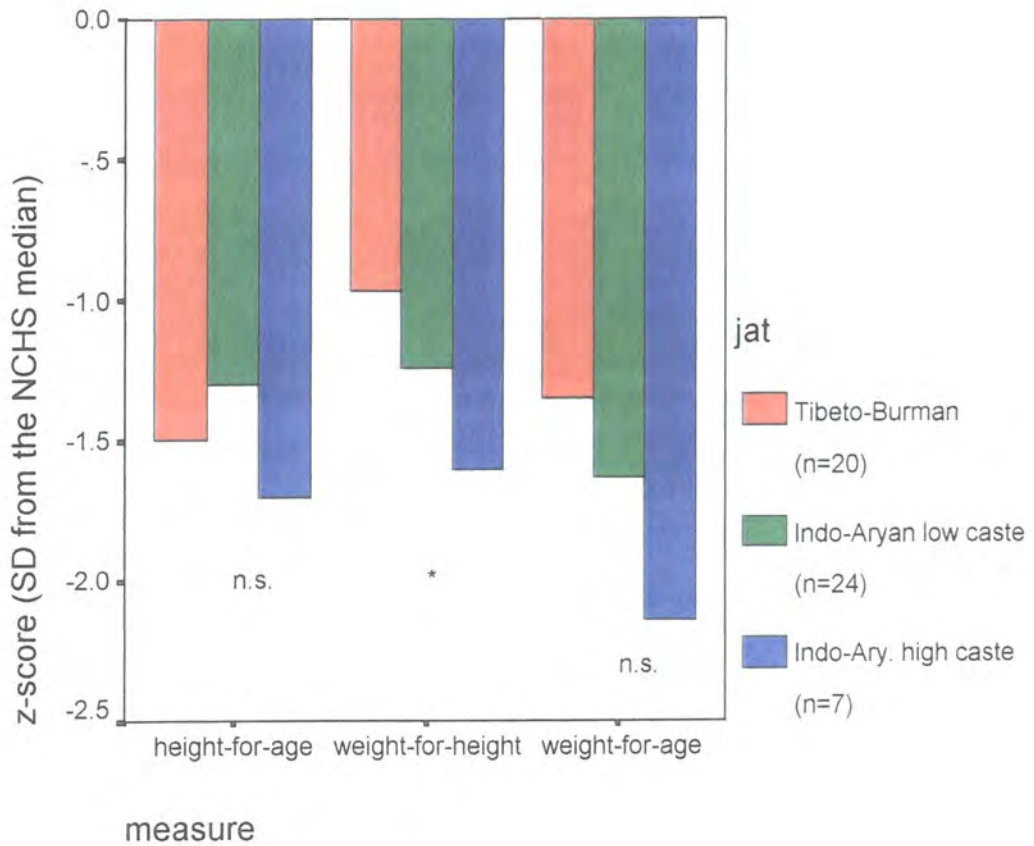
	Tibeto-Burm. (n=20)		low caste (n=24)		high caste (n=7)	
	mean	SD	mean	SD	mean	SD
height-for-age n.s.	-1.29	1.09	-1.24	0.95	-1.70	0.88
weight-for-height *	-0.74	0.54	-1.22	0.76	-1.60	0.25
weight-for-age n.s.	-1.35	0.78	-1.63	0.76	-2.13	0.58

* difference between three *jati* significant at $p=0.024$ in one-way ANOVA, difference between T-B and low caste only significant at $p=0.023$ in Tukey's HSD Post Hoc test

n.s. not significant

Tibeto-Burman children have greater weight-for-height than low caste children who have greater weight-for-height than high caste children; this difference is significant ($p=0.024$). Tukey's HSD test was used to make Post Hoc pairwise comparisons; the difference between Tibeto-Burman and low caste children only is also significant ($p=0.023$). Weight-for-age scores follow the same pattern of variation but *jat* differences are not significant. Tibeto-Burman and low caste children have similar mean height-for-age scores, the high caste mean is lower; again, this variation is not significant.

Figure 4.3 Variation in growth status by *jat*, March 1997



Significance of *jat* difference in one-way ANOVA: * $p=0.024$; n.s. no significant difference

4.2.8. Variation with sex

Means and standard deviations of anthropometric measurements for males and females in March 1997 are shown in table 4.7. Mean of height-for-age, weight-for-age and weight-for-height z-scores are all slightly greater for females than for males. Sex was not associated with significant variation in growth status in the GLM analysis of variance model, but these small sex differences might be significant in a larger sample.

Table 4.7 Variation in growth status by sex, March 1997

	male (n=51)		female (n=47)	
	mean	SD	mean	SD
height-for-age	-1.58	0.95	-1.31	1.05
weight-for-height	-1.13	0.69	-0.99	0.64
weight-for-age	-1.77	0.74	-1.53	0.81

Results of independent samples t-tests: no significant difference between males and females for any measure.

4.3. Discussion

4.3.1. Growth status of children in this sample, and a comparison with the findings from other studies in Nepal

A large proportion of children in the current sample are suffering from chronic growth failure, or stunting; however, few are wasted, indicating current acute problems. 20.4% of measurements over the four rounds showed children were moderately stunted, and 9.4% were severely stunted. The prevalence of wasting is much lower, with 3.0% of children moderately wasted, and 0.2% severely wasted⁴. The mean z-scores for the children in this study indicate mild stunting, but adequate weight-for-height. This pattern, of a high prevalence of moderate to severe stunting, but comparatively few cases of wasting, is repeatedly found in studies of Nepali children.

The rates of wasting for Marpha and Thini children are in line with those found in other studies of rural Nepali children. The linear growth status of the Mustang children is intermediate between the western reference population, and the findings of many other Nepal studies. This probably reflects the fact that at least some of the Mustang population form a privileged group in comparison to most rural Nepalis. The Thakali villagers of Marpha are certainly relatively affluent in a Nepali context, indeed some are wealthy even by western standards. There is, of course, great variation in prosperity between families in both villages, but no families appeared to go hungry, although some were certainly malnourished. By this, I mean that whilst some poorer families were unable to obtain a diet of sufficient quality, uncontaminated, palatable and adequate in all nutrients, they were able to supply children with a sufficient quantity of food. Land in Mustang is scarce, arid, and vulnerable to erosion, but can potentially be made very productive through careful terracing and irrigation, as water is plentiful because of extensive run-off from the Himalaya. The tourist industry generates significant cash income in Marpha, which although largely restricted to families owning businesses, is distributed to some extent through several mechanisms. The differences in wealth within Mustang, between *jati*, and between villages, warrant the closer analysis of children's growth status to determine which factors are associated with variation in growth status.

⁴ To make the relationship between these figures and the reference population clearer, a brief explanation of the properties of the normal distribution is useful. For a large population, such as the NCHS reference, the distribution of z-scores is very close to the normal distribution. Thus, by definition, approximately 50% of children in the reference population have z-scores between +1 and -1, 95% between +2 and -2 and 99.7% between +3 and -3. As a perfect normal curve is symmetrical about the median, 25% of children thus have growth status below -1z, only 2.5% of children have growth status falling below -2z, and far less than 1% below -3z.

4.3.2. Association of age with variation in growth status

Children were divided into three age groups, five to seven year olds, eight and nine year olds, and ten and eleven year olds. Mean weight-for-age, weight-for-height and height-for-age z-scores increased through the three age groups, and age was associated with significant variation in weight-for-height in an ANOVA model. This may be because older children in Mustang generally suffer less from infectious disease, so are likely to be better nourished relative to the reference population than younger children. Waterlow et al. (1977) stated that weight-for-height is “nearly independent of age between 1.0 and 10.0 years”. Other investigators do not necessarily find this to be the case, and there may be a tendency for older children to have greater weight for a given height.

There is evidence from several authors that stunting increases with age in Nepali children⁵, with increasing numbers of children defined as stunted in older age groups, suggesting that “stunted children remain permanently retarded in linear growth, and with each year more children become stunted” (NNSS, 1975). Huijbers et al. (1996), in their study of children in eastern Nepal, showed that infants started off close to the median of the reference population, and scores then declined, before stabilising at the end of the second year. Moffat (1998), working with children under five years in ‘peri-urban’ Kathmandu, found the lowest mean height-for-age and greatest prevalence of growth stunting in three and four year olds. The Mustang children in the present sample are older, and they did not show evidence of stunting increasing with age. In fact, mean height for age was greatest in children aged over ten years, suggesting that children may begin to ‘catch up’ in height relative to the reference population.

4.3.3. Seasonal differences

The climate of Mustang differs from most of Nepal in that there is no summer monsoon (see section 2.2.1). Summer is still the wettest time of year, but most days are dry, and rainfall is relatively light when it does occur. Cereal harvests occur in June and October, and planting in

⁵ Height-for-age, weight-for-height and weight-for-age z-scores already incorporate a correction for age and sex differences for the NCHS (or other reference) population. If an age or sex difference is found for the population being studied, this indicates variation beyond what would be expected from the reference population. Age differences may be explained either in terms of genetically different growth rates for different populations, or in terms of children of different ages suffering greater environmental challenge. Sex differences may be explained either in terms of genetically different growth rates, or possibly socially, with some researchers inferring selective neglect, in particular of female children.

July and November, but without the extremely intense labour demands placed by rice cultivation. At lower altitudes in Nepal, temperatures are generally higher, and there is much greater rainfall, particularly during the summer monsoon. This heat and humidity brings a greater risk of infection, particularly gastrointestinal and skin diseases. A variety of cereal crops may be grown, but in the Terai and many hill areas, rice is the most important crop, and places extremely high demands for labour during the summer months. This is also a time when food may be running short as most crops are harvested between September and December. Although both physical work and gastrointestinal infections do increase slightly during the summer in Mustang, local people consider the winter to be the difficult season. Winter can be extremely cold in Mustang, with several feet of snow cutting off villages for days or weeks at a time.

The short time scale of the present study makes drawing definite conclusions about seasonality of growth an impossibility. Significant differences exist between the four sets of measurements performed at different seasons ($p < 0.001$ for all measures), but it is not clear whether these differences are genuinely caused by an annually cycling pattern of seasonality, inter-annual climatic variation, or some other factor. Rates of stunting are highest during the summer months, and lower during spring each year. Weight-for-height and weight-for age both improve steadily over the course of the study, with children most severely retarded compared to the reference population in March 1997, and values increasing over the four seasons to a peak in March 1998.

I spent March and April of both 1997 and 1998 in Mustang; the weather differed noticeably between the two years, and local accounts of the preceding winter differed too. Winter 1996/7 was reported as mild, with no snow, but February and March were then colder and considerably wetter than usual. In contrast, winter 1997/8 was more severe, with several feet of snow falling in December, and lying for four weeks in low temperatures; the weather from the end of March was then warm and sunny. Local people described the second year's pattern as typical of their weather, and spoke of the warm spring as important for the success of crops. Food production and also disease exposure may vary during a single year, and also between years, depending on climatic variation. Both factors may affect children's food intake and energy expenditure, and thus their growth status. To confirm that seasonal climatic changes are associated with seasonal variation in growth status for children in Mustang would certainly require several years of repeated measurements. Even then, the combination of intra- and inter-annual factors may make the meaningful interpretation of longitudinal data difficult, and of cross-sectional data almost impossible.

Several other studies in Nepal have found evidence of seasonal differences in growth status in children, and weight loss and gain in adults. Costello (1989) measured children aged up to six

years from the middle hills of western Nepal. In August, 54% were stunted, and 3.1% wasted; in February, 51% were stunted and 1.9% wasted. Panter-Brick (1997) found the prevalence of stunting was greatest in February, whilst wasting was most prevalent in August, for children aged less than four years in a hill village in central Nepal. The children in her study gained most weight during the winter months, December to February; weight gain faltered during the summer monsoon months. This coincided with peak energy intake from newly harvested cereal crops. In comparison to these findings, Mustang children's height-for-age is lowest in the summer months (July and September), and there is no obvious seasonal pattern to weight-for-height scores, which increase incrementally over the four visits.

4.3.4. Village differences

It is instructive to compare results of this study with the findings of the previous study in the Kali Gandaki valley by Bennett & Panter-Brick (1996). They reported anthropometric measurements for children from seven tourist and non-tourist villages, including Marpha and Thini. Their measurements were taken during July and August, and are similar to the results I obtained in July 1997 (see table 4.8).

Table 4.8 Comparison of the percentage of stunted and underweight children in tourist and non-tourist villages in Mustang in two studies

	percentage of stunted children (HAz<-2)		percentage of underweight children (WAZ<-2)	
	tourist villages	non-tourist villages	tourist villages	non-tourist villages
Bennett & Panter-Brick (1996) ¹	30	44	16	20
Parkin (present study) ²	23	37	20	29

¹ measurements from 116 children aged 9 to 12 years from seven tourist and non-tourist villages in Mustang during July and August

² measurements from 125 children aged 5 to 12 years from Marpha (TV) and Thini (NTV) during July 1997

Villages on and off the tourist trail vary markedly in *jati* distribution with many off-trail villages almost homogeneously Thakali, and larger tourist centres having a much more mixed population. Bennett & Panter-Brick (1996) did not incorporate children's caste or ethnicity in their analysis, and I anticipated that differences between *jati* would account for some of the

observed difference in growth status between tourist and non-tourist villages. However, in my study, village was associated with significant differences in weight-for-height, and weight-for-age, even when *jat* was included in the statistical model. There was also a significant interaction of village and season for all anthropometric measures. Marpha children's weight-for-height and weight-for-age z-scores improve through the four seasons, and their height-for-age declines from March through July and September 1997, and then increase again in March 1998. Thini children's weight-for-height and weight-for-age scores also improve over the course of a year, albeit more slowly (figure 4.2). However, in contrast to the Marpha children, their height-for-age scores continue to decline. The gap between the children from the two villages widens until March 1998, when the difference is most marked for all measures. The preceding winter had been particularly long and cold in Mustang, and this may be the reason for the increased village difference. Whereas the wealthier villagers in Marpha were able to buffer the harsh climatic effects by buying in extra supplies of food and fuel, families without a reliable source of cash income would have to simply wait and endure.

4.3.5. Jat: ethnicity and socio-economic status

Previous studies of children's growth in Nepal have considered the effects of both ethnicity and socio-economic status on children's growth, either independently or together, depending on the *jat* composition of the sample studied. There is often a problem of interpretation when comparing children of different ethnic groups in Nepal, as different *jati* tend to be associated with a particular socio-economic niche, at least within a single area. Thus, as well as genetic differences between endogamous ethnic groups, there are frequently consistent differences in household wealth, and in cultural practices, such as food habits. In Mustang, *jat* and socio-economic status are strongly associated, although there are, of course, exceptions to the general pattern. The wealthiest families in each village are always Thakali, and although there is a great deal of disparity of wealth between Thakali families, no Thakali family is ever destitute. All Thakali households own a house and some land to grow food; many Marpha Thakali also run hotels or other businesses. Brahmin and Chettri households living in Mustang are usually there temporarily whilst the male head of household fills some government post. These posts are adequately, if not generously, paid - particularly as Mustang is designated a 'hardship posting' and attracts higher than normal salaries. The poorest families in each village are low caste Kami and Damai, who are usually recent immigrants with little or no land to grow food. They survive by their traditional artisanal occupations, or through agricultural or domestic labouring for Thakalis (see chapter 2).

Tibeto-Burman children in the Mustang sample have significantly greater weight-for-height than

low caste Indo-Aryan children ($p=0.024$, table 4.6). This could be explained either as a result of genetic differences between the two groups affecting height, or in terms of socio-economic differences. As both factors are undoubtedly at work, it seems inappropriate to emphasise one over the other. Unfortunately, growth data were only available for a handful of high caste Indo-Aryan children, so statistical comparison between Indo-Aryan castes is impossible. Data for these few children are reported in table 4.6, and the means for this group show them to be much shorter, lighter and thinner for their age than both the Tibeto-Burman and low caste group means. This was unexpected as high caste families in Mustang were economically better off than almost all low caste families, and some Thakali.

Nabarro et al. (1988) comment on the different physical appearance of Tibeto-Burman and Indo-Aryan people, and state, "there are clear genetic influences on the final height and physical shape of Nepali adults". Indo-Aryans tend to be slimmer and Tibeto-Burmans stockier in build. However, it is not clear to what extent genetic factors affect childhood growth rate and tempo. This is still widely debated, but some consensus seems to be emerging that children of "Asiatic" origin (i.e. Tibeto-Burman, but not Indo-Aryan) *may* be genuinely shorter than other children, purely as a result of genetic rather than environmental differences (Davies, 1988; Ulijaszek, 1994). Not all researchers in the field of child growth and nutrition agree with this view. The Nepal Nutrition Status Survey (1975) showed that the linear growth of privileged Nepali children (mostly of Indo-Aryan high caste) aged less than five years was intermediate between that of Western children, and of the Nepal sample as a whole. It is probable that genetic factors become more crucial in determining growth patterns of children under harsh environmental conditions of poor nutrition and high rate of infection.

A survey of children under 5 years in the Terai showed that Tibeto-Burman children had a higher rate of stunting than Indo-Aryan children (Black, 1979). The KHARDEP baseline study of children under 8 years in Eastern Nepal, found similar prevalence rates of stunting in Tibeto-Burman and Indo-Aryan children (Thompson, 1979). Panter-Brick (1997) found no effect of ethnicity on growth status in her sample of Tamang and Kami children under four years from a village in central Nepal. However, Panter-Brick et al. (1996) did find significant ethnic differences for a large sample of 10-14 year old Nepali boys, with Tibeto-Burman boys shorter and stockier than Indo-Aryans.

Unsurprisingly, many surveys show an association of household socio-economic status with children's growth status. The 1979 Nepal Baglung Nutrition Survey of children aged under six years (Howard, 1984, cited by Nabarro et al., 1988) showed that stunting was more prevalent in children from poorer households. The number of months of the year for which the household was sufficient in food was a highly significant predictor of height-for-age, after accounting for

the effects of age, sex, caste and number of children in the family. The detrimental effects of household poverty on children's growth may be exacerbated by seasonal food shortage, and catastrophes such as harvest failure. Wealthier families are able to provide an economic 'buffer' to cushion the impact of seasonal fluctuation and natural disasters.

Martorell et al. (1984) showed that high caste children had significantly better growth status than low caste children in a sample of three to ten year olds from the Terai. However, several socio-economic indicators were strongly associated with caste, and if these were included in a statistical model, caste was no longer significant. Value of crops produced, and land area cultivated by the household were the most significant predictors of children's growth status. The KHARDEP baseline survey of children under eight years in Eastern Nepal found stunting was more prevalent in children from poorer households (Thompson, 1979). Land area was another significant predicative variable for stunting. Children from households cultivating less than half a hectare of land were more likely to be severely stunted than children from households cultivating more than a hectare of land. As the rate of stunting varied with both age and household wealth, Nabarro et al. (1988) suggest that catch-up linear growth may occur in children from wealthier households.

In Mustang, high caste families tend to be wealthier than low caste families, but this is not always the case elsewhere. However, the data suggest that high caste children may have worse nutritional status; this may be due to changes in diet. The Brahmin families in the study were vegetarian immigrants from the Terai, who were used to consuming dairy products. The change of climate, and limited availability of milk and yoghurt may have had an adverse effect on children's health. Huijbers et al. (1996:142) found that in Eastern Nepal, "surprisingly, offspring in high caste households have a diminished nutritional status compared to offspring in lower caste households". High caste was associated with greater parental education and larger land holdings, so the finding of worse growth status in high caste children was contrary to expectation. The only tentative explanation offered was that "interactions between caste, socio-economic factors and different customs on the treatment of sick children" might be responsible

4.3.6. Sex differences

Female children in South Asia are frequently assumed to be discriminated against in terms of household food allocation and access to medical care. However, studies that have examined possible sex differences (see footnote 5) in the growth status of Nepali children report conflicting conclusions. Martorell et al. (1984) found no differences between the growth status of boys and girls in a sample of Hindu children aged 3 to 10 years from the Terai plains.

Huijbers et al. (1996) found no sex difference in the growth status of children less than 14 years in Eastern Nepal. Black (1979) showed that 37% of girls under 5 years in the Terai plains were severely stunted, compared to 25% of boys. A longitudinal study of children under six years in Eastern Nepal showed that from the age of three months, female children were shorter, relative to the reference population, than males of the same age (Nabarro et al., 1988). Gittelsohn (1991) studied intra-household food allocation in rural hill villages in Western Nepal by analysing detailed structured observations of meals. He found no differences in food distribution or estimated nutrient intake between male and female children.

These conflicting results may relate in part to the social and religious characteristics of the particular community studied. Sex discrimination is considered by ethnographers to be more common amongst some Hindu castes, whilst Buddhist Tibeto-Burman groups are usually more socially egalitarian (although Levine, 1979, reports selective neglect, and possibly even female infanticide for a Buddhist group in far Western Nepal). There is a dearth of studies combining ethnographic observation with anthropometric evidence to support either view.

I did not note any sex-selective feeding behaviour in either Hindu or Buddhist households in Mustang. Nor did the answers given by mothers during conversations about childcare and feeding lead me to suspect any sex bias in health care. Thakali families are noticeably egalitarian with even young women enjoying a particularly high status, probably due to their frequent involvement in tourist shops and hotels. In Hindu households, male and female children there was a greater tendency to treat the sexes differently, with boys tending to receive any infrequently available perks, such as newer clothes and toys (but not food items). It was also more common for girls from low caste households to be kept out of school, or removed from school after only one or two classes. Boys and girls show different patterns of work and play (see section 2.6.3), with girls often expected to help more with household chores such as fetching water. However, as boys definitely tended to be more physically active during play, I had no reason to think that either sex was expending substantially more energy in physical activity.

As discussed previously, most families in Mustang are not desperately poor, and do not find themselves in a marginal economic situation. This may be why no difference in feeding behaviour was observed, and no significant difference in growth status was found. It may be that sexual discrimination is much rarer in Nepal than was once thought, and that the effects are only seen in communities living in desperate situations of both food and cash shortage. A more complex explanation may be that the cost of dowry leads to discrimination, but only against later born girls in families with several children. Another possible explanation is that the Thakali who dominate life in Mustang socially and economically, have also come to dominate the area



culturally, and other groups have adopted their tradition of sexual egalitarianism.

Although there is no statistically significant difference, it is apparent from studying the data that there is a tendency for girls to have better growth status than boys. This may of course be considered a chance effect in a relatively small sample. However, the direction of variation is consistent for every comparison, with girls always tending to have better scores than boys for all anthropometric measures. A possible explanation is that some of the older girls in the sample were beginning a pubertal growth spurt, whilst the boys had not yet reached this stage.

4.3.7. The effect of altitude on linear growth in children

The altitude of Mustang, at around 2700 metres is higher than most hills villages in Nepal, but permanent human habitations exist in the mountain regions at heights up to 4000 metres. There is some evidence, mostly from South America, to suggest that hypoxia at high altitudes may cause a moderate reduction in linear growth in children. However, studies carried out in Nepal have tended not to find evidence of this effect, and some even show that highland peasant children have slightly better growth status than their lowland counterparts (Pawson, 1977; Gupta & Basu, 1981). Huijbers et al. (1996), in a study of children under 14 years in Eastern Nepal (altitude 1700 to 3000 metres), showed that high altitude was associated with better nutritional status. It is suggested that this may be due to a lower prevalence of parasitic infections, including malaria, at higher altitudes. The 1975 Nepal Nutrition Status Survey showed that stunting prevalence varied with terrain and geographical area. 55% of children living in the hills were stunted, compared to 45% of children in the lowland Terai. However, there are other differences between the hills and Terai as well as altitude. The land in the Terai plains is flat, fertile and easy to cultivate, whilst land in the hills is scarce, steep and less productive.

It is difficult to know from the evidence whether hypoxia genuinely has a growth retarding effect, and whether this effect may be offset by a reduction in infections at higher altitudes. The arid climate and low temperature in Mustang, compared with the hills and plains of Nepal, certainly seems to reduce the occurrence of gastrointestinal infections, and skin diseases. Both observations and anecdotal evidence suggest a high rate of infectious and non-infectious respiratory tract disorders, aggravated by the dry, dusty atmosphere. The difference in altitude within the area covered by Marpha and Thini is negligible, amounting to no more than 100 metres between the highest and lowest points.

CHAPTER FIVE : MORBIDITY AND PLASMA PROTEIN LEVELS

5.1. Results

5.1.1. Descriptive statistics of plasma marker values

Bloodspots were collected from Marpha and Thini children in March 1997, September 1997 and March 1998. The samples from all three periods were assayed for levels of albumin and ACT; IgG assays were also performed on the September 1997 and March 1998 samples. Table 5.1 below gives the number of children, the range of values, and the median, mean and SD, for each measure at each season. Kolmogorov-Smirnov test was performed on each variable, to test for deviations from normality. All values given in this chapter are plasma equivalent values obtained by converting the blood spot values obtained (see section 3.4.4)

Figure 5.1 shows the distribution of ACT values in March 1997, September 1997 and March 1998. There are little differences between minimum, mean and median values between periods. The maximum value does vary, mostly due to single outlying values of 0.50 g/l in March 1997 and 0.81 g/l in September 1997. Both these values were associated with children reporting sick: with respiratory infection and fever, and diarrhoea and fever, respectively. The distribution of ACT was found to deviate significantly from normality in March 1997 and September 1997, but not in March 1998.

Figure 5.2 shows the distribution of albumin values in March 1997, September 1997 and March 1998. There is little variation in the minimum, maximum, mean and median values between the three time periods. The distribution of albumin differed significantly from normality in March 1997, but not in subsequent rounds.

Figure 5.3 shows the distribution of IgG values in September 1997 and March 1998. There is little difference between mean and median values. Values for IgG are approximately 40% higher overall for March 1998 than for September 1997, with a wider range and greater SD. The distribution of IgG differed significantly from normality in September 1997, but not in March 1998.

Table 5.1 N, range, median, mean and SD for plasma markers measured during three rounds of samples on Marpha and Thini children

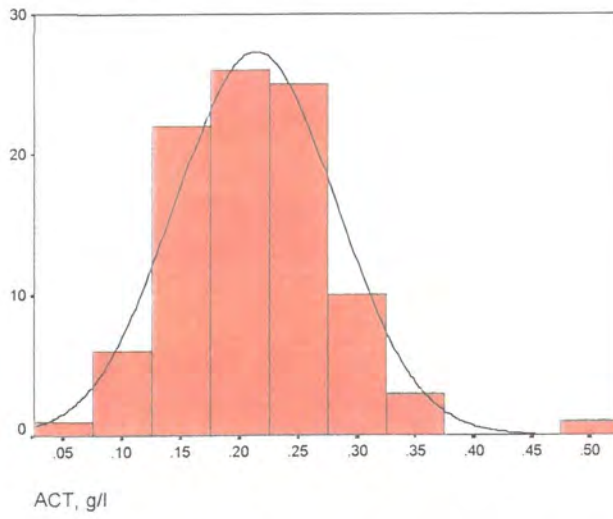
measure	month and year	N, number of children	range	median	mean	SD
ACT (g/l)	March 1997 ***	94	0.07-0.50	0.210	0.213	0.068
	September 1997 *	113	0.07-0.81	0.220	0.239	0.111
	March 1998 n.s.	85	0.05-0.34	0.180	0.177	0.051
	all rounds **	292	0.05-0.81	0.200	0.213	0.087
albumin (g/l)	March 1997 *	94	22.39-39.34	30.27	30.13	2.87
	September 1997 n.s.	113	20.80-39.29	30.32	29.93	4.01
	March 1998 n.s.	85	21.63-46.72	33.36	33.65	5.24
	all rounds n.s.	294	20.80-46.72	30.74	31.08	4.41
IgG (g/l)	September 1997 *	113	6.61-22.61	11.71	11.95	2.85
	March 1998 n.s.	85	3.80-13.40	8.52	8.64	1.84
	all rounds *	201	3.80-22.61	9.92	10.53	10.54

Significance of Kolmogorov-Smirnov test: n.s. not significant; * $p < 0.05$; ** $p < 0.005$; *** $p < 0.001$

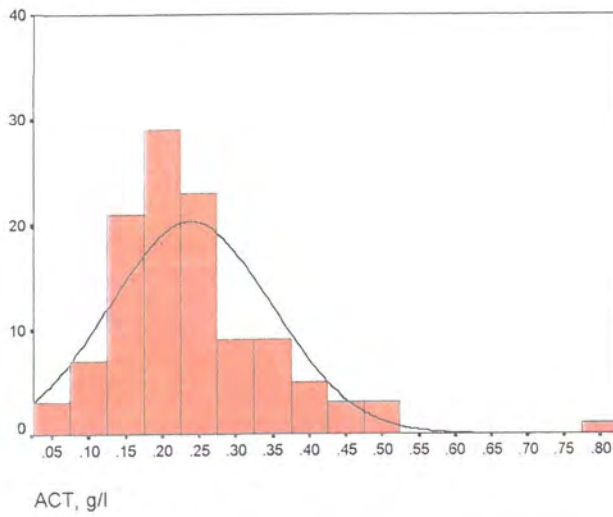
As all the variables had non-normal distributions at some seasons, logarithms of the raw values were taken before any subsequent analysis was performed. The distribution of the logged values did not differ significantly from normality in a Kolmogorov-Smirnov test, so parametric tests, such as t-tests, could be performed. However, logged values are difficult to understand and compare, so raw values are reported in text and tables for ease of comprehension. For example, the median values reported in table 5.3 are raw assay values of serum markers for ill and well children, but t-tests for significance of differences were performed on the logged values.

Figure 5.1 Histograms of ACT values for Marpha and Thini children

a) March 1997



b) September 1997



c) March 1998

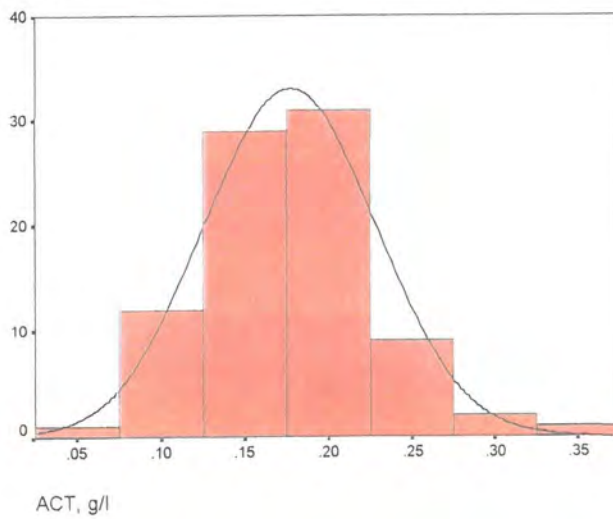
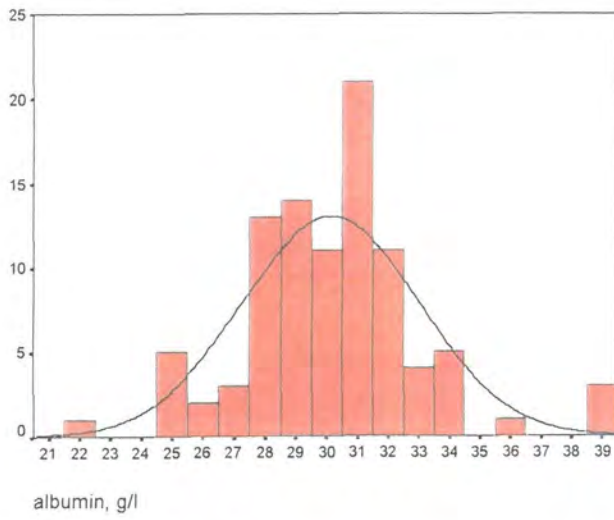
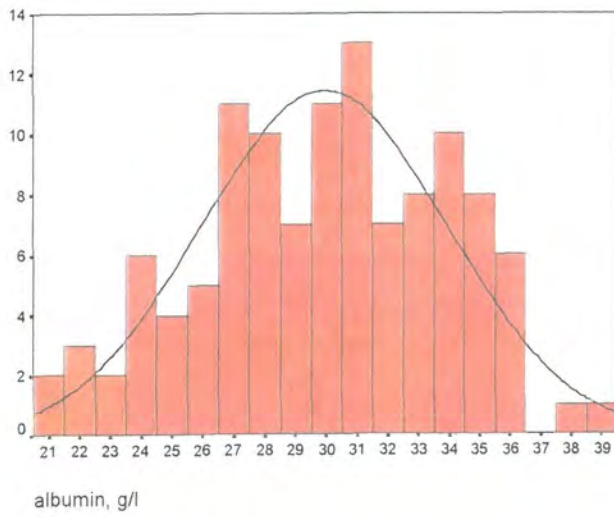


Figure 5.2 Histograms of albumin values for Marpha and Thini children

a) March 1997



b) September 1997



c) March 1998

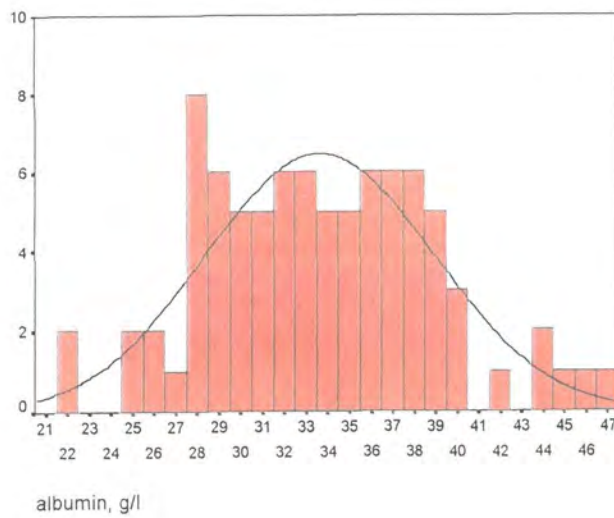
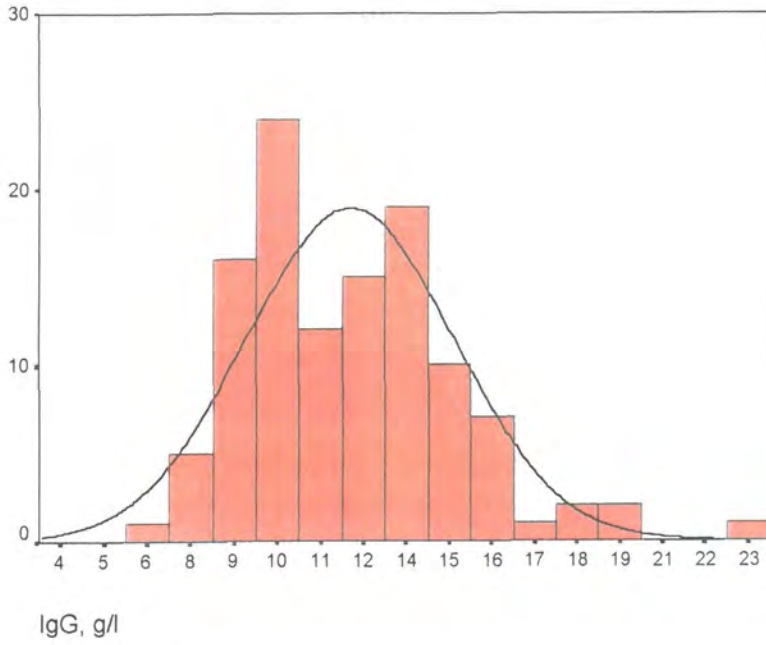
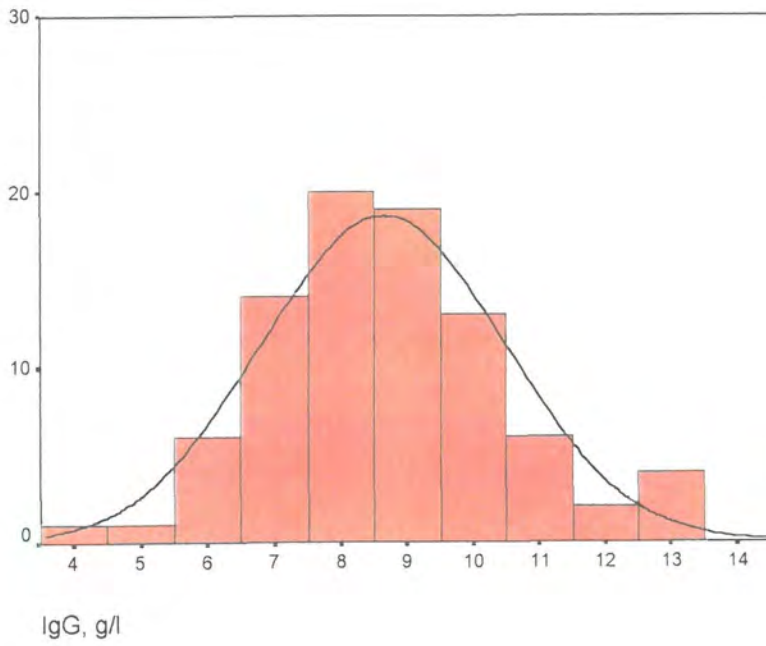


Figure 5.3 Histograms of IgG values for Marpha and Thini children

a) September 1997



b) March 1998



5.1.2. Point prevalence rates of reported morbidity, with variation by season, village, age and caste

Morbidity data were coded to describe whether children were suffering from acute respiratory infection (ARI), diarrhoea, or fever. Each of these three conditions was coded as a separate variable, with two possible values: 1 if the child reported suffering from the condition, or 0 if not. For example, a child reporting a respiratory infection with fever, but not diarrhoea, would score 1 for the 'ARI' variable, 1 for the 'fever' variable, and 0 for the 'diarrhoea' variable. Another variable, 'overall morbidity' was also coded 0 or 1 to describe whether the child reported suffering from *any* illness (irrespective of type). To give some idea of varying severity or intensity of illness, the total number of symptoms (ARI, fever or diarrhoea) reported by each child (0,1,2 or 3) was counted. Table 5.2 shows the number and percentage of children reporting different numbers and types of symptoms.

Table 5.2. Number and percentage of children reporting different numbers and types of symptoms (285 reports from 125 children over three rounds of reporting)

Morbidity type	Self-report	Number of reports	Percentage of reports
overall morbidity	ill	117	41.1
	well	168	58.9
ARI	yes	71	24.9
	no	214	75.1
diarrhoea	yes	38	13.3
	no	247	86.7
fever	yes	38	13.3
	no	247	86.7
no. of symptoms	1	89	30.9
	2+	28	9.8

Overall, children reported some symptom in 41% of the 285 reports. 30.9% of children reported a single symptom, 9.8% reported two or more symptoms. Where multiple symptoms were reported, 22 cases were ARI with fever, 6 cases were diarrhoea with fever, and one child reported ARI, diarrhoea and fever simultaneously.

Multivariate model

The impact of demographic factors and seasonality on reported prevalence of morbidity was tested in a multivariate model using the GLM procedure in SPSS to provide repeated measures analysis of variance. Season was entered as a within subjects factor (3 levels), *jat* (3 levels) and village (2 levels) as between subjects factors, and age as a covariate. Age ($p=0.009$) and *jat* ($p=0.022$) had a significant impact on overall morbidity; season and village did not. The analysis was repeated using the same factors, with ARI, diarrhoea and fever reports in turn as the dependent variable. For ARI, only age had a significant impact ($p=0.031$). No factors had a significant impact on reported prevalence of diarrhoea. For fever, *jat* was highly significant ($p<0.001$), whilst age approached significance ($p=0.077$).

Variation with age

When figures for all three rounds of reports are collated, there is a steady decrease in the percentage of children reporting illnesses by age. Five to seven year olds reported illness on 52.4% of occasions, compared to 47.4% for eight and nine year olds, and 27.6% for ten year olds and over. A Pearson chi-square test was performed to test for significant variation in prevalence of reported illness by age, and there was a highly significant difference ($\chi^2=13.094$, $df=2$, $p=0.001$).

Variation with village

44.1% of 145 reports from Marpha children mentioned some symptom, compared with 37.9% of 140 reports from Thini children; this difference was not significant.

Variation with *jat*

Table 5.3 gives the number of children from each *jat* who reported symptoms, collated over three rounds of reports. There was significant variation by *jat* in prevalence of reported overall morbidity ($p=0.004$), for diarrhoea only ($p=0.041$), and for fever only ($p<0.001$). *Jat* differences in reporting between Tibeto-Burman and low caste children, ignoring high caste children, were not significant.

Table 5.3 Percentage of reported morbidity by *jat* (285 reports from 125 children over three rounds of reporting)

self-reports	Tibeto-Burman (n=194)	low caste (n=78)	high caste (n=13)	results of Pearson χ^2 test
overall morbidity	37.6	42.3	84.6	$\chi^2=11.185$, df=2, p=0.004
resp. infection	24.7	24.4	30.8	n.s.
diarrhoea	10.3	17.9	30.8	$\chi^2=6.393$, df=2, p=0.041
fever	12.4	9.0	53.8	$\chi^2=19.902$, df=2, p<0.001

Variation with season

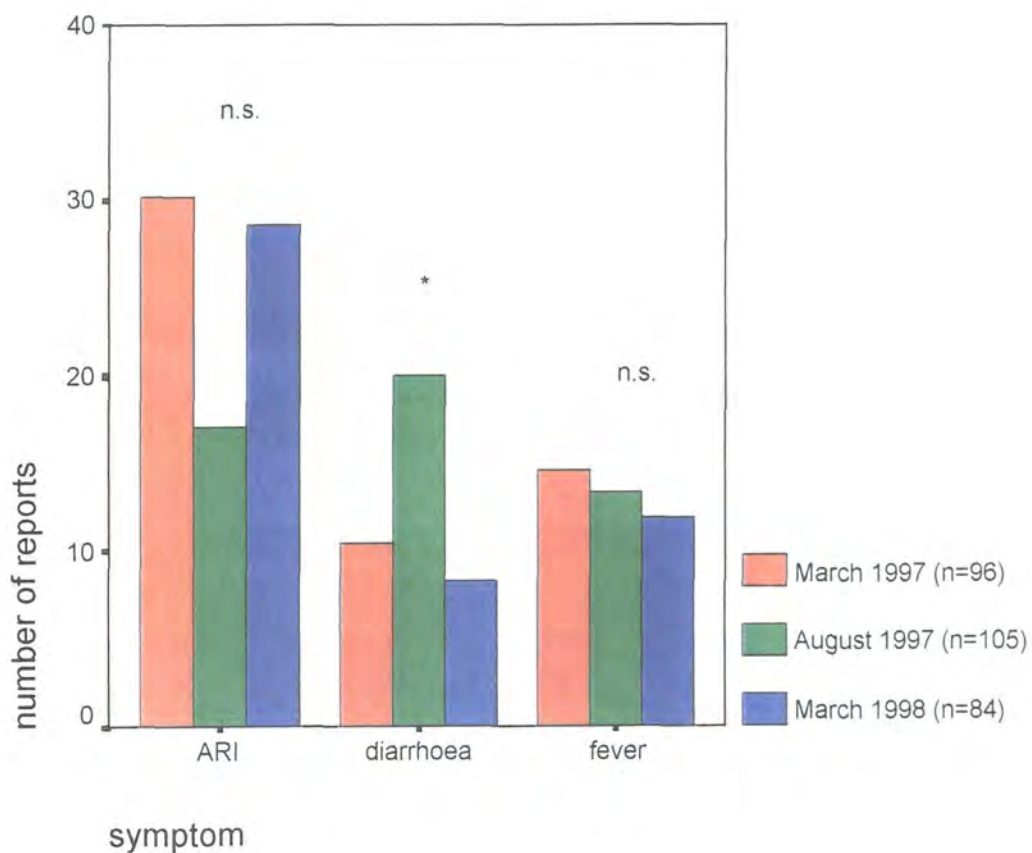
Table 5.4 gives the percentage frequency of reported morbidity at each round of reporting; figure 5.4 illustrates this variation. Prevalence of reported diarrhoea differed significantly by season (p=0.038), and for ARI approached significance (p=0.066).

Table 5.4. Percentage frequency of reported morbidity over three rounds of morbidity (285 reports from 125 children)

self-reports	March 1997 (96)	Sept. 1997 (105)	March 1998 (84)
overall morbidity ^{n.s.}	41.7	41.0	40.5
resp. infection ^{n.s.*}	30.2	17.1	28.6
diarrhoea [*]	10.4	20.0	8.3
fever ^{n.s.}	14.6	13.3	11.9

n.s. not significant; n.s.* $\chi^2=5.429$, df=2, p=0.066; * $\chi^2=6.563$, df=2, p=0.038

Figure 5.4 Seasonal difference in reported rate of fever, diarrhoea and respiratory infections (based on 285 reports from 125 children aged 5 to 12 years from both Marpha and Thini)



Results of Pearson chi-square test, difference between rounds of reports:

* ($\chi^2=6.563$, $df=2$, $p=0.038$); n.s. not significant

5.2. Discussion

5.2.1. Serum protein values

Over all the rounds of measurement, the median value of ACT was 0.23 g/l, and that of albumin was 34.74 g/l.; values found in other studies are given in table 5.3. The Mustang children, on average, had lower ACT levels than other studies of children in developing countries. The median, in fact, falls at the lower end of the normal range (0.2-0.6 g/l) given by Calvin & Price (1986). The median albumin value is below the normal range for UK children, but similar to values found in other studies of children in developing countries (Panter-Brick et al., 2001; Sullivan et al., 1991).

Other studies have found an inverse relationship between ACT and albumin levels (Panter-Brick et al., 2001). ACT and albumin values in the Mustang data were not significantly associated, but the direction of association was, in fact, positive (Pearson correlation $r=0.341$, $n=290$, n.s.). However, ACT and IgG were significantly positively correlated ($r=0.388$, $n=197$, $p<0.001$).

Table 5.3 Comparison of ACT and albumin values obtained in studies of different populations

study	sample	ACT, g/l	albumin, g/l
Panter-Brick et al. (2001)	Nepali boys aged 10-14 years	mean 0.73*	mean 32.04*
	rural village	mean 1.52*	mean 29.12*
	squatter	mean 0.37*	mean 32.56*
	homeless	mean 0.53*	mean 31.82*
	middle class	mean 0.31*	mean 34.80*
Calvin & Price (1986)	'normal' adults	range 0.2-0.6	
Calvin et al. (1988)	UK adults	range 0.33-0.64	
Rousham et al. (1998)	'healthy' rural Bangladeshi 2-5 yr olds	mean 0.49-0.53, at different seasons	mean 35.7-39.3, at different seasons
Belfast City Hospital, cited by Rousham et al. (1998)	normal UK		range 36-52
Sullivan et al. (1991)	severely malnourished Gambian children, 6-36 months	mean 0.9 range 0.65-1.37	mean 34.3 range 20.7-45.5

* from blood spots using conversion factor supplied by Dr P. Lunn (details in methodology)

5.2.2. *Reported morbidity*

Overall, levels of reported morbidity are high, with 41% of the children's reports mentioning some sort of illness (table 5.2). In the majority of cases, children reported only one symptom; almost a quarter of reports mentioned two or more symptoms (as numbers in the study were small, interactions between different symptoms, i.e. if a child reported ARI *and* fever, were not considered in the subsequent analyses). Although self or maternally reported data should not necessarily be considered as representative of actual morbidity levels, it is still interesting to consider the levels of morbidity reported in other health surveys. The level of reported morbidity I found in Mustang is remarkably similar to that given by Rousham et al (1998), for young Bangladeshi children. 34% of Bangladeshi mothers reported some symptoms, and about a quarter of reports mention a combination of two or more symptoms. 10% of reports mentioned diarrhoea, 24% fever and 8% ARI; the comparable figures in the present study are 13%, 13% and 25% (see table 5.2). Moffat (1998) collected maternal reports of morbidity for children under five living in Kathmandu; she found a point prevalence of 29% for diarrhoea on a specific day. When mothers were asked to use a two-week recall period, 59.7% reported that their children had been ill during this time. 55% of reported illness was gastrointestinal, and 30% acute respiratory infections, the remainder being mainly unspecified fevers and skin diseases.

According to the Marpha health post records (appendix 8), the most common diagnoses over a one-year period are skin infections (13%), acute respiratory infections (11%), diarrhoea (8.1%) and abdominal pain (7.7%), worms (7%) and other fevers (3.5%). In the initial round of morbidity interviews, none of the children reported a skin infection, although several appeared to be suffering from them. Only two mentioned worms, and as this diagnosis could not be confirmed without microscopic examination of stool samples, I decided to record only what the children said about their actual symptoms, and in fact concentrated on just the three categories (respiratory infection, diarrhoea and fever). Children seemed to mention only their more acute and distressing symptoms in response to my open questions, whereas they (or their parents) might decide to visit the health post over more chronic conditions.

Age was strongly associated with variation in rates of reported illness ($p=0.001$, section 5.1.2). Five to seven year olds reported illness on 52% of occasions, compared to 47% for eight and nine year olds, and 28% for ten year olds and over. This agrees with the expectation that younger children suffer from more infectious diseases, partly because their behaviour may put them more in contact with pathogens, but also due to the fact that more of the pathogens they encounter are new to them. As children get older, not only do their immune systems function more effectively, but also the number of novel pathogens to which they are exposed decreases.

Subsequent exposure to the same pathogen is much less likely to result in illness as the immune system 'remembers' the antigen, and can mount a stronger and faster attack.

The significance of *jat* on rates of reported morbidity is not so clear. If figures are collated over three rounds of reports, 38% of Tibeto-Burman children report sick, 42% of low caste Indo-Aryan children, and 85% of high caste Indo-Aryan children. The unusually high rate amongst high caste children is difficult to examine or explain due to the small numbers involved in the study. One factor, which may be important, is that all the high caste children in the survey belong to families who were recent immigrants from lower, warmer areas of Nepal. They were not poor, as they all had fathers working in relatively well-paid government posts, in agriculture or education. However, they lacked a network of extended family or friends, which mean that their families were often very isolated. Most of the families had also conspicuously failed to adapt their lifestyle to suit the different climate of Mustang and the children often appeared to be inadequately clothed and fed, not through poverty, but through habit.

There does not appear to be a significant impact of village on rates of reported illness, although there is a tendency towards higher rates of reported illness in Marpha, which may have been significant in a larger sample. I had expected rates to be higher in Marpha, because of the large number of trekkers, porters and traders who pass through villages on the main trail, and presumably introduce a wider variety of pathogens than are endemic in Mustang.

The overall proportion of children reporting sick was fairly constant at different seasons, and season did not have a significant impact in the multivariate model. However, examination of the numbers for different symptoms apparently reveals a seasonal pattern. In March 1997 and March 1998, the largest group of reported illnesses were acute respiratory infections, with around 30% of children reporting suffering during the previous week. The rate of ARI in September 1997 was 17%, less than two thirds of the March rate. These were usually minor upper respiratory tract infections, coughs and colds, although a few children simultaneously reported fever and longer lasting coughs, and appeared to be more seriously ill, which may have signified presence of a more serious acute lower respiratory infection such as pneumonia, or chronic lung disease, particularly tuberculosis.

In contrast, the rate of gastrointestinal diseases was higher during September. Around 20% of children reported diarrhoea in September 1997, compared to 10.4% in March 1997, and 8.3% in March 1998. Some of the children obviously were suffering from more serious infections, and initially I tried asking about frequency and consistency of stools, and whether blood or mucus was present. However, this proved confusing, and too complicated for the younger children in the study, and I eventually decided to accept the children's criterion for diarrhoea.

Unspecified fevers were also commonly reported, sometimes in association with ARI or diarrhoea, and sometimes alone. The incidence of reported fevers did not vary markedly by season, ranging from 12 to 14%.

The seasonal difference in rates of different symptoms is almost certainly due to climatic variation. The pattern of higher rates of respiratory infections during the cold season, and higher rates of gastrointestinal disorders during warmer weather is seen elsewhere in Nepal. Moffat (1998) reported a point prevalence rate for diarrhoea of 23% during the cold season, 40% in the hot season, and 44% during the monsoon for children less than five years living in Kathmandu. The prevalence of diarrhoeal diseases is probably not so great in Mustang as in some other areas of Nepal, as sanitation standards are relatively high, with effective drainage and sewage disposal. A plentiful supply of piped water is available to all residents of Marpha and Thini, either from privately installed domestic or shared street taps. This water is not chemically treated, but is piped from higher altitudes and allowed to settle in tanks to reduce sediment. It appears to be clean and uncontaminated: I drank untreated water throughout my time in Mustang, and never got ill.

In many other areas of Nepal, sanitation is poor, and public water supplies are often heavily contaminated with a wide range of pathogens including *Escherichia Coli*, *Shigella*, *Campylobacter* and *Salmonella* bacteria, *Giardia*, *Entamoeba Histolytica* and other protozoa, and the hepatitis A virus (Shlim, 1994). The World Bank (1999) reported that in 1996, 61% of the urban population and 59% of the rural population of Nepal, had access to "improved water", and 74% of the urban population and only 18% of the rural population had access to "improved sanitation". Particularly in the cities, public water supplies may run dry at some times of year, leaving families with no choice but to spend a large proportion of their income on purchasing drinking water from private sources, and fuel to boil water. In Mustang, local people are aware of this, and speak proudly of their climate and environment as a healthy one, a good place to bring up children, particularly in comparison to cities like Kathmandu and Pokhara, where many of them recall getting ill on visits. However, rates of respiratory problems may well be higher in Mustang- not necessarily from infections, but chronic coughs caused by exposure to the strong winds and dust of the Kali Gandaki valley. Lowland Nepalis working in Mustang complain a lot about this, and also about the sometimes extreme low temperatures and snow during winter months. They believe their home towns and villages to have a much healthier climate, and to be the best place to raise children.

CHAPTER SIX : CONCLUSIONS- THE RELATIONSHIP BETWEEN GROWTH, MORBIDITY AND SERUM MARKERS

The previous two chapters presented data on biological variables: the anthropometric status, reported morbidity and serum protein levels of children in Mustang. I examined biological variation depending on seasonal and socio-economic factors: the season of measurement, the village, the *jat*, sex and age of the individual child, using multivariate statistical models. In this chapter, I will examine interrelationships between the biological variables. Subsequently, I aim to test hypotheses linking growth and illness, using the data presented thus far, and increments of height and weight gain. Section 6.1.1 examines the factors associated with variation in ACT; 6.1.2, the relationship between growth status and markers of morbidity; 6.1.3, the factors associated with variation in growth increments.

6.1. Results

6.1.1 *Factors associated with variation in ACT*

a) multivariate model

The impact of demographic factors and morbidity was tested by linear regression of logged March 1997 ACT values on village, sex, caste, age and morbidity (table 6.1.). The impact of morbidity, village and *jat* were all highly significant ($p < 0.001$; $p < 0.001$; $p < 0.007$); sex and age were not significant.

Table 6.1 Linear regression of March 1997 ACT values onto morbidity and demographic variables (n=94)

R²	variable	unstandardized coefficient B	SE	significance
0.152	intercept	-0.553	0.055	p<0.001
	overall morbidity (ill vs. healthy)	0.117	0.019	p<0.001
	village (Marpha vs. Thini)	-0.085	0.023	p<0.001
	<i>jat</i> (Tibeto-Burman vs. low vs. high caste)	-0.055	0.020	p<0.007

b) variation in median ACT by type of symptom

Table 6.2 reports median values of serum markers for children reporting themselves to be ill, or not ill. The significance of group differences was tested with independent samples t-tests using logged values of serum markers, but actual values are reported in the table for ease of comprehension. Levene's test for equality of variances was performed to test the hypothesis that there was no statistically significant difference between the variances for the groups, an assumption true in the majority of cases. Where variances were unequal, SPSS calculates corrected statistics, and the appropriate significance value is reported for that t-test.

Over all symptoms, group median ACT was higher for those children reporting ill than for the well group (p<0.001); this is shown in figure 6.1. Children reporting either diarrhoea or fever had very significantly higher ACT than those not reporting ill (p<0.001). The difference in ACT between children reporting ARI and those not reporting ARI approached significance (p=0.061).

There was a significant group difference in IgG between children reporting diarrhoea and children not reporting diarrhoea (p=0.014), but no difference in albumin levels for any symptom. Figure 6.2 illustrates median ACT, albumin and IgG levels in children reporting sick (all symptoms) or well.

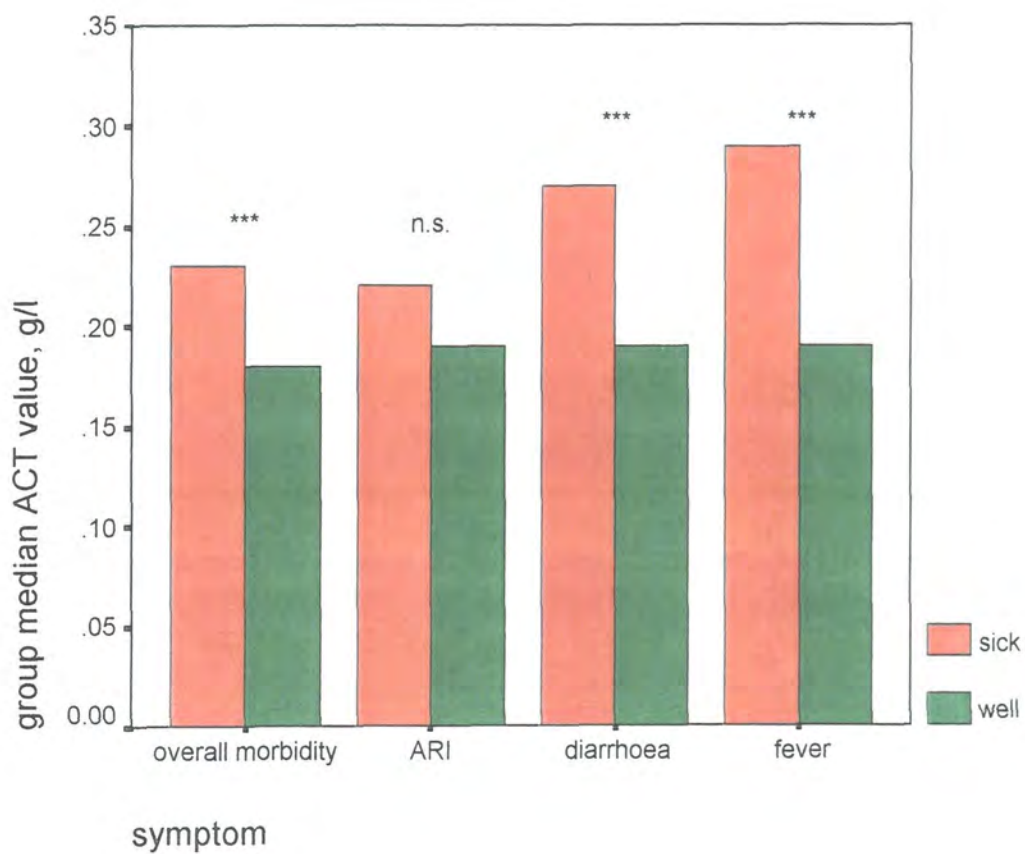
Table 6.2 Serum markers for children reporting as ill or well, pooled over three rounds of reporting

reported morbidity	number of children	ACT, g/l median	ACT, g/l range	albumin, g/l median	albumin, g/l range	IgG, g/l median	IgG, g/l range	
any illness	yes	117	0.23 ***	0.07-0.81	30.66	22.39-46.72	10.11	5.38-22.61
	no	168	0.18	0.05-0.41	30.79	20.80-43.67	9.87	3.80-19.79
ARI	yes	71	0.22	0.07-0.50	30.58	22.39-46.72	9.58	5.38-22.61
	no	214	0.19	0.05-0.81	30.77	20.80-46.13	10.24	3.80-19.79
diarrhoea	yes	38	0.27 ***	0.08-0.81	30.73	23.78-42.20	11.12 *	6.72-19.54
	no	247	0.19	0.05-0.46	30.75	20.80-46.72	9.77	3.80-22.61
fever	yes	38	0.29 ***	0.12-0.81	30.58	22.48-46.72	10.44	5.38-22.61
	no	247	0.19	0.05-0.48	30.75	20.80-45.05	9.89	3.80-19.79

Raw values of serum markers are reported in this table. Independent samples t-tests were performed on logged values.

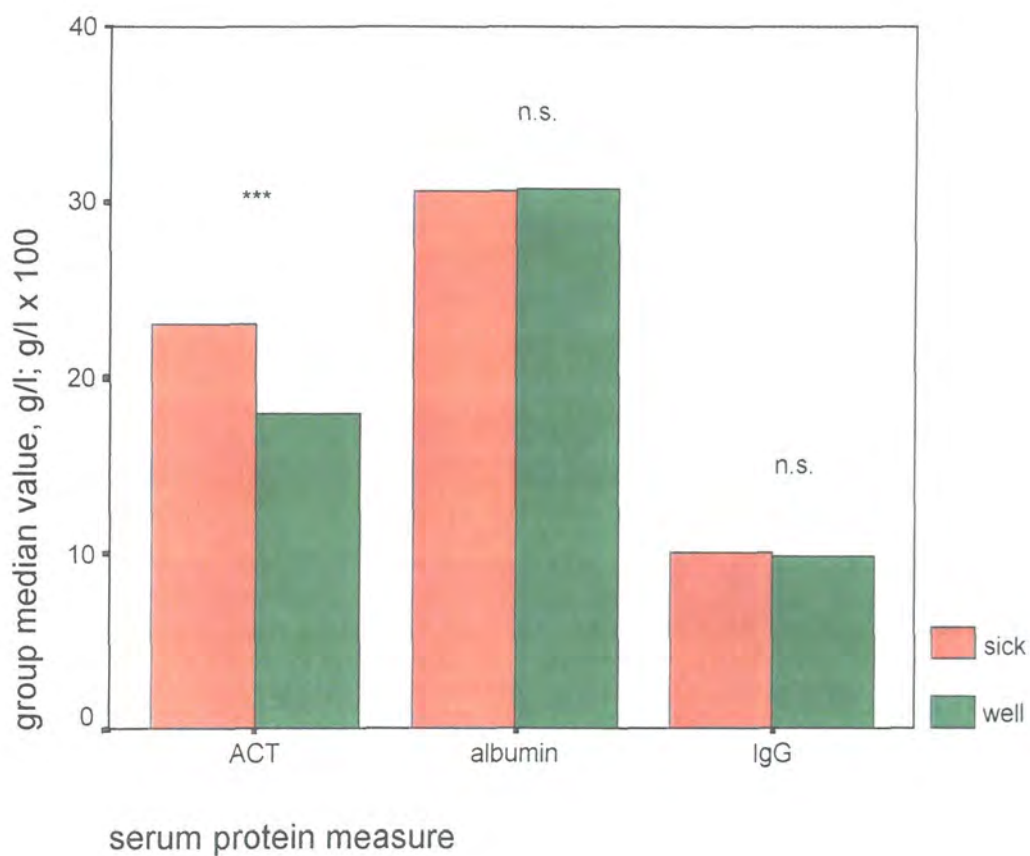
*- $p < 0.05$; ***- $p < 0.001$

ARI = acute respiratory infections

Figure 6.1 Median ACT levels for children reporting sick and well

Results of independent samples t-tests, significance of difference between sick and well: n.s. not significant; *** $p < 0.001$

Figure 6.2 Median ACT, albumin and IgG levels in children reporting sick and well (all symptoms) at three seasons



Results of independent samples t-tests, significance of difference between sick and well: n.s. not significant; *** $p < 0.001$.

N.B. albumin & IgG values are shown in g/l; ACT is shown as g/l x 100.

c) variation in median ACT by number of reported symptoms

Table 6.3 shows the median values of serum markers, grouped by number of reported symptoms. One-way analysis of variance was performed on logged values (actual values are reported in the table for ease of comprehension) of serum markers, to test for a difference by number of reported symptoms. The difference was significant for ACT ($p < 0.001$), but not for other markers.

Table 6.3 Serum markers values for children reporting different numbers of symptoms

number of symptoms	ACT, g/l median (n) ***	albumin, g/l median (n) ^{n.s.}	IgG, g/l median (n) ^{n.s.}
0	0.180 (165)	30.79 (164)	9.87 (110)
1	0.215 (84)	30.66 (87)	10.10 (59)
2	0.300 (27)	30.85 (27)	10.45 (16)

Results of one-way ANOVA on logged values, significance of difference between children with different numbers of symptoms: *** $df=276$, $F=31.309$, $p < 0.001$, n.s. not significant

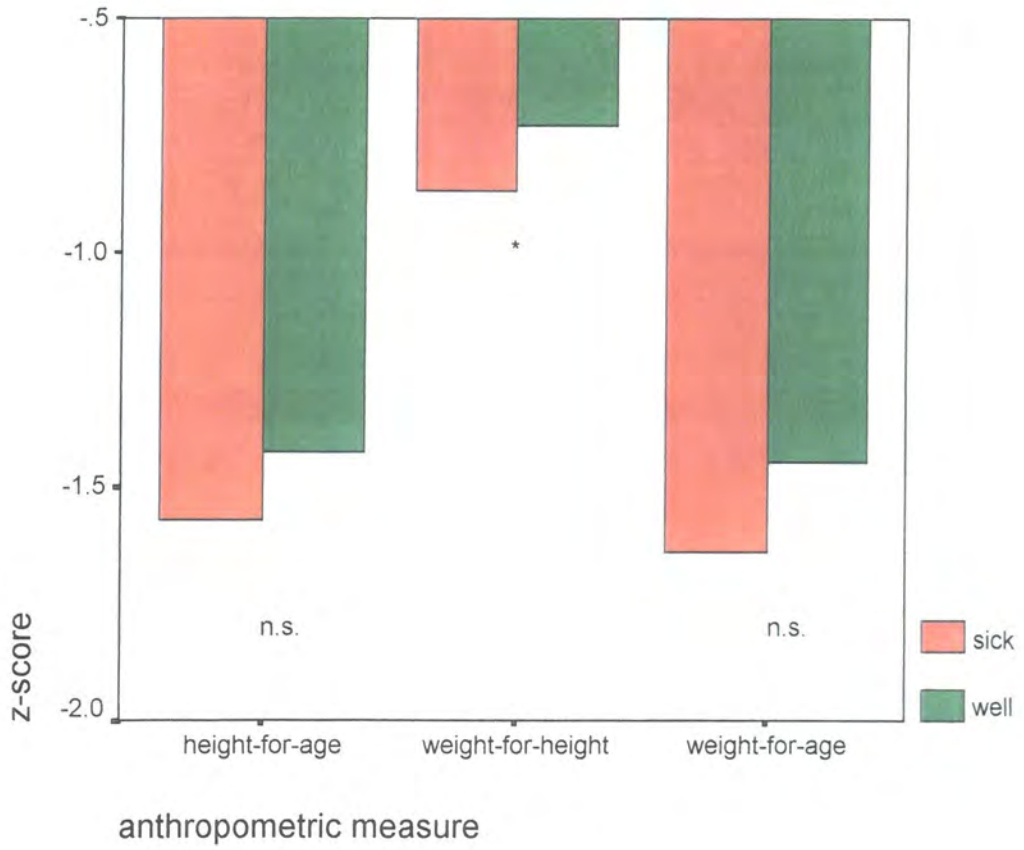
6.1.2. Association between growth status and markers of morbidity

It is pertinent to ask whether children with poor growth status have different levels of serum proteins to children with better growth status. In independent samples t-tests, there was no significant difference in mean values of albumin, ACT or IgG between children in the highest and lowest quartiles of HAz, WHz or WAz.

To test whether poor growth status (stunting or wasting) was associated with rates of reported illness, children in the lowest quartiles for HAz, WHz, and WAz were compared with those in the highest quartiles (see appendix 7 for quartile values). In chi-square tests, there was no significant difference between quartiles in the rate of reported illness. If diarrhoea alone was considered, variation in reporting rates by quartile of WHz approached significance (Pearson $\chi^2 = 7.181$, $df=3$, $p=0.066$). 11% of the highest WHz quartile reported diarrhoea, 6% of second, 13% of third, and 21% of lowest quartile.

Mean HAz, WHz and WAz for children reporting as sick and well are shown in figure 6.3; the difference was significant only for weight-for-height ($p = 0.049$).

Figure 6.3 Anthropometric measurements between children reporting as sick (n=113) and well (n=166)



Independent samples t-test: * $p < 0.05$; n.s. not significant

6.1.3. Factors associated with variation in growth increments

Height and weight increments were calculated for all children between each round of measurements, with time periods varying from 2 to 12 months. Table 6.4 gives the mean and standard deviation of the growth increment for each period, and also as a rate per month.

A multivariate model was designed to test the impact of demographic factors, initial anthropometric status, morbidity and ACT levels on subsequent growth. Height gain between March and September was regressed onto ACT, HAZ and WHz in March, morbidity in March, age and village (table 6.5). Village, ACT and morbidity had a significant impact on height gain ($p < 0.001$, $p = 0.032$, $p = 0.001$ respectively).

In a similar model, weight gain from March to September was regressed onto ACT, HAZ and WHz in March, morbidity in March, age and village (table 6.6). Village, initial WHz and age had a significant impact on weight gain ($p = 0.003$, $p = 0.049$, $p = 0.010$ respectively).

Table 6.4 Monthly height and weight gain over 2 to 12 month periods

months of study	time period	no. of children	height gain, cm per month		weight gain, kg per month	
			mean	SD	mean	SD
March to July 1997	4 months	113	0.22	0.29	0.31	0.32
July to Sept. 1997	2 months	93	0.58	0.38	0.22	0.34
March to Sept. 1997	6 months	94	0.33	0.15	0.27	0.24
Sept. 1997 to March 1998	6 months	100	0.52	0.26	0.32	0.21
March 1997 to March 1998	12 months	88	0.42	0.13	0.29	0.15

Table 6.5 Factors associated with height gain from March to September (n= 90 children)

	coefficient B	SE	significance
regression	-0.718	0.516	n.s.
ACT March 1997	-1.052	0.483	0.032
village	0.506	0.137	<0.001
morbidity March 1997	0.469	0.132	0.001
WHz March	-0.025	0.096	n.s.
HAz March	-0.067	0.063	n.s.
age	-0.032	0.003	n.s.

Multiple regression model of height gain from March to September on to ACT, WHz, HAz, morbidity in March 1997, village and age. Model summary: $R^2=0.351$, $SE=0.576$, $p<0.001$

Table 6.6 Factors associated with weight gain from March to September (n= 90 children)

	coefficient B	SE	significance
regression	0.862	1.194	n.s.
ACT March 1997	0.333	1.114	n.s.
village	-0.980	0.314	0.003
morbidity March 1997	-0.039	0.305	n.s.
WHz March	-0.445	0.223	0.049
HAz March	0.047	0.145	n.s.
age	0.020	0.008	0.010

Multiple regression model of weight gain from March to September onto ACT, WHz, HAz, morbidity in March 1997, village and age. Model summary: $R^2=0.211$, $SE=1.335$, $p=0.003$

Walker et al. (1996) suggested that variations in weight-for-height may be a more critical influence of linear growth than weight-for-height per se. They had found that children who had increased weight-for-height over the preceding six months went on to gain most height. For 94 Marpha and Thini children with available data, the change in WHz between March and September 1997 was calculated (ΔWH); values varied from $-0.48z$, to $+1.20z$. To test whether the same effect is true for the Mustang sample, height gain from September 1997 to March 1998 was regressed onto ACT, HAZ and WHz in March, morbidity in March, age and village (as above), plus the new variable (ΔWH). Table 6.7 gives the results of this model. Only village had a significant impact on height gain over this period ($p < 0.001$).

The analysis was repeated, this time using weight gain as the dependent variable; the results are given in table 6.8. Village, initial HAZ, age and ΔWH all had a significant impact on weight gain ($p = 0.017$, $p < 0.001$, $p < 0.001$, $p = 0.034$ respectively). Overall, the model explained 51.6% of variation in weight gain.

Figure 6.4. shows the negative association between ΔWH and weight gain September 1997 to March 1998.

Table 6.7 Factors associated with height gain from September 1997 to March 1998 (n= 87 children)

	coefficient B	SE	significance
intercept	3.602	1.095	0.002
village	-1.110	0.304	<0.001
ACT September	-0.517	0.809	n.s.
HAz September	-0.102	0.140	n.s.
morbidity Sept.	0.333	0.323	n.s.
age	0.007	0.008	n.s.
WHz September	0.224	0.256	n.s.
ΔWH Mar-Sep	-0.253	0.311	n.s.

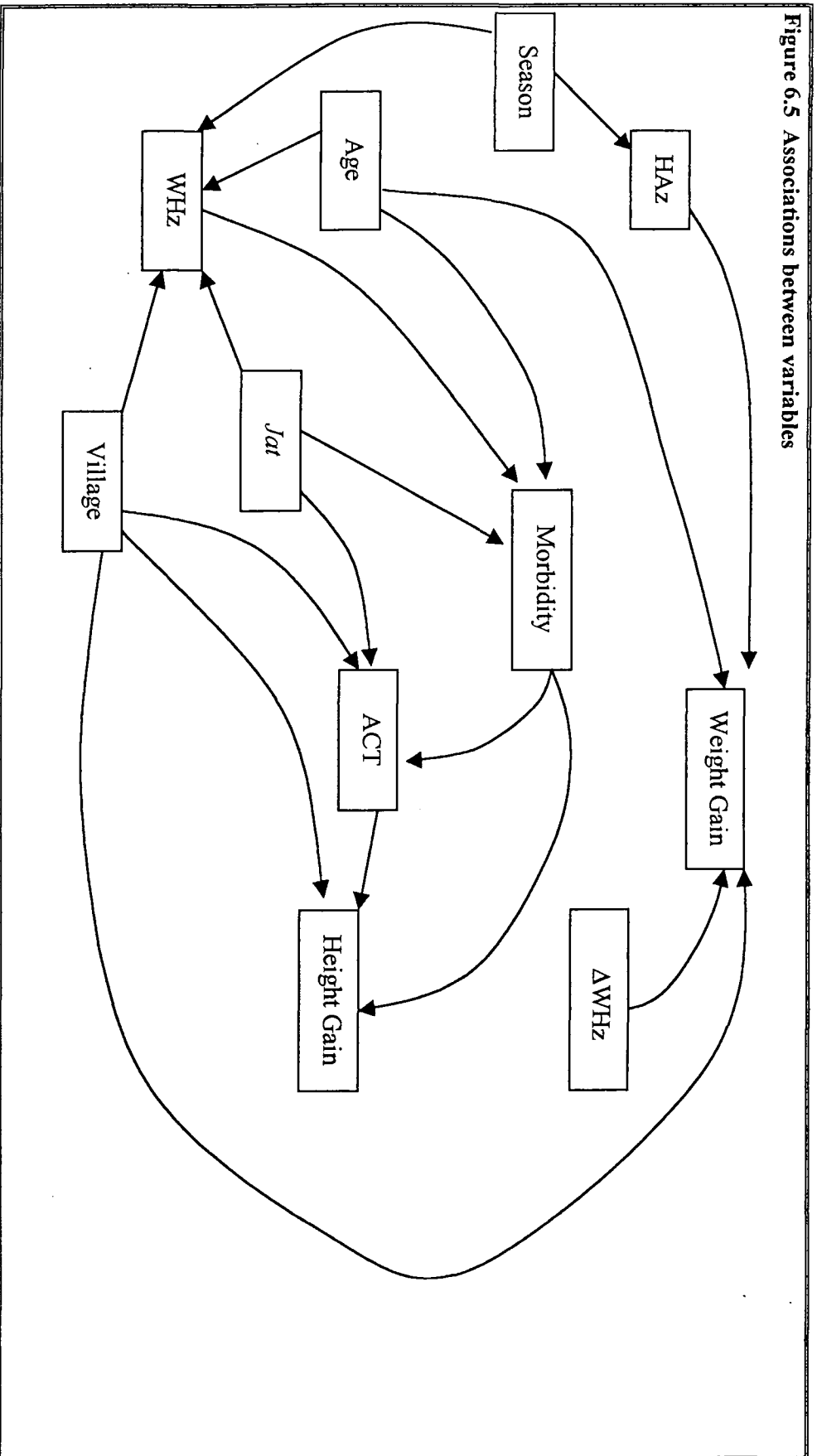
Multiple regression model of height gain from September 1997 to March 1998 onto ACT, WHz, HAz, morbidity in September 1997, ΔWH Mar-Sep, village and age. Model summary: $R^2=0.194$, $SE=1.240$, $p=0.021$

Table 6.8 Factors associated with weight gain from September 1997 to March 1998 (n=87 children)

	coefficient B	SE	significance
intercept	0.814	0.787	n.s.
village	-0.535	0.218	0.017
ACT September	0.813	0.581	n.s.
HAz September	0.411	0.101	<0.001
morbidity Sept.	-0.151	0.232	n.s.
age	0.030	0.005	<0.001
WHz September	0.087	0.184	n.s.
ΔWH Mar-Sep	-0.482	0.223	0.034

Multiple regression model of weight gain from September 1997 to March 1998 onto ACT, WHz, HAz, morbidity in September 1997, ΔWH Mar-Sep, village and age. Model summary: $R^2=0.516$, $SE=0.891$, $p<0.001$

Figure 6.5 Associations between variables



6.2. Interpreting the results

In this thesis, I have described some markers of health and well-being for children living in two rural communities in an area of Nepal that is isolated and physically hostile. Section 6.1 analysed relationships between these markers of health and well-being. Significant results are illustrated in figure 6.5, which shows the associations found between all demographic and biological variables in this study. Growth status, growth increments, ACT, morbidity and demographic factors are all linked; age, *jat* and village of residence have a significant impact on several markers. The major findings of this thesis are discussed below, followed by an appraisal of the overall study design and methodology in section 6.3. Recommendations for future research are made in the light of the present findings.

1) Morbidity and ACT are very strongly associated

The results show a clear link between reported illness and raised levels of ACT ($p < 0.001$, table 6.1). Rousham et al. (1998) similarly showed that children reporting episodes of diarrhoea or fever were associated with significantly higher ACT and lower albumin levels than children reported as well. They found no effect for episodes of ARI, but observed that “reports of ARI with fever were associated with significantly higher levels of ACT than either illness individually” (Rousham et al., 1998: 451). In the present study, the sample size was too small to test for interactions between illnesses, but children who reported more than one symptom did have significantly higher ACT (40% greater) than children reporting only one symptom. This was also the case in Rousham et al.’s study. Reported illness was not associated with changes in albumin or IgG level in the present study (table 6.2).

Panter-Brick et al. (2001) collected blood samples and self-reported morbidity data from four groups of Nepali boys aged 10 to 14 years. The boys were from a remote village, and three populations in urban Kathmandu: middle class schoolboys, homeless boys living on the street, and boys from poor squatter families. There was a dramatic difference between the serum marker values and self-reports of the village boys and all three urban groups. Only 7% of village boys reported some health problem on the day of blood sample collection, compared with 13% of homeless boys and 15% of squatter boys (no comparable data available for middle class boys). Over a longer period of data collection, 14% of village boys reported symptoms, compared with 73% of homeless boys, 61% of squatter boys and 46% of middle class boys. However, ACT values for village boys were approximately three times higher than for the homeless boys, four times higher than for the squatters, and five times higher than for the middle class boys (see table 5.3). There was a positive association between ACT value and reported

morbidity for the three urban groups only. It is remarkable that village children reported the lowest disease burden, despite the fact that their ACT levels suggest very much otherwise. Panter-Brick et al. observe that morbidity reports “not only reflect different exposure to diseases, but also different experiences of illnesses or habituation to ill-health as well as different demands or expectations for treatment”. This may partially explain the village boys’ apparently anomalous ACT and morbidity results. They also suggest that this may be due to the presence of chronic inflammation in response to asymptomatic infections and damaged gut function.

This evidence shows that children’s own self-reports of morbidity are related to biochemical indicators of health, suggesting that the Mustang children are reporting illness both consistently and at an appropriate threshold. Panter-Brick et al.’s study (2001) demonstrates the inherent difficulties in trying to compare morbidity reports from different populations, even those of the same age and nationality, as more local level factors may have dramatic effects on the level of illness reported. Assuming that children reporting more than one symptom are more severely ill than children reporting one symptom only, both this research, and Rousham et al.’s Bangladeshi study (1998) suggest that ACT may be very useful as an objective measure of the severity of illness, as well as indicating the presence or absence of illness. There is clearly vast potential for measuring ACT as a proxy for morbidity, to make comparisons between populations where maternal or self-reports may not be considered reliable or comparable. In addition, ACT may be used to assess the presence of asymptomatic infections or inflammation, which are most unlikely to be reported, as individuals are probably unaware of the condition. Unfortunately, difficulties with the assay methodology and the changing international standard for ACT mean that figures given in different studies may not currently be comparable unless careful work is done to validate the assay used in each case. This should be avoidable in the future by taking care that samples are assayed in a replicable way, using the same standard solution.

2) Morbidity and ACT both have a significant impact on height increments over certain periods

There are several factors suggested by different studies as being associated with variation in children’s height or weight gain. Those of particular interest include ACT levels, morbidity, initial height-for-age, initial weight-for-height, and also the change in weight-for-height over preceding months. Thus, the multivariate regression model (section 6.1.3) used to test for factors associated with height or weight gain contained all these factors, plus village and age.

I found a significant negative relationship between ACT and linear growth existed over one time period, but not another. ACT in March had a significant negative impact on height gain between March and September 1997 ($p=0.032$, table 6.5). However, ACT in September had no impact

on height gain between September 1997 and March 1998 (table 6.7). Panter-Brick et al. (2001) found that high levels of stunting were significantly associated with elevated ACT. They comment that the conditions leading to high ACT (high pathogen exposure, repeated episodes of illness and acute inflammation) would also be expected to be conducive to slower growth. Lunn et al. (1991) found that plasma concentrations of ACT, cortisol and immunoglobulins A, G and M were all associated with variation in growth for rural Gambian infants. They suggested that the high levels of these proteins may be due to chronic inflammation resulting from mucosal enteropathy allowing the gut wall to become 'leaky'.

Morbidity was also associated with reduced height gain (but not weight) over the period March to September 1997 ($p=0.001$, table 6.5), but not September 1997 to March 1998 (table 6.7). The only factor with a significant impact on height gain from September 1997 to March 1998 was the child's village ($p<0.001$, table 6.7). It is not clear why morbidity should be related to height gain over one time period, but not another. It is possible that different types of pathogens predominate at different seasons, or that the intensity of illness varies, thus having a greater effect on subsequent growth. Children were certainly reporting different symptoms at different times of year, with diarrhoea more common during the summer months, and ARI more common in the early spring (section 5.1.2). Several studies (reviewed in the introduction) have found an effect of weight loss, or failure to gain height following individual episodes of diarrhoea (Guerrant et al., 1983; Black et al., 1984; Nabarro, 1985). Solomons et al (1993) hypothesise that a heavy burden of infections in children, even at a sub-clinical level, may overload the immune system, and impair mechanisms of growth and development.

Other studies have considered the relationship between a child's initial growth status and their subsequent height and weight gain. Walker et al (1996), and Costello (1989) report that in their longitudinal studies of children, weight-for-height was positively associated with linear growth in the following six months interval. Panter-Brick (1997) reports that thinner and shorter Nepali children gained less height over a period of eight months; there was no significant association of initial growth status with subsequent weight gain. Waterlow (1994) suggests the reason for this may be a physiological relationship, possibly mediated by IGF-1, between body weight and linear growth. IGF-1 is reduced in acute malnutrition, and rises with feeding of adequate levels of protein and energy. Walker et al. (1996) suggested that changes in an individual's weight-for-height might be a more critical influence of their subsequent linear growth than weight-for-height per se. They found that children whose weight-for-height had improved over the preceding six months went on to gain most height.

For the Mustang children, height gain was not associated with initial growth status. Weight gain between March and September 1997 was negatively associated with initial weight-for-height

($p=0.049$, table 6.6), so thinner children gained more weight, suggesting that some 'catch-up' weight gain is taking place in initially thinner children during this period. Change in weight-for-height was significantly negatively associated with variation in individual weight gain (but not height gain) between September 1997 and March 1998 (tables 6.7 and 6.8). Children who had a greater positive change in weight-for-height over the previous six months gained less weight than those children who had either a smaller positive, or a negative, change. As with the previous result, this seems to suggest that some compensatory growth is taking place in children who have previously lost, or failed to gain, weight.

An examination of the growth increments in table 6.4 reveals that height gain is lowest between March and July 1997 and greatest between July and September 1997. Weight gain is lowest between July and September 1997, and higher at other times. Thus, the period of peak height gain occurs after a period of rapid weight gain, and weight gain slows down during the period of rapid height gain. This is similar to the findings of research in Nepal and other countries that looked at the temporal relationship between gain of height and gain of weight in mild-to-moderately under-nourished children.

Nabarro et al. (1988) report that children under five years in Eastern Nepal gained most weight during the months immediately following the first cereal harvest, with peak linear growth occurring approximately three months after the period of peak weight gain. Brown et al. (1982) in Bangladesh report a similar seasonal pattern to height and weight gains, with height gain peaking three to four months after weight gain. Waterlow (1994) suggests that this 'time-lag' phenomenon observed in Asian data is a real effect, although it is not always observed in data from other countries. McGregor et al. (1968) report height and weight increasing simultaneously for Gambian children, and Wiersinga & van Rens (1973) showed a similar coincidence of peaks and troughs in weight and height velocity in Kenyan children. Cole (1993) found length gain lagging behind weight gain by approximately six weeks in Gambian infants, but says, "It is clear that both measurements respond to the same stimulus...the only reason for the phase shift is that length is slower to respond to the stimulus."

3) Demographic factors (*jat* and village) have a significant impact on markers of health and well-being

Jat and village are independently associated with variation in weight-for-height ($p=0.004$ and $p=0.003$, table 4.3); Tibeto-Burman children had greater WHz than low caste children and Marpha children greater than Thini children. *Jat* and village are also associated with variation in ACT ($p<0.001$ and $p<0.007$, table 6.1); high caste children had greater ACT than low caste who had greater ACT than Tibeto-Burman children, and Marpha children had greater ACT than

Thini. *Jat* is associated with morbidity ($p=0.004$, table 5.2), with high caste children reporting more illness than low caste or Tibeto-Burman. Village is associated with height gain between March to September 1997, and September 1997 to March 1998 ($p<0.001$, tables 6.5 and 6.7). What mechanisms might explain these associations?

One possibility, discussed in chapter four, is that genetic differences between children of different ethnic groups may account for some variation in weight-for-height, with Tibeto-Burman children having a tendency to be stockier. It is also possible to speculate that genetic differences *could* account for differences in susceptibility to disease, in ACT production, and in height gain under particular conditions. However, it seems much more probable that the most important factor underlying variation with both *jat* and village is the socio-economic status of the household. There are obvious ramifications of poverty on health; there may also be indirect mechanisms affecting children's well-being. Tomkins (1988) wrote that,

“It is frequently observed that within a region or community, those children who are stunted are often from poorer socio-economic environments not only with respect to type and availability of food but also housing, sanitation, parental education, and access to health services.”

Within Mustang, it is certainly true that the poorer families are almost always low caste Kami and Damai, where the parents have little or no education. Access to health services is officially the same for all, but in reality, the Health Post (and other public services) was used far more by Thakali families than any other group. However, the group that consistently had the poorest growth status, the highest morbidity and the most elevated ACT were the high caste children. Some caution must be exercised as numbers of children in this group were low, but the pattern appears convincing. The high caste families living in Mustang were not poor or uneducated; without exception, the fathers were working as teachers or other government officials, on relatively high salaries. It seems probable that cultural, as well as economic, factors are important determinants of children's health in Mustang. Differences in diet, beliefs and lifestyle exist between the high caste families and Thakali families living on a similar economic level.

Key differences exist between Marpha and Thini, indeed between any tourist and non-tourist village in the Kali Gandaki valley. The large numbers of foreign tourists, traders and pilgrims passing through villages on the main trail have several effects. Economically, there is a positive impact, as hotels and tea houses cater for the travellers. There is also a greater range of goods available as merchants pass through, which may affect the diet of the population of on-trail villages. There is a greater exposure to the wider world, both through word of mouth from fellow Nepalis, and the multiple influences of foreign tourists and media. This undoubtedly affects adolescents and young adults living in Marpha, who see television, hear radio and talk with tourists from other countries about their different lifestyles. Whether this has a major

effect, either directly on the attitudes and behaviour of children themselves, or whether these cultural influences have filtered down to parents and affected child rearing practises, is less certain. Pollard et al (2000) suggest that this may lead to greater psychosocial stress from the conflict between the actual lifestyle lived, and a person's aspirations to a different and unobtainable lifestyle, and that this may have adverse effects on health and well-being. Finally, the contact with large numbers of passing travellers may also increase infectious disease rates in on trail villages. However, this may be offset by improved standards of public health and hygiene to cater for foreign tourists.

6.3. Appraisal of methodology

The combination of novel and established methods used in this study enabled rigorous testing to be performed, and yielded several important results, which are discussed above. In particular, the close association between raised levels of ACT and reported illness is of methodological interest in two ways. I feel that these findings taken along with similar results reported by Rousham et al. (1998), both confirm the value of child self-reports of ill health for comparison within a single group of subjects and suggest the use of ACT as a more objective measure of morbidity where comparison is required across different groups of subjects. The simultaneous use of the two methods allows a greater depth of data on morbidity. Other serum markers, such as albumin, immunoglobulins, C-reactive protein and haemoglobin may also be measured from a single small blood sample. Albumin levels are reported to fall with reported illness (Rousham et al., 1998), although this was not the case in the current study.

Of course, clinical examinations may be of great additional value where there are grounds for serious doubts about the value or meaning of reported information from a particular population. Results will also be objective, and transferable across populations, which may be important for some studies. Maternal or self-reported data are inevitably going to be comparable only within a limited population group, because of the many social and cultural factors affecting responses. I did not feel this was a major difficulty, as my primary objective was to look at variation within my own sample, and the inter-relationships between variables. Other limitations of morbidity interviews are lack of data on the severity of the illness, and the impossibility of identifying the causal pathogen. This could be partially overcome by supplementing interviews with analysis of stool samples to identify parasite infestation. Several types of intestinal parasite are endemic in Nepal, including protozoa such as *Giardia lamblia* and *Entamoeba histolytica*, which may both cause acute and chronic diarrhoea, and nematodes such as roundworm, and whip worm (Shlim, 1994). Worm infections are not generally associated with diarrhoea, and may not lead to elevated ACT levels. However, severe infestations may cause bloating of the stomach and anorexia, and are particularly associated with anaemia, perhaps because of increased internal blood loss. Laboratory testing of stool samples would have yielded valuable information on rates of infection, and also permitted investigation into effectiveness of treatment, and rates of re-infection.

Unfortunately, there were no facilities available within Mustang for the analysis of stool samples, or reliable means of transporting samples to laboratories further afield. As I was working alone, and am not clinically trained, full medical examinations of children was not a realistic option. The methods I used have some limitations and drawbacks, as discussed above, but there are also, I believe, advantages in obtaining subjective reports. Self-reports from the

children enabled me to understand much more about the impact and meaning of illness in their lives, and to explore their definitions of illness, health and well-being. Although this thesis focused on physiological rather than psychosocial aspects of health and well-being, the greater understanding I gained from conducting morbidity interviews was invaluable. The specific techniques of questioning children that I developed, described in chapter 3 and appendix 2, proved to be satisfactory for eliciting the required information from children.

It became clear when attempting to test the models proposed in the final chapter that more detailed data on morbidity were needed. Ideally, each child should be interviewed weekly, or at least fortnightly, over the entire study period, by the same investigator, using the same technique of questioning. This would yield much richer data, including information on the duration and frequency of episodes of illness, which would allow more meaningful analysis of the relationship between illness, inflammation and growth. ACT and morbidity were associated with reduced linear growth over certain time periods ($p=0.032$ and $p=0.001$, table 6.5), but not others. Better data on morbidity, as well as more frequent anthropometric measurements might shed light on this puzzle.

Ideally, I would also advocate more frequent collection of anthropometric data, at least height and weight, to allow calculation of changes in z-scores of height-for-age, weight-for-age and weight-for-height. Children may grow both very rapidly, and extremely irregularly, meaning that infrequent measurement may not provide an accurate picture of their growth patterns. In particular, weight can be quickly lost, following episodes of illness, or in times of food scarcity, and gained, under conditions of health and plentiful availability of good quality food. Monthly height and weight measurements are usually considered optimal to obtain good quality longitudinal data. However, frequent measurements are time-consuming and tedious for both investigator and subject. The best anthropometric data rely on measurements being taken by the same worker with the same equipment on each occasion to reduce error. Height and weight measurements are relatively simple and quick to perform, but in a dispersed rural community, there may be considerable problems inherent in tracking down each child on a specified day every month. Participants may well tire of overly frequent investigations, reducing compliance for all procedures. I feel this is less of a problem when working with children, as they are often entertained by the anthropometric techniques and questioning, and glad to avoid tasks they would otherwise be involved in, such as school work, or domestic chores. Of course, this may in turn lead to straining of the investigator's relationship with parents or teachers.

Similarly, it would be desirable to obtain some measurement of inflammation or immune function on a more frequent basis. It is clearly not acceptable to repeat blood sampling too often; I felt that my request for three samples from each child over a period of a year was

pushing the limits of acceptability. However, saliva sampling is much better received by children (although not so much by adults, particularly amongst the Hindu population), so perhaps measurements of secretory IgA in saliva would be one way forward. There should be no problem with a study design requiring weekly collection of saliva samples over an extended time, or even daily collection of samples over a period of a week or two. This would allow sample collection, and measurement of immune function, coincident with morbidity interviews, if required, or a finer grained analysis of variation in immune function over a shorter period of time.

In conclusion, I feel that the difficulties I encountered when analysing data were more concerned with the limitations of my study design (due to finances) than the actual techniques employed. For all measures, sampling more frequently over the whole year would have been immensely useful in yielding a larger and more versatile data set. Obviously, the possibilities for pursuing this kind of research in practise are restricted by constraints of time and money. To collect the type of data I suggest from a reasonably sized sample of children would involve two or more researchers able to be based constantly at the field site or sites over an extended period, preferably at least an entire year. An ideal example of this kind of project would be the research described by Baqui et al (1993 a, b) where 700 children were followed over the course of one year as part of the Matlab longitudinal study in Bangladesh. Morbidity data was collected every fourth day by home visits, anthropometric measurements performed monthly, and cell-mediated immune function assessed every three months. Unfortunately, the financial support that would allow this kind of presence in the field, plus sufficient equipment, and funds to cover the laboratory analysis of the blood or saliva samples collected is extremely hard to come by. The combination of funding and expertise is often only possible in large scale, long running, multidisciplinary projects, such as the Matlab study and the Keneba project in the Gambia.

Moffat (1998) wrote, "Although growth stunting may manifest itself similarly in children living in a wide variety of low-income countries, the underlying determinants of it no doubt differ in each individual community." Similarly, the relationship between growth status and infections is complex and multi-factorial, and significant results from a study of one population may not be replicable in another environment, even one apparently similar. The evidence summarised in earlier chapters makes clear both that repeated infections may lead to poor growth status, and that children with poor growth status may be more susceptible to infections. However, the results of my research emphasise that there are many other factors at work, some of which are not easily identifiable, but associated with demographic variables such as *jat* and village; seasonal variation further complicates the results. The key to understanding the synergistic relationship between infections and growth status must be to investigate more closely the intermediary variables of the immune system.

APPENDICES

Appendix 1. Repeated anthropometric measurements on 10 children aged 5 to 12 years

child ID	T21	T22	T23	T25	T26	T28	T29	T30
height 1, cm	129.4	123.2	136.7	120.7	112.3	107.8	128.8	126.3
height 2, cm	129.8	122.4	136.0	121.3	112.7	108.5	128.6	125.5
weight 1, kg	29.0	22.4	28.2	22.6	17.4	15.8	25.0	25.6
weight 2, kg	29.4	22.4	28.4	22.2	17.6	16.0	24.8	25.2
arm circumference 1, cm	20.1	16.1	17.3	19.2	14.9	14.0	16.0	17.1
arm circumference 2, cm	20.1	16.2	17.4	19.2	14.9	14.0	15.9	16.9
biceps skinfold 1, mm	10.2	4.5	4.7	6.7	2.7	4.5	3.9	5.3
biceps skinfold 2, mm	9.9	5.3	4.5	6.9	3.1	4.3	3.7	5.3
triceps skinfold 1, mm	12.1	6.1	7.1	9.0	3.8	6.3	4.9	8.2
triceps skinfold 2, mm	12.5	6.4	6.7	8.4	3.9	5.9	5.1	8.4
subscapular skinfold 1, mm	7.0	4.9	4.4	6.1	4.1	4.0	4.5	4.7
subscapular skinfold 2, mm	7.4	4.7	4.1	6.4	3.7	4.1	3.9	5.1
suprailiac skinfold 1, mm	7.1	4.3	3.9	6.0	3.1	2.9	3.1	3.5
suprailiac skinfold 2, mm	6.5	3.8	4.2	5.2	3.5	3.4	3.1	2.7

**Appendix 2. Typical questions used when obtaining child morbidity reports,
with Nepali translation**

How are you?

Timilai sanchao chha?

What's wrong?

Ke bhayo?

In the last week have you been ill?

Gaeko haptaamaa timi biraami bhayo?

In the last week have you been well?

Gaeko haptaamaa timi sanchai bhayo?

Which illness?

Kun kun rog?

Do you have (a fever) today?

a cough/cold

diarrhoea

dysentery

Aaja timile (jwaro) lageko chha?

khoki/ruga

disaa/jhada/pakhala

ragat masi

Did you have a fever yesterday? (the day before?)

Hijo (asti) timile jwaro lageko chha?

For how many days?

Kati din bhayo?

How long since (the fever) started?

Kahile dekhi (jwaro) lageko?

How do you feel now?

Ahile kasto chha?

Did you take any medicine?

Ausadhi khanu bhayo?

Did you go to the health post (jankri / medicine shop)?

Timile health post (jankri/ aushadi pasal) janu bhayo?

Appendix 3. Questions used for child structured interview, with Nepali translation

Personal details

What is your name?

Timro naam ke ho?

What is your caste/ ethnicity?

Timro jat ke ho?

How old are you?

Timi kati barsa bhayo?

What is your date of birth?

Timro janmaa miti kati ho?

How many brothers and sisters do you have? (Answer also gives birth order in family)

Timro dajubhai ra didibahini kati chhan?

How many people live in your house?

Timro gharmaa kati jana chha?

Who are they?

Ko ko chha?

Migration from other villages

How long have you lived in this village?

Timi kahile dekhi yes gaunma hunuhuncha?

What was the name of the previous village?

Yedi yes aghi kumai gaunma basek bhaya tesko naam?

How far from this village?

Ahile ko thegana bata kati tadha?

Visits to other towns

Have you been to Kathmandu? Who with? How long? Why?

Timi Kathmandu janu bhayeko chha? Ko sanga? Kati samaya? Kina?

Have you been to Pokhara? Who with? How long? Why?

Timi Pokhara janu bhayeko chha? Ko sanga? Kati samaya? Kina?

How many times have you been to Jomsom?

Jomsom kati patak gayeko chha?

Where do your family spend the winter?

Jadomaa timro paribar kahaa bos chha?

Child's education and work

What class are you in at school?

Timi schoolko kati classma hunuhunchha?

Or if not in school, up to what class did you study?

Yedi schoolma chhaina bhane kati class summa padheko chha?

Why did you stop?

Kina chhodeko?

What sort of work do you do out of school?

School chhadera aru ke kam garchaau?

Family's work

What is your father's work?

Timro bubako kam ke ho?

What is your mother's work?

Timro amako kam ke ho?

Have any members of your family left home to find work?

Timro paribarma kahi gaun chhadi kam garna gayeko chha?

Where did they go? Why? When?

Kahaa gayeko chha? Kina? Kahile?

Contact with tourists and outside influences

Do tourists give you things when they pass through? What?

Gora harule timiharulai kehi dinchha?

Do you speak to tourists?

Timi gorasangai bolnu hunchha?

Have you eaten foreign foods?

Timile bideshi khana khanu bhayeko chha?

Have you seen TV?

TV hernu bhayeko chha?

Do you know any foreign languages?

Bideshi bhasa jannu hunchha?

Does someone in your family have a radio?

Timro paribarma kosaiko radio chha?

When you are ill, where do you go? Health post? Hospital? Jankri? Medicine shop?

Jaba timi biraami huncha, taba khaale janu bo? Health post? Hospital? Jankri? Aushadi pasal?

Appendix 4. Topics of interest in household socio-economic survey

name and age of parents

parents' level of education

number of people living in house

names and ages of children in house

are children in school?

place of birth of parents and children (if not Marpha, where, and when did they move?)

parents' occupation (s)

do they derive any income from tourists? (if yes, estimate of size and type of business)

where do the family spend winter?

does the household own land? what type? (farm/forest/grazing/kitchen garden) how much?

is any agricultural land irrigated?

does the household own animals? what type? how many?

does anyone outside the family work for the household?

does house have tap?

does house have toilet?

Appendix 5. Community food use survey (Weiner & Lourie, 1981)

- a) *Identify suitable representatives of community.*
- b) *Record personal details.*
- c) *Administer questionnaire to informants.*

(i) **The staple food or foods** (i.e. the main energy-yielding food(s) which is/are eaten at all meals).

How is it processed?

What happens to the fractions of cereals?

In what different ways is it cooked?

Are there local names for different preparations?

Is it fermented in any way?

What are the substitutes for the main staple in times of shortage (e.g. pre-harvest, in drought, if price rises steeply)?

Is meal considered 'adequate' without some form of this staple?

(ii) **Foods eaten with the staple**, especially fat- and protein-yielding foods.

The use of fruit and vegetables.

Use of processed foods, and whether they are processed in the home, locally or commercially on a large scale.

Drinks which may have nutritive value.

Strategies for times of famine, food shortage or low household income.

Which foods are luxuries and which necessities?

Seasonal variations in food use and supply.

Social variations in food use: i.e. what foods are especially associated with festivals or ceremonies, and not used frequently otherwise?

The informants should be reminded at intervals to give information about the community in general and not only their own personal food pattern.

Appendix 6. Arm circumference and skinfold data

Median, mean, standard deviation and range of arm circumference and skinfold measurements for 125 children aged five to twelve years

measure	median	mean	standard deviation	range
arm circ. (cm)	16.9	16.97	1.74	14.0-23.2
biceps skinfold (mm)	4.10	4.49	1.63	1.9-11.8
triceps (mm)	6.90	7.06	1.67	3.9-12.2
subscapular (mm)	5.00	5.25	1.22	3.3-9.9
suprailiac (mm)	3.70	4.13	1.19	2.1-10.2
sum of 4 skinfolds (mm)	20.30	21.30	4.55	12.7-42.1

Appendix 7. Marpha health post records

This section contains statistics I compiled from Marpha health post in August 1997 with the assistance of Raj Kumar Bista of ACAP. The 1364 records covered each individual visit made over a complete year, and the tables below give the diagnosis made in each case (using existing categories in the records), and the number of cases attending the health post each month.

Health post records by diagnosis

diagnosis	number	percentage
skin infections	351	13.1
acute respiratory infections	149	11.3
diarrhoea	107	8.1
abdominal pain	102	7.7
worms	99	7.5
toothache	57	4.3
eye infections	56	4.2
unknown fever	46	3.5
arthritis and gout	45	3.4
injury/ fractures	43	3.2
ear infections	34	2.5
vitamin deficiencies/ anaemia	27	2.0
urinary tract infections	22	1.6
other diseases	351	26.7

Health post records by month, July 1996 to August 1997

Nepali month	number of patients	percentage
Saaun (mid July to mid August)	312	22.8
August-	200	14.7
September-	122	8.9
October-	81	5.9
November-	83	6.1
December-	25	1.8
January-	42	3.1
February-	60	4.4
March-	29	2.1
April-	84	6.2
May-	178	13.0
June-	148	10.9
total	1364	100

Appendix 8. Quartiles of anthropometric data

		25th percentile	50th percentile	75th percentile
HAz	March 1997 (n=98)	-2.10	-1.44	-0.74
	July 1997 (n=116)	-2.22	-1.56	-0.85
	Sept. 1997 (n=119)	-2.19	-1.56	-0.85
	March 1998 (n=102)	-1.99	-1.42	-0.79
	all seasons (n=435)	-2.12	-1.46	-0.84
WHz	March 1997 (n=98)	-1.53	-0.99	-0.60
	July 1997 (n=116)	-1.18	-0.78	-0.35
	Sept. 1997 (n=119)	-1.19	-0.69	-0.26
	March 1998 (n=102)	-0.99	-0.57	-0.14
	all seasons (n=436)	-1.24	-0.75	-0.33
WAz	March 1997 (n=98)	-2.16	-1.64	-1.21
	July 1997 (n=116)	-1.96	-1.58	-1.14
	Sept. 1997 (n=119)	-2.03	-1.53	-1.09
	March 1998 (n=102)	-1.92	-1.46	-0.84
	all seasons (n=434)	-2.03	-1.55	-1.07

BIBLIOGRAPHY

- Anderson, R. & Mitchell, E.M. (1984) Children's health and play in rural Nepal. Social Science and Medicine 19: 735-740.
- Baker, R. (1996) PRA with street children in Nepal. PLA Notes 25: Special Issue on Children's Participation. Sustainable Agricultural Programme.
- Baker, R., Panter-Brick, C. & Todd, A. (1996) Methods used in research with street children in Nepal. Childhood 3: 171-193.
- Banik, N.D., Nayar, S., Krishna, R. & Raj, L. (1972) The effect of nutrition on growth of pre-school children in different communities in Delhi. Indian Paediatrics 9: 440-446.
- Baqui, A.H., Sack, R.B., Black, R.E., Chowdhury, H.R., Yunus, M. & Siddique, A.K. (1993) Cell-mediated immune deficiency and malnutrition are independent risk factors for persistent diarrhea in Bangladeshi children. American Journal of Clinical Nutrition 58: 543-548.
- Baqui, A.H., Black, R.E., Sack, R.B., Chowdhury, H.R., Yunus, M. & Siddique, A.K. (1993) Malnutrition, cell-mediated immune deficiency, and diarrhea: a community-based longitudinal study in rural Bangladeshi children. American Journal of Epidemiology 137:355-365.
- Baumann, H. & Gauldie, J. (1994) The acute phase response. Immunology Today 15: 74-80.
- Baungartner, R.N., Roche, A.F. & Himes, J.H. (1986) Incremental growth tables: supplementary to previously published charts American Journal of Clinical Nutrition 43: 711-722.
- Bennett, T. (1996) The Effect of Tourism on Child Well-being and Health. Durham University Expedition report.
- Bennett, T. & Panter-Brick, C. (1996) The effect of Western trekkers on the growth status of children in the Annapurna area, Nepal: a preliminary report. Social Biology and Human Affairs 61: 1-6.
- Bernard, H.R. (1994) Research Methods in Anthropology- Qualitative and Quantitative Approaches. 2nd ed. Sage.

Bhandari, N., Bhan, M.K., Sazawal, S., Clemens, J., Bhatnager, S. & Khoshoo, V. (1989) Association of antecedent malnutrition with persistent diarrhea: a case-control study. British Medical Journal 298: 1284-1287.

Bista, D.B. (1991) Fatalism and development: Nepal's struggle for modernization. Calcutta: Orient Longman.

Bista, D.B. (1971) The political innovators of upper Kali-Gandaki. Man 6: 52-60.

Black, R.E., Lanata, C.F. & Lazo, F. (1989) Delayed cutaneous hypersensitivity: epidemiologic factors affecting and usefulness in predicting diarrheal incidence in young Peruvian children. Pediatric Infectious Disease Journal 8: 210-215.

Black, R.E., Brown, K.H. & Becker, S. (1984) Malnutrition is a determining factor of diarrheal duration, but not incidence, among young Bangladeshi children in a longitudinal study in rural Bangladesh. American Journal of Clinical Nutrition 37: 87-94.

Brown, K.H., Black, R.E. & Becker, S. (1982) Seasonal changes in nutritional status and the prevalence of malnutrition in a longitudinal study of young children in rural Bangladesh. American Journal of Clinical Nutrition 36: 303-313.

Bundy, D.A.P. & Guyatt, H.L. (1996) Schools for health: focus on health, education and the school-age child. Parasitology Today 12: 1-16.

Calvin, J & Price, C.P. (1986) Measurement of serum α -1-antichymotrypsin by immunoturbidimetry. Annals of Clinical Biochemistry 23: 206-209.

Calvin, J., Neale, G., Fotherby, K.J. & Price, C.P. (1988) The relative merits of acute phase proteins in the recognition of inflammatory conditions. Annals of Clinical Biochemistry 25: 60-66.

Carey, J.W. (1990) Social system effects on local level morbidity and adaptation in the rural Peruvian Andes. Medical Anthropology Quarterly 4: 266-295.

Chandra, R.K. (1991) 1990 McCollom award lecture. Nutrition and immunity: lessons from the past and new insights into the future. American Journal of Clinical Nutrition 53: 1087-1101.

- Chen, L.C., Huq, E. & Huffman, S.L. (1981) A prospective study of the risk of diarrheal diseases according to the nutritional status of children. American Journal of Epidemiology 114: 284-292.
- Cole, T.J. (1993) The use and construction of anthropometric growth reference standards. Nutrition Research Reviews 6: 19-50.
- Corriel, R.N., Kniker, W.T., & McBryde, J.L. (1985) Cell-mediated immunity in school children assessed by Multitest CMI skin-testing: normal values and proposed scoring system for healthy children. American Journal of Diseases of Childhood 139: 141-146.
- Costello, A.M. de L. (1989) Growth velocity and stunting in rural Nepal. Archives of Diseases of Childhood 64: 1478-1482.
- Currimbhoy, Z. (1963) Growth and development of Bombay children. Indian Journal of Child Health 12: 627-651.
- Dettwyler, K.A. (1992) Infant feeding practices and growth. Annual Review of Anthropology 21: 171-204.
- Dobrowolska, H. & Panter-Brick, C. (1998) How much does lifestyle matter? Growth status and cortisol variation in Ethiopian children. Social Biology and Human Affairs
- Eveleth, P.B. & Tanner, J.M. (1990) Worldwide Variation in Human Growth. Cambridge: Cambridge University Press.
- Farquharson, S.M. (1976) Growth patterns and nutrition in Nepali children. Archives of Diseases in Childhood 51: 3-12.
- Ferro-Luzzi, A. & Branca, F. (1993) Nutritional seasonality: the dimensions of the problem. pp149-165 in Seasonality and Human Ecology Ulijaszek, S.J. & Strickland, S.S. (Eds.) Cambridge: Cambridge University Press.
- Filteau, S.M., Morris, S.S., Raynes, J.G., Arthur, P., Ross, D.A., Kirkwood, B.R., Tomkins, A.M. & Gyapong, J.O. (1995) Vitamin A supplementation, morbidity, and serum acute-phase proteins in young Ghanaian children. American Journal of Clinical Nutrition 62: 434-438.

Filteau, S.M., Morris, S.S., Abbott, R.A., Tomkins, A.M., Kirkwood, B.R., Arthur, P., Ross, D.A., Gyapong, J.O. & Raynes, J.G. (1993) Influence of morbidity on serum retinol of children in a community based study in Northern Ghana. American Journal of Clinical Nutrition 58: 192-197.

Fischer, W. & Sulzer, W. (1994) Economic and ecological effects of tourism in Langtang national-park (Nepal). Mitteilungen der Osterreichischen Geographischen Gesellschaft 136: 225-242.

Frisancho, A.R. (1981) New norms of upper limb fat and muscle areas for assessment of nutritional status. American Journal of Clinical Nutrition 34: 2540-2545.

Gadomski, A.M., Aref, G.H., Hassanien, F., el Ghandour, S., El-Mougi, M., Harrison, L.H., Khallaf, N. & Black, R.E. (1993) Caretaker recognition of respiratory signs in children: Correlation with physical examination findings, X-ray diagnosis and pulse oximetry. International Journal of Epidemiology 22: 1166-1173.

Garmezy, N. & Rutter, M. (Eds.) (1983) Stress, Coping and Development in Children. New York: McGraw-Hill.

Gershwin, M.E., Beach, R.S. & Hurley, L.S. (Eds.) (1985) Nutrition and Immunity. London: Academic Press.

Gittelsohn, J. (1991) Opening the box: intrahousehold food allocation in rural Nepal. Social Science and Medicine 33: 1141-1151.

Glaser, R., Kutz, L.A., MacCallum, R.C. & Malarkey, W.B. (1995) Hormonal modulation of Epstein-Barr virus replication. Neuroendocrinology 62: 356-361.

Glaser, R. & Kiecolt-Glaser, J.K. (1994) Stress-associated immune modulation and its implications for reactivation of latent herpesviruses. In R. Glaser & J. Jones (Eds.), Human Herpesvirus Infections (pp. 245-270). New York: Dekker.

Gomez, F., Galvan, R.R., Frenk, S., Munoz, J.C., Chavez, R. & Vasquez, J. (1956) Mortality in second and third degree malnutrition. Journal of Tropical Pediatrics 2: 77-83.

Gopalan, C. (1983) Small is healthy? For the poor, not for the rich. Nutrition Foundation Of India Bulletin, October.

- Gracey, M., Cullity, G.J. & Suharjono, S. (1977) The stomach in malnutrition. Archives of Diseases of Children 52: 325-7.
- Guerrant, R.L., Kirchoff, L.F., Shields, D.S. et al. (1983) Prospective study of diarrheal illnesses in north-eastern Brazil: patterns of disease, nutritional impact, etiologies, and risk factors. Journal of Infectious Disease 148: 986-987.
- Gupta, R. & Basu, A. (1981) Variations in body dimensions in relation to altitude among the Sherpas of the eastern Himalaya. Annals of Human Biology 8: 145-151.
- Hamill, P.V.V., Drizd, T.A., Johnson, C.L., Reed, R.B., Roche, A.F. & Moore, W.M. (1979) Physical growth: National Center for Health Statistics percentiles. American Journal of Clinical Nutrition 32: 607-629.
- Hamill, P.V.V., Drizd, T.A., Johnson, C.L., Reed, R.B. & Roche, A.F. (1977) NCHS Growth Curves for Children, Birth-18 years. Vital and Health Statistics, Series 11, no.165.
- Harrison, G.A., Tanner, J.M., Pilbeam, D.R. & Baker, P.T. (1988) Human Biology, 3rd edition. Oxford: Oxford University Press.
- His Majesty's Government of Nepal, Office of Nutrition (1975) Nepal Nutrition Status Survey, January -May 1975. Washington: United States Agency for International Development.
- Huijbers, P.M.J.F., Hendriks, J.L.M., Gerver, W.J.M., de Jong, P.J. & de Meer, K. (1996) Nutritional status and mortality of highland children in Nepal: impact of sociocultural factors. American Journal of Physical Anthropology 101: 137-144.
- James, J.W. (1972) Longitudinal study of the morbidity of diarrheal and respiratory infections in malnourished children. American Journal of Clinical Nutrition 25: 690-694.
- Jelliffe, D.D. (1966) The assessment of the nutritional status of the community. World Health Organisation Monogram Series 53: 1-271.
- Jemmott, J.B. III & McClelland, D.C. (1989) Secretory IgA as a measure of resistance to infectious disease: comments on Stone, Cox, Valdimarsdottir & Neale. Behavioural Medicine 12: 63-71.

- Johnston, F.E. & Low, S.M. (1984) Biomedical anthropology: an emerging synthesis in anthropology. Yearbook of Physical Anthropology 27: 215-227.
- Kalter, H.D., Gray, R.H., Black, R.E. & Gultiano, S.A. (1991) Validation of the diagnosis of childhood morbidity using maternal health interviews. International Journal of Epidemiology 20: 193-198.
- Katz, J., West, K.P. Jr, LeClerq, S.C., Thapa, M.D., Khatri, S.K., Shresta, S.R., Pradhan, E.K. & Pohkrel, R.P. (1998) Agreement between clinical examination and parental morbidity histories for children in Nepal. Journal of Tropical Pediatrics 44: 225-229.
- Kiecolt-Glaser, J.K. & Glaser, R. (1995) Measurement of immune response. In Cohen, S., Kessler, R.C. & Gordon, L.U. (Eds.) Measuring Stress- a Guide for Health and Social Scientists Oxford University Press.
- Klurfeld, D.M. (Ed.) (1993) Nutrition and Immunology. New York: Plenum Press.
- Kniker, W.T., Lesourd, B.M., McBryde, J.L. & Corriel, R.N. (1985) Cell-mediated immunity assessed by Multitest CMI skin testing in infants and preschool children. American Journal of Diseases of Childhood 139: 840-845.
- Kniker, W.T., Anderson, C.T., McBryde, J.L., Roumiantzeff, M. & Lesourd, B. (1984) Multitest CMI for standardised measurement of delayed cutaneous hypersensitivity and cell-mediated immunity. Normal values and proposed scoring system for healthy adults in the U.S.A. Annals of Allergy 52: 75-82.
- Koster, F.T., Plamer, D.L., Chakrabarty, J., Jackson, T. & Curlin, G.G. (1987) Cellular immune competence and diarrheal morbidity in malnourished children: a prospective field study. American Journal of Clinical Nutrition 45: 115-120.
- Koster, F.T. (1987) Cellular immune competence and diarrheal morbidity in malnourished Bangladeshi children: a prospective field study. American Journal of Clinical Nutrition 46: 115-120.
- Kroeger, A. (1983) Health interview surveys in developing countries: a review of the methods and results. International Journal of Epidemiology 12: 465-481.

- Kugler, J., Hess, M. & Haake, D. (1992) Secretion of salivary immunoglobulin A in relation to age, saliva flow, mood states, secretion of albumin, cortisol, and catecholamines in saliva. Journal of Clinical Immunology 12: 45-49.
- Levine, N.E. (1979) Differential child care in three Tibetan communities: beyond son preference. Population and Development Review 13: 281-307.
- Lunn, P.G. (2000) The impact of infection and nutrition on gut function and growth in childhood. Proceedings of the Nutrition Society 59: 147-154.
- Lunn, P.G., Northrop-Clewes, C.A. & Downes, R.M. (1991) Intestinal permeability, mucosal injury and growth faltering in Gambian infants. Lancet 338: 907-910.
- Manzardo, A.E. (1982) Impression management and economic growth: the case of the Thakalis of Dhaulagiri zone. Kailash 9: 45-60.
- Martorell, R. (1989) Body size, adaptation and function. Human Organization 48: 15-20.
- Martorell, R. (1985) Child growth retardation: a discussion of its causes and its relationships to health. pp. 13-39 in Nutritional Adaptation in Man (Eds. Blaxter, K. & Waterlow, J.C.) London: Libbey.
- Martorell, R. & Ho, T.J. (1984) Malnutrition, morbidity and mortality. pp. 49-68 in Child Survival: Strategies for Research, Mosley, W.H. & Chen, L.C. (Eds.) New York: Cambridge University Press.
- Mascie-Taylor, C.G.N. (1994a) Statistical issues in anthropometry. In Anthropometry: the individual and the population, pp.56-77 [S.J. Ulijaszek and C.G.N. Mascie-Taylor, eds.]. Cambridge: Cambridge University Press.
- Mascie-Taylor, C.G.N. (1994b) Analysing cross-sectional anthropometric data. European Journal of Clinical Nutrition 48(supp. 3): s190-s202.
- Mata, L.J. (1978) The children of Santa Maria Cauque: a prospective field study of health and growth. Cambridge, MA: MIT Press.

- Mata, L.J., Kromal, R.A., Urrutia, J.J. & Garcia, B. (1977) Effect of infection on food intake and the nutritional state: perspectives as viewed from the village. American Journal of Clinical Nutrition 30: 1215-1227.
- Mata, L.J., Jiminez, F. & Gordon, M. (1972) Gastrointestinal flora of children with protein-calorie malnutrition. American Journal of Clinical Nutrition 25: 1118-1126.
- McDade, T.W., Stallings, J.F. & Angold, A. (2000) Epstein-Barr virus antibodies in whole blood spots: a minimally invasive method for assessing an aspect of cell-mediated immunity. Psychosomatic Medicine 62: 560-568.
- McDade, T.W. & Worthman, C.M. (1998) The weanling's dilemma reconsidered: a biocultural analysis of breastfeeding ecology. Journal of Developmental and Behavioral Pediatrics 19: 286-299.
- McDade, T.W., Shell-Duncan, B., Worthman, C.M. & Stallings, J.F. (1998) Methodological and conceptual issues in field studies of cell-mediated immune function. American Journal of Human Biology 10: 131.
- McDade, T.W., Worthman, C.M., Rilling, J., Stallings, J.F. & Angold, A. (1996) Stress, Depression, Gender and Immune Function in American Adolescents. Presented at AAPA annual meeting, April 1996, Durham, NC.
- McElroy, A. (1990) Biocultural models in studies of human health and adaptation. Medical Anthropology Quarterly 4: 243-265.
- Moffat, T. (1998) Urbanization and child growth in Nepal. American Journal of Human Biology 10: 307-315.
- Moffat, T. (1998) Growing up among the looms: the growth and nutrition of children living in a peri-urban environment in Kathmandu, Nepal. PhD thesis. McMaster University.
- Mosley, W.H & Chen, L.C. (1984) An analytical framework for the study of child survival in developing countries. pp. 25-45 in Child Survival: Strategies for Research, Mosley, W.H. & Chen, L.C. (Eds.) New York: Cambridge University Press.

Nabarro, D., Howard, P., Cassels, C., Pant, M., Wijga, A. & Padfield, N. (1988) The importance of infections and environmental factors as possible determinants of growth retardation in children. in Linear Growth Retardation in Less Developed Countries Waterlow, J.C. (Ed.) Nestle Nutrition Workshop Series, Vol. 14. New York. Vevey/Raven Press.

Nabarro, D.N. (1985) Influences on the growth of children: observations from Nepal. Journal of the Nepal Pediatric Association 2: 137-205.

Nabarro, D. (1984) Social, economic, health and environmental determinants of nutritional status. Food and Nutritional Bulletin 6: 18-32.

Northop-Clewes, C.A., Rousham, E.K. & Lunn, P.G. (1991) The effect of regular antihelminthic administration on rural Bangladeshi children: intestinal permeability and plasma protein concentrations.

Pagdin, C. (1995) Assessing tourism impacts in the third-world- a Nepal case-study. Progress in Planning 44: 193-

Panter-Brick, C., Lunn, P.G., Baker, R. & Todd, A. (2001) Elevated acute-phase protein, stunting and morbidity reports in Nepali children: different urban and rural profiles. British Journal of Nutrition (in Press).

Panter-Brick, C., Dobrowolska, H. & Drewett, R. (1999) Hormonal and anthropometric markers of lifestyle in Nepali and Ethiopian children. Abstract in American Journal of Physical Anthropology s28:218.

Panter-Brick, C. (1998) Biological anthropology and child health: context, process and outcome. In Biosocial perspectives on children. Panter-Brick, C. (Ed.) CUP, Cambridge.

Panter-Brick, C. (1997) Seasonal growth patterns in rural Nepali children. Annals of Human Biology 24: 1-18.

Panter-Brick, C., Todd, A. & Baker, R. (1996) Growth status of homeless Nepali boys: do they differ from rural and urban controls? Social Science and Medicine 42: 441-451.

Panter-Brick, C. (1992) The energy-cost of common tasks in rural Nepal- levels of energy-expenditure compatible with sustained physical-activity. European Journal of Applied Physiology and Occupational Physiology 64: 477-484.

- Panter-Brick, C. (1987) Subsistence work and motherhood in Salme, Nepal. PhD thesis. Oxford University.
- Parker, B. (1988) Moral economy, political economy, and the culture of entrepreneurship in highland Nepal. Ethnology 27: 181-194.
- Parker, B. (1991) Beyond the vote: responses to centralization among Nepal's Marpha Thakali. Human Organization 50: 349-357.
- Parker, B. & Patterson, D.W. (1993) He's no good: sexual division of labor and habitus among Nepal's Marpha Thakali. South Asia Bulletin 13: 81-89.
- Pawson, I.G. (1977) Growth characteristics of populations of Tibetan origin in Nepal. American Journal of Physical Anthropology 47: 473-482.
- Pollard, T.M., Ward, G.A., Thornley, J., Wooster, G, Wooster, J. & Panter-Brick, C. (2000) Modernisation and children's blood pressure: on and off the tourist trail in Nepal. American Journal of Human Biology 12: 478-486.
- Pollard, T.M., Bennett, T., Whittle, L., Clark, J., Bartell, A. & Panter-Brick, C. (1997) Children's blood pressure on and off the tourist trail in Nepal. Poster presented at the 1997 meetings of the Human Biology Association, St Louis, Missouri.
- Prentice, A. & Prentice, A. (1988) Reproduction against the odds. New Scientist 118: 42-6.
- Quandt, S.A. (1987) Methods of determining dietary intake, in Johnston, F.E. (ed.) Nutritional Anthropology Alan Liss, NY.
- Ross, D.A. & Vaughan, J.P. (1986) Health interview surveys in developing countries: a methodological review. Studies in Family Planning 17: 78-94.
- Rousham, E.K., Northrop-Clewes, C.A. & Lunn, P.G. (1998) Maternal reports of child illness and the biochemical status of the child: the use of morbidity interviews in rural Bangladesh. British Journal of Nutrition 80: 451-456.
- Scheper-Hughes, N. Ed. (1987) Child survival: anthropological perspectives on the treatment and maltreatment of children. Dordrecht: Reidel.

Scrimshaw, N.S. & Young, V.R. (1989) Adaptation to low protein and energy intakes. Human Organization 48: 20-30.

Scrimshaw, N.S., Taylor, C.E. & Gordon, J.E. (1968) Interaction of Nutrition and Infection. Geneva: WHO.

Seckler, D. (1980) Malnutrition: an intellectual odyssey. Western Journal of Agricultural Economics 5: 219-227.

Shell-Duncan, B. & Snyder, K. (1999) Effect of settlement and development on child nutritional status: individual, household and community level factors. Abstract in American Journal of Physical Anthropology. S28: 248-9.

Shell-Duncan, B. (1997) Determinants of child survival in traditional societies: the application and test of a theoretical framework. Working Paper at the Center for the Study of Demography and Ecology, University of Washington, Seattle, WA.

Shell-Duncan, B. (1997) Evaluation of infection and nutritional status as determinants of cellular immunosuppression. American Journal of Human Biology 9: 381-390.

Shell-Duncan, B. & Wood, J.W. (1997) The evaluation of delayed-type hypersensitivity responsiveness and nutritional status as predictors of gastrointestinal and acute respiratory infection: a prospective field study among traditional nomadic Kenyan children. Journal of Tropical Pediatrics 43: 25-32.

Shell-Duncan, B. (1995) Impact of seasonal variation in food availability and disease stress on the health status of nomadic Turkana children: a longitudinal analysis of morbidity, immunity and nutritional status. American Journal of Human Biology

Shell-Duncan, B. (1993) Cell-mediated immunocompetence among nomadic Turkana children. American Journal of Human Biology 5: 225-235.

Shlim, D. (1994) Health and Safety pp. 104-136, in Trekking in the Nepal Himalaya, 6th edition. Armington, S. (Ed.) London: Lonely Planet Publications.

Shrestha, N.R. (1990) Landlessness and migration in rural Nepal. Westview.

- Soliani, L. & Rossi, O. (1992) Demographic-factors and land-use planning in the small islands of Southern Europe. Environmental Management 16: 603-611.
- Stevens, S.F. (1993) Tourism, change and continuity in Mount-Everest region, Nepal. Geographical Review 83: 410-427.
- Stone,A.A., Cox,D.S., Valdimarsdottir,H. & Neale,J. (1987) Secretary IgA as a measure of immunocompetence. Journal of Human Stress 13: 136-140.
- Sullivan, P.B., Mascie-Taylor, C.G.N., Lunn, P.G., Northrop-Clewes, C.A. & Neale, G. (1991) The treatment of persistent diarrhoea and malnutrition: Long-term effects of in-patient rehabilitation. Acta Paediatrica Scandinavia 60: 1025-1030.
- Sustainable Agriculture Programme (1996) Special issue on children's participation. PLA Notes: 25. London: International Institute for Environment and Development.
- Sustainable Agricultural Programme (1992) Special issue on applications for health. RRA Notes: 16. London: International Institute for Environment and Development.
- Thomas-Slayter, B. & Bhatt, N. Land, livestock, and livelihoods: changing dynamics of gender, caste, and ethnicity in a Nepalese village. Human Ecology 22: 467-494.
- Thompson,D., Milford-Ward,A. & Whicher, J.T. (1992) The value of acute phase protein measurements in clinical practice. Annals of Clinical Biochemistry 29: 123-131.
- Tomkins, A. (1993) Environment, season and infection. pp. 123- 134 in Seasonality and Human Ecology Ulijaszek, S.J. & Strickland, S.S. (Eds.), Cambridge: Cambridge University Press.
- Tomkins, A. (1988) The risk of morbidity in a stunted child. in Linear Growth Retardation in Less Developed Countries Waterlow, J.C. (Ed.) Nestle Nutrition Workshop Series, Vol. 14. New York, Vevey/Raven Press.
- Tomkins, A. (1981) Nutritional status and severity of diarrhea among pre-school children in rural Nigeria. Lancet 1981 (1): 860-862.
- Trowbridge, F.L., Newton, L.H. & Campbell, C.C. (1981) Nutritional Status and severity of diarrhea. (Letter). Lancet 1981(1): 1375.

Udani, P.M. (1963) Physical growth of children in different socio-economic groups in Bombay. Indian Journal of Child Health 12: 593-611.

Ulijaszek, S.J. (1997) Transdisciplinarity in the study of undernutrition-infection interactions. Coll. Antropol. 21: 3-15.

Ulijaszek, S.J. (1994) Between-population variation in pre-adolescent growth. European Journal of Clinical Nutrition 48(suppl. 1): s5-s14.

Ulijaszek, S.J. & Strickland, S.S. (1993) Eds. Seasonality and Human Ecology. Cambridge: Cambridge University Press.

Ulijaszek, S.J. & Lourie, J.A. (1994) Intra- and inter-observer error in anthropometric measurement. pp. 30-55 in Anthropometry: the Individual and the Population, Ulijaszek, S.J. & Mascie-Taylor, C.G.N. (Eds.) Cambridge University Press.

UNICEF (1996) Nepal Multiple Indicator Surveillance Health and Nutrition- Cycle 1, January-March 1995. Kathmandu: UNICEF-Nepal.

US Bureau of the Census (1998) BUCEN International Database

Van Lenthe, F.J., Kemper, H.C.G. & Twisk, J.W.R. (1994) Tracking blood pressure in children and youth. American Journal of Human Biology 7: 535-542.

Vinding, M. (1984) Making a living in the Nepal Himalayas: the case of the Thakalis of Mustang district. Contributions to Nepalese Studies 12: 51-106.

von der Heide, S. (1988) Thakali Field Studies. Journal of the Nepal Research Centre 8: 39-54.

von Fürer-Haimendorf, C. (1966) Caste concepts and status distinctions in Buddhist communities of Western Nepal. In Caste and Kin in Nepal, India and Ceylon: Anthropological Studies in Hindu-Buddhist Contact Zones, edited by C. von Fürer-Haimendorf. (Bombay: Asia Publishing House), pp. 140-160.

Walker, S.P., Grantham-McGregor, S.M., Himes, J.H. & Powell, C.A. (1996) Relationships between wasting and linear growth in stunted children. Acta Paediatrica 85: 666-669.

Walker, S.P. & Golden, M.H.N. (1988) Growth in length of children recovering from severe malnutrition. European Journal of Clinical Nutrition 42: 395-404.

Waterlow, J.C. (1994) Relationship of gain in height to gain in weight. European Journal of Clinical Nutrition 48 (suppl.): s72-s74.

Waterlow, J.C. (1988) Preface. In: Linear Growth Retardation in Less Developed Countries, Ed. Waterlow, J.C. Nestle Nutrition Workshop Series, vol. 14. New York: Raven Press.

Waterlow, J.C. (1985) What do we mean by adaptation? pp. 1-11 in Nutritional Adaptation in Man, Blaxter, K. & Waterlow, J.C. (Eds.) London and Paris: John Libbey.

Waterlow, J.C., Buzina, R., Keller, W., Lane, J.M., Nichamann, M.Z. & Tanner, J.M. (1977) The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. Bulletin of the World Health Organisation 55: 489-498.

Waterlow, J.C. (1972) Classification and definition of protein-calorie malnutrition. British Medical Journal 1972 (iii): 566-569.

Weiner, J.S. & Lourie, J.A. (1981) Practical Human Biology. Academic Press: London.

Wiersinga, A. & van Rens, M.M. (1973) The simultaneous effect of protein-calorie malnutrition on weight and height velocity. Environmental Child Health (special issue).

WHO (1999) WHO Statistical Information Website.

WHO (1998) The World Health Report, 1998. Switzerland: World Health Organization.

The World Bank (1999) World Development Indicators 1999. Washington DC: World Bank.

Worthman, C.M. & McDade, T.W. (1996) Anthropology Meets Immunology: a Developmental-Adaptationist Model of Immunocompetence. Presented at the AAPA annual meeting, April 1996, Durham, NC.

