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THE MORINDA EXPERIENCE

An Economic Analysis of the Determinants of Malnutrition Among Young Children in Rural India

F. James Levinson

Ph.D. Dissertation
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June, 1972

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The Indian research was conducted in collaboration with the Indian Food and Nutrition Board directed by an old friend and colleague, Dr. P. K. Kymal. The Board was extremely helpful in all phases of the field work and its efforts are genuinely appreciated.

Two other Indian entities actively involved in the research were the Post Graduate Institute of Medical Research and Training (P.G.I.) in Chandigarh which undertook the parasitology analysis, and the Punjab Department of Health. Arrangements for the actual conduct of the data collection were facilitated by Dr. B. K. Aikat, Dean of the P.G.I. and Dr. H. K. Dhillon, then Assistant Director of Health Services in Punjab. Assistance in the parasitology work was provided at the P.G.I. by Professor N. L. Chitkara and Assistant Professor R. C. Mahajan of the Microbiology Department, by Messrs. Gurdeep Singh, Raj Kumar and Inderjeet Singh who analyzed the slides and tried to teach me how to identify a giardia flagellate, and by Mr. Prem Singh who did the dirty work.

Probably the primary factor contributing to the rapid and effective conduct of the field work was our good fortune in being able to work with Mrs. Gurdial Kaur, a highly skilled, remarkably dedicated medical paraprofessional holding the barely descriptive title of Lady Health Visitor in the Morinda area of Ropar District, Punjab. Clearly the future of Punjab's health depends far more on these women than on those much higher paid but largely irrelevant officials who, in the words of Solzhenitzen "preside over the inauguration of undertakings...and then reappear to officiate over their deaths or to crown their achievements."

With the help of Gurdial Kaur we were able not only to collect the information presented here, but also to provide certain health services

to the children in this critical age group. Although accurate accounting is difficult in the absence of an explicit evaluation we were able to get rid of, at least for a few months (but probably an important few months at that age), most of the giardia infection and also, surprisingly, bring about significant improvement in all but one case of frank marasmus.

If this study contributes anything to our knowledge of the malnutrition problem among young children, it is in large part because of the solid base of Punjab health and nutrition information painstakingly collected over the years by Johns Hopkins and Harvard Universities. Results of the Harvard work, to which I refer frequently in the text, have been published in The Khanna Study by Drs. John Wyon and John Gordon. I was fortunate in having Dr. Wyon's counsel both at the beginning and conclusion of the field work.

The Johns Hopkins work directed by Dr. Carl Taylor and the Department of International Health is being done at the Narangwal Rural Health Research Center in Ludhiana District of Punjab. It was the existence of their work which largely prompted my selection of Punjab and specifically Ropar District for the field work. The Johns Hopkins work at Narangwal has included the collection of large bodies of data, much of it longitudinal, as well as controlled studies on the effects of particular combinations of health, nutrition, and family planning interventions. Accordingly, rather than starting from scratch, I was able to begin the field work with as much accumulated knowledge and experience as the Johns Hopkins group could fill me with during my pre-field work visits. Similarly, they were extremely helpful in the analysis. Clearly the future of this kind of work depends on such cooperation within the academic community rather than the rivalries which often have characterized it in the past.

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compilation and card sorting. One of my lasting memories will be of the two of us checking columns of figures (in the true spirit of research) by flashlight during the blackout imposed by the Indo-Pakistan war. These are her people, and it is to her that this study is dedicated.

to Sati

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SUMMARY

Widespread recognition of the importance of combating malnutrition among young children in low income countries has increased the need for systematic planning to permit the development of effective strategies to deal with the problem. Such country or regional planning might be thought of as a three step process. The first assesses the dimensions and magnitude of the problem. Step two seeks to identify the relative importance of the determinants of malnutrition. Where malnutrition exists, how much of the problem is due to income levels or relative prices of important commodities, to what extent is parasitic infection a limiting factor, how important are belief patterns relating to health and nutrition? The final step then attempts, through some form of cost-benefit or cost-effectiveness analysis, to find the optimum means of affecting those determinants which prove most limiting.

This study addresses primarily the second step of the process through an analysis of 496 children in the critical 6-24 month age group, the period of highest malnutrition-related mortality and the time of origin for any mental debilitation which occurs among the survivors. The study was carried out in 17 villages in Ropar District of Punjab in Northern India surrounding the small market town of Morinda, an area on the periphery of, or in an early stage of the so-called "Green Revolution".

Using multiple regression analysis on cross section data the study attempts to identify the primary direct determinants of nutritional status and then, in turn, to examine these determinants in terms of a series of socioeconomic explanatory variables. Nutritional status was measured using anthropometric measures. Food intake was assessed using the 24-hour recall method, after which the foods consumed were translated into calories,

protein, vitamin A, and iron. Infection was measured by the child's disease history, the frequency and severity of his diarrheal infection, and by the extent of parasitic infection assessed through the laboratory analysis of stool samples. Belief patterns were measured on the basis of answers to a series of questions relating to optimum age of food supplementation, dietary response to infection, and the cause of a Punjabi language equivalent of nutritional marasmus. In addition to the above, basic social-demographic data was collected, and a stock (wealth) and flow (income) measure of economic status was estimated for the family of each child.*

The study found the extent of malnutrition among these children, in spite of their location on the outskirts of the Green Revolution, particularly serious--more serious than in most other parts of the low-income world. Almost half were suffering from 2nd or 3rd degree malnutrition using the Gomez classification.

With respect to food intake, the most serious deficiencies were of calories (average 61.3 percent of allowance) and iron (36.7 percent of allowance) although there may be some question regarding the validity of the caloric allowance. Protein deficiency is less serious and not a significant problem independent of the calorie one. Similarly vitamin A deficiencies do not appear as serious as in other parts of India. In terms of infection, diarrhea proved considerably more important for children of this age than either their disease history or giardia (the only parasite-like infection found in this population).

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* A more detailed summary of the analytical results of the study is found at the beginning of Chapter 6.

Variation in nutritional status among the young children was explained both by differences in their caloric intake and the extent of their diarrheal infection. Variation also was explained by three other variables:

a. Age - From about the age of 6 months, as breast feeding alone becomes inadequate and with the onset of the syndrome of weanling diarrhea, children begin to depart sharply from the standards.

b. Sex - The much higher premium placed on living sons in this society is reflected in the better care and attention devoted to them, particularly at the low end of the economic spectrum.

c. Such non-quantified factors as pre-natal environment, demand vs. opportunity breast feeding, and the psychological effect of a mother's presence, all of which would be closely related to economic status.

The determinants of caloric intake and diarrheal infection, and hence the means of addressing them differ significantly between children of Jat (landowning) and Ramdasia (landless agricultural laborer) families. While malnutrition exists in both groups the most critically affected are the Ramdasias. For the Jats, the most important determinant of food intake is belief patterns suggesting that an information dissemination program addressing these beliefs could well prove an effective intervention. Among the Ramdasias, estimation of the determinants of both caloric intake and diarrheal infection suggests that the factor most critically inhibiting improvement in their nutritional status is income. The income problem relates both to the availability of resources and to the mother's time. For the Ramdasia woman, required by economic necessity to spend a major portion of the day working outside of her home, the adequate care of a young child is seriously problematic. If the child is a girl, the case is that much more serious.

In terms of interventions, it is likely that the Jat child will derive higher benefits from virtually any intervention program than will the Ramdasia. For the Jat woman, most of the preconditions would seem to be met for the effective translation of her income and time into improved health for her children once the facilities to permit such translation (education, programs, health clinics, or other interventions) are established. For the Ramdasia, largely bypassed by the development process, these preconditions generally have not been met.

To positively affect the nutritional status of Jat children a program of information dissemination related to child care and feeding probably would be the single most important intervention. Such information dissemination might be facilitated by a weaning food distribution which, in turn, could strengthen the outlets selected for such distribution, among them family planning institutions. For the Ramdasias, a substantial improvement in their economic position appears to be a prerequisite for viable improvement in the nutritional status of their children. Only when this basic income constraint is overcome, are these children likely to be able to derive significant benefits from specifically nutrition intervention programs. Such economic betterment, in turn, probably requires rather basic changes in social and political organization through which the poor can restructure and more fully avail themselves of the opportunities inherent in the development process.

CHAPTER 1

INTRODUCTION AND PERSPECTIVE

The planning and implementation of programs to combat malnutrition in low income countries is, at best, a complex undertaking. Perhaps nowhere else in the development process does an area of undertaking cut across so many disciplines, so much subject matter. Further, given the relative infancy of international concern with the subject, we lack precision in identifying and quantifying the developmental benefits of better nutrition and hence effectively bidding for scarce resources. Finally, while there are widely differing schools of thought on the segment of the population to address, the best means of reaching it and the cost, there is remarkably little empiricism on any of this. These problems coupled with what often seem to be the unmanageable dimensions of the problem, not only have complicated the nutrition planning process but also, undoubtedly, have served as a deterrent to major investment in this area.

Nonetheless, malnutrition is becoming a matter of increasing concern in low income countries both as a major source of mortality and sickness, and as a serious drain on developmental efforts to achieve human resource potential. The mortality rate among children aged one to four in low income countries ranges from roughly 20 to 80 times higher than in industrialized ones (11,57). Probably over half of the deaths in this age group could be considered malnutrition-related. FAO contends that "malnutrition is the biggest single contributor to child mortality in the developing countries" (22). Berg has compiled Latin American data indicating that malnutrition is an underlying or associated cause of between 52 and 70 percent of all deaths between the ages of one and four (11).

Further, those malnourished children who survive may be physically and mentally debilitated, perhaps irreparably.

On purely humanitarian grounds the case would appear sufficiently convincing. Yet, in the context of scarce budgetary resources, and in competition even with advocates of solutions to other human needs (insufficient food on a macro level, communicable diseases, and inadequate shelter), the humanitarian case for combatting malnutrition has not fared particularly well. As a result, the nutrition advocate during the past decade has begun to examine the developmental implications of malnutrition. He has begun to examine the hypothesis that malnutrition-caused mental and physical debilitation may limit the utilization of a country's existing educational capacity and adversely affect productivity. He also has advanced an argument suggesting that high child mortality rates, in large part a function of malnutrition, provide a disincentive for social security-conscious parents to practice family planning.

More recently, advocates of these positions have been joined by critics of the overall patterns of development which have emerged in low income countries during the past few decades. These critics note that investment-oriented development programs in many of these countries essentially have excluded major segments of their populations and that concerns with income distribution and employment, though frequently voiced, seldom have been addressed explicitly. Consequences have been both economic (un- and underemployment probably representing the first limiting factor in the development process in many countries) and political (disruptive violence being a natural outgrowth of major income differentials and large scale unemployment). The equity problems inherent in these patterns of development often are reflected in widespread malnutrition. Conversely, nutrition

intervention emerges as a meaningful, attractive and visible component of broader strategies designed to reorient these development processes.

Thus, not withstanding the difficulties, the development of strategies to combat malnutrition is likely to become an increasingly important pursuit of planning commissions in low income countries.

It has been suggested elsewhere (15) that the nutrition planning process basically involves a threefold investigation. The first level involves identification in a particular geographic area of the nutrition problem in terms of food availability and intake, and in terms of physical, clinical and biochemical measurements. This first step in the analysis also should provide at least a general idea of the population target group to be addressed.

All too often the process of investigation ends with this first step after which program decisions are made according to the interests of existing administrative and technical entities. Further levels of analysis are clearly necessary, however, to provide some basis for rational investment decisions. A second level of the investigation would identify the determinants or causal factors of malnutrition among a target group, while a third level would attempt, through cost-effectiveness analysis, to find the optimum means of positively affecting these determinants.

This study is concerned primarily with the second level of the investigation: identification of the determinants of nutritional status or health and their relative importance. The phrasing of the sentence poses the thorny conceptual problem arising here; namely the question of whether we are dealing with nutritional status or with health. At first glance it may appear that the types of measurements used to quantify so-called "nutritional status" (i.e., clinical, biochemical or, as in this

study, anthropometric measurements) are actually measures not only of nutrition but also of diarrheal and parasitic infection and the individual's disease history. This would seem to suggest that, at least for the young child, such measures are in reality a measure of overall health.

Looked at another way, however, it could be argued that the health of an individual is a complex set of highly interrelated constituent elements including mental health, disease and nutritional status. In such a context nutritional status would not be defined simply as a measure of food intake, but rather as the extent to which food constituents are physiologically absorbed or utilized. The extent of this absorption will depend significantly on the presence or absence of infection and disease as well as on the food consumed. Clinical, biochemical and anthropometric measures serve to quantify this nutritional status variable as thus defined (although, in some cases, such measures for a young child might also serve as a reasonable proxy for his overall health). Using such a conceptualization, infection and disease, aside from their effects on the nutritional status component of health, are independent components of health in their own right along with numerous other health components which have little or no effect on nutritional status. A child contracting diarrheal infection today could not be considered in good health even though the infection has not yet affected his nutritional status as defined here.

The case for isolating this nutritional status component of overall health for analysis is twofold. First, there is reason to believe, at least in low income countries, that the nutritional status component of health among young children is the most important component of overall health status, often more important than the others combined, and a major

determinant of the severity of virtually all the others. Second, there is the more practical consideration that while ideally the nutritional status component might best be addressed as part of an overall health approach (in the same way that inadequate food, housing and education might best be jointly addressed as manifestations of poverty in industrialized nations), there is little evidence this is happening or that it will happen on the scale required.[1/] To date the vast majority of health directed efforts in these countries have been medical, usually curative, in nature. In part it was the success of these measures which pointed up the vital, but relatively untouched matter of nutritional status. The medical groups quantified the magnitude of the problem but seldom addressed it, in large part because the interventions called for usually were non-medical. It soon became evident that if this problem were to be addressed -- and its dimensions and implications demanded it -- the problem would have to be addressed by a group other than the traditional medically-oriented one and with a very different set of tools. Thus, the analysis in this study is designed not so much for the medical or public health professions per se (although there is major overlap into the public health field) as for this new group attempting to address nutritional status specifically.

Nutritional status will be examined through a micro study designed to estimate the primary determinants and where possible their interaction for a particular population group. The study rests on the assumptions that, (1) malnutrition has negative effects on economic growth and social

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1/ Interestingly, one of the few places where this is being done is at Narangwal by the Rural Health Research Center (RHRC) whose work is discussed throughout this study.

well-being, and (2) combatting this problem has some valid claim on the budgetary resources of the area. The seriousness of the malnutrition will speak for itself.

Not actually part of the second level of investigation, but necessary for its undertaking is a determination of the target group to be addressed. Cases can and have been made for different groups depending on the circumstances. The target group in a highly labor intensive economy that is not labor surplus could be the adult working populace, particularly with respect to its caloric deficiency. Alternatively, in situations of food scarcity coupled with high fertility rates, the primary problem might be maternal malnutrition, perhaps reflected in a high proportion of low birthweight infants. In most low income countries, however, the primary nutritional target should be the preschool age child. Both the mental debilitation and family planning motivation arguments noted earlier suggest the preschool age child as the target. Similarly the equity argument would have sympathy with a concentration on this group as a highly meaningful and visible object of concern.[2/] More specifically, these arguments probably point to the child between 6 and 24 months of age. Studies of mental growth indicate that malnutrition-caused debilitation, where it occurs, traces back to this critical 18 month period. Similarly, Wyon and Gordon's findings in India (66) add further empirical evidence that the major bulk of preschool age, malnutrition-related mortality occurs within this age period. Their study, conducted in Ludhiana District of Punjab, found a

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2/ One must assure, however, that these visible kinds of intervention accompany and not substitute for change in existing patterns of development. Otherwise they will represent nothing but a palliative, and probably have the effect of delaying the day of reckoning on the larger issue.

particularly high mortality rate during the first month of age (averaging between 70 and 80 deaths of liveborn children per 1000 live births) resulting largely from birth-associated difficulties or diseases such as tetanus. During the next four months, the mortality rate decreased to about 30 deaths per 1000 live births. Between 6 and 11 months, with the onset of more severe malnutrition and weanling diarrhea, the mortality rate increased sharply to 50 for males and close to 70 for females per 1000. The rate remained almost as high for the 12-17 month age group, then began to drop regularly with age. The 24-29 month age group had a mortality rate of only about 10 per 1000. In terms at least of the hypothesized developmental returns on nutrition investment then, this 6-24 month age group would appear to constitute the primary target. On this basis it has been selected as the age group addressed in the micro study.

The following chapter presents a general discussion of the determinants usually believed to affect the nutritional status of the target group. Chapter 3 presents the methodology utilized in examining these determinants in the micro study, and Chapters 4 and 5 examine the results found. Chapter 6 presents conclusions and a discussion of appropriate interventions.

CHAPTER 2

THE DETERMINANTS OF NUTRITIONAL STATUS

This chapter provides a brief, general examination of those determinants usually believed to affect the nutritional status of young children. The following chapters will examine the extent to which these factors are in fact important determinants for children in the micro study. The discussion here is limited to those factors which, unlike religion or genetic traits, lend themselves to intervention.

Conceptually, these determinants might be classified into direct and indirect factors. Basically, the nutritional status of a child is determined by (1) his food intake, and (2) the presence or absence of disease and infection, the direct determinants. These two, in turn, are functions of such factors as family purchasing power (involving income, commodity prices and the cost of other demands on a family budget), the nutrition and health beliefs of the child's mother, the nutritional content of the foods consumed, the presence or absence of health care and non-family feeding programs, plus numerous environmental and social phenomena. These determinants presented diagramatically in Figure 1 are considered separately below.

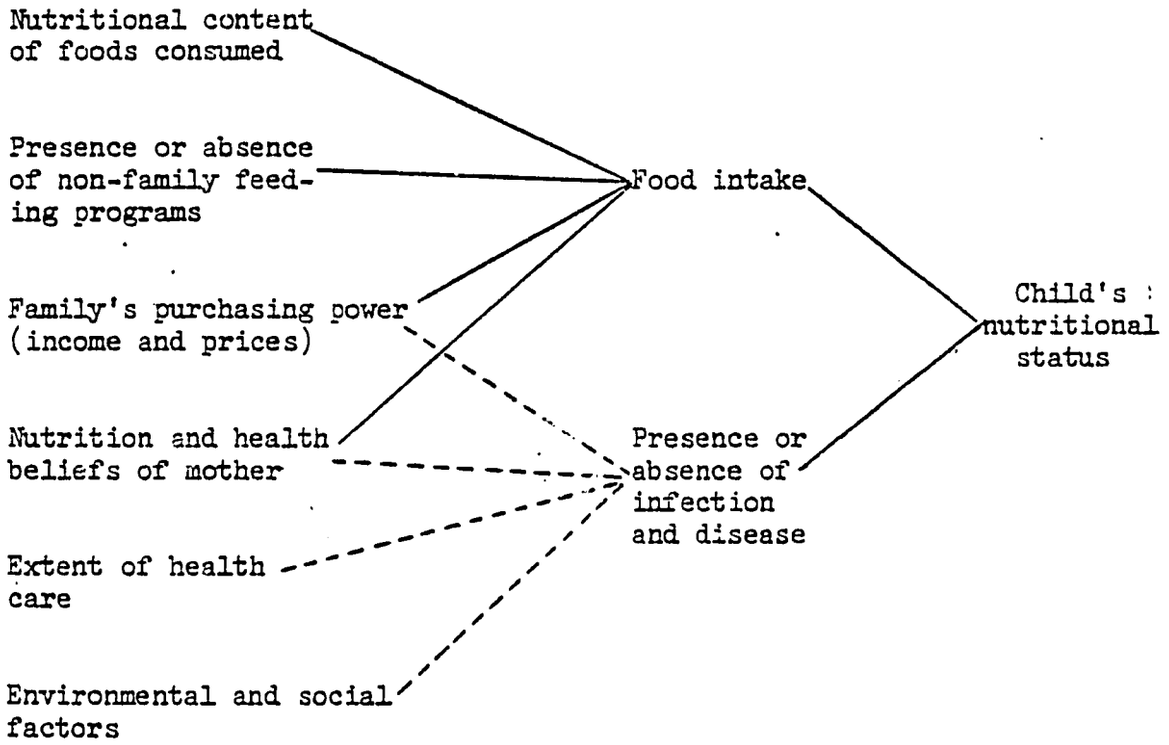
Family Purchasing Power

A family's purchasing power depends basically on (1) its wealth and income position, (2) the relative prices of food commodities it buys, and (3) the cost of other demands on its budget, particularly necessities that require cash. Thus, at least conceptually, increasing a family's purchasing power or real income for nutritional purposes can be accomplished by augmenting income flows to the family, by reducing the prices

of food it consumes, or by subsidizing its other budgetary necessities, i.e. housing, schooling, health, or clothing, thereby releasing additional funds for food purchase. The third approach suggests that existing government financing of education, health centers, and low-cost housing provides a secondary benefit to food consumption and hence nutrition.

Income and prices, the primary components of purchasing power, are discussed separately below and in the ensuing discussion.

Figure 1. DETERMINANTS OF A CHILD'S NUTRITIONAL STATUS



Income: Probably no other single factor has so major an effect on the components of nutritional status for the population as a whole in low income countries as income. Examination of cross section food consumption data in these countries (21) reveals highly significant differences in food consumption patterns along the income spectrum. Three

trends appear to be almost universal, none of which is particularly surprising. The first, commonly referred to as Engel's law, finds that as income rises the percentage of that income allocated to food declines but that absolute expenditures rise.[1/] A second trend is that the proportion of total calories supplied by carbohydrate staples (cereals and tubers) decreases and is replaced by more expensive animal or vegetable commodities as income increases (8). A third trend is that within food groups there is a shift toward processed, more expensive items and varieties.

In nutritional terms the third trend, usually involving payment for various marketing services, may have a negative effect. The literature abounds with examples of shifts from brown rice to polished rice, high extraction to low extraction flour, and cane to refined sugar as income increases (9). On balance, processed foods in general probably represent a nutritional minus where lost nutrients are not restored.

In terms of overall nutritional effect, however, these negative effects of income are entirely outweighed by the positive effects of the first and second trends. While part of the increase in absolute expenditure suggested by the first trend results in the purchase of more expensive items, the increase will almost invariably result in the ingestion of more food, hence more calories, thereby overcoming a major, often limiting, nutritional obstacle (23). In surveys that have examined caloric intake explicitly, a clearly positive linear relationship of calories with income emerges (53).

1/ The exception lies with the lowest income groups in most countries. Though the percentage of their incomes spent on food is quite high (60 to 80 percent) the absolute expenditures are still so low that the first income increments usually result in a still higher percentage spent on food.

While the amount of food consumed increases with income, so does the variety as suggested by the second trend. Diets based on cereals, plantains, roots or tubers gradually become more diversified, and legumes, fruits and vegetables, milk, and other sources of animal protein become more important in terms of total calories. With reference to some foods, notably legumes, consumption increases with the first income increments and then levels off. More often, however, consumption of nutritious foods increases more or less linearly along the income spectrum. Monthly family expenditures on milk, for example, increase 50-fold from the lowest to the highest income groups in India (as compared with an 8-fold increase in cereal expenditures) (31). These differences are best reflected in income elasticities of demand[2/] for the commodities. In general, the more nutritious items are those with the highest elasticities (although there is no evidence whatever that the relationship is causal). In Asia and the Far East (excluding Japan) the elasticities of vegetables, meat and eggs are estimated at 0.9, 1.5, and 2.0 respectively, while the elasticity of cereals is 0.5. In the Near East, Africa, and Latin America the elasticities are somewhat lower but in almost the same proportions[3/] (20).

While for the population as a whole increases in income almost automatically are translated into larger quantities and a higher quality of food and hence improved nutritional status, the relationship for the target

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2/ The percentage increase in consumption of a food as income increases by 1 percent. Thus consumption of a food with an income elasticity of demand of .6 will increase by 0.6 percent as income increases by 1 percent.

3/ As a rule, these elasticities decrease as income increases and tend to be higher in rural than in urban areas (48).

6 to 24 month old population is less clear. Although prior studies focusing exclusively on this target group have been few and those rarely income specific, it has been suggested (66) that even in cases where available food is adequate to meet the young child's requirements, his difficulty in digesting and absorbing solid adult foods (preparation of specific foods for children among lower income groups in these countries is a rarity) often results in solid foods being withheld.

Commodity prices: Income is, of course, a relative concept, which takes on a specific meaning only in the context of its inherent purchasing power. This depends on food prices which, together with income, clearly affect the consumer's purchases and hence the child's diet. While some might argue that availability should be included here along with price, availability is actually built into the price concept since any existing item becomes available at some price. In the case of "on the farm" consumption of goods that never reach the market, the "price" of the item becomes its imputed value or opportunity cost; in other words the amount of money the family "sacrifices" by not selling the item. Basically price is a function of the supply of and the demand for particular commodities and of their transfer costs.

Nutritional Content of Food Commodities

A family's income and the prices of food commodities, to a significant extent, will dictate the amount of particular commodities purchased. The child's nutritional status then will depend in large part on the nutritional content of these commodities. Frequently the commodity itself implies a certain nutritional value although differences within commodity groups or even among varieties of a given commodity can be significant. The food's nutritional content might also be affected by ecological

factors or by processing between points of production and consumption.

Traditions and Beliefs

Almost regardless of the aforementioned factors, food consumption always has been based to an extent on preconceived beliefs relating to foods and their functions and on traditional preparation and consumption practices. In some cases these beliefs and processes have obvious validity relating to the health value of the item. In others the practice may support a basic cultural tenet of the population group and thus be equally valid (16,47). In still other cases, in both non-industrialized and industrialized countries, where such validity cannot be ascertained, these practices have been, rightly or wrongly, attributed to ignorance.

Practices relating to the feeding of young children have been under particular surveillance in recent years. Two such practices emerge as being notably significant. The first involves the critical period of weaning where problems are numerous. In some cases breast feeding continues well beyond six months but without supplementation. Elsewhere the milk is supplemented but with foods low in essential nutrients. Where more nutritious items are explicitly withheld, they sometimes reflect underlying association of these items with intestinal parasites or diarrhea. When weanling diarrhea does occur, any protein rich foods that were consumed are often withheld or solid foods are withheld altogether, a practice that further exacerbates the problem.

To some these practices simply reflect ignorance. Probably more accurate is Wyon and Gordon's contention that behavior is based on empirical experience. In many cases a mother recognizing the increased incidence of diarrheal infection when supplemental foods are given and recognizing the incidence of mortality from the infection, makes a

conscious, seemingly sensible decision to withhold such foods. What she will fail to recognize, largely because it is so undramatic, is the much higher mortality rate resulting from protein-calorie malnutrition and the child's inability to resist infection when supplemental foods are withheld (66).

The preceding set of practices or malpractices are usually attributed to tradition. Yet tradition is not always the culprit. Frequently problems arise as a direct result of abandoning traditions, often as a result of direct exposure to more industrialized regions. The prime example is the cessation of breast feeding in several parts of the low income world. Substituted is higher priced commercially bottled milk or powdered concentrate. All too often the higher price results in the use of inadequate quantities. Just as often the concentrate is reconstituted with unclean water. In either case the nutritional and health consequences are serious (35).

Infection and Disease

Even if the right foods are available to the child, they may not have their full effect upon his nutritional status if he suffers from other health problems, particularly gastrointestinal infection. Such infection can lower nutritional status or precipitate malnutrition in several ways. It can reduce food intake through loss of appetite. It results in loss of nitrogen, hence requiring increased protein consumption thereafter. Where the infection is the result of intestinal parasites, such as hookworm, the blood loss from the intestinal tract frequently leads to anemia. Finally, where the infection causes diarrhea, absorption of nutrients in the intestine will be reduced. Where protein levels already are low, diarrheal disease can precipitate kwashiorkor

(40,58). In addition, it has been well established that common childhood diseases like measles can have a drastic effect, either precipitating severe malnutrition or having a much higher degree of severity in the chronically underfed child.

The child also may be affected by the nutritional status of his mother during pregnancy and lactation, although findings here are less clear. In general, the quality of breast milk, with the exception of its thiamine content, does not appear to be affected significantly by the mother's nutritional status. However, in times of severe food shortage the quantity of milk secreted might be reduced.

Non-Family Feeding

In much of the world the preceding five factors are the primary determinants of a target group's nutritional status. For increasing numbers of children in many countries, however, there is a sixth determinant in the form of food received outside the home. In most cases such feeding represents a government initiative, at times supported with international assistance. Such feeding may appear to be more an intervention than a determinant, but its widespread prevalence at present probably qualifies it for the latter category as well.

The micro study presented in the following chapters looks at food intake, infection and disease, income and wealth, and beliefs as the primary categories of determinants. Given the cross sectional, geographically concentrated nature of the study, there was no variation in commodity prices or in the nutritional content of foods, hence these variables could not be examined. Non-family feeding also was eliminated as a variable since no program aimed at this group presently exists in

this area. Of course, the inability to quantify the effects of these variables by no means eliminates them as appropriate for intervention, and we accordingly shall return to them in the final chapter.

Although less easily affected the study also looks at family size, caste and sex to ascertain their importance relative to the other determinants.

CHAPTER 3

METHODOLOGY

The Study Objective and Research Design

The micro study was designed to identify the actual importance of the variables discussed in the preceding chapter as determinants of nutritional status among a group of children aged 6 to 24 months in rural North India. To carry out such an analysis it was proposed to collect, from a rather large sample of children of this age, information on various measures of nutritional status and on a wide range of potentially direct and indirect determinants of such status, to quantify these variables, and to examine their relationship through so-called ordinary least squares multiple regression analysis.

The general model originally envisaged for this analysis closely resembles the diagram in Figure 1 and will be elucidated further in Chapter 5. In the first equation, nutritional intake and infection are expressed as determinants of nutritional status. In the second and thir equations, nutritional intake and infection become dependent variables explained by a series of socioeconomic variables plus each other. Thi would give us the following three equation model:

Nutritional Status = f (Nutritional intake, Infection)

Nutritional Intake = f (Economic status, Family size, Sex, Caste, Mother's beliefs, Infection)

Infection = f (Economic status, Family size, Sex, Caste, Mother's beliefs, Nutritional intake)

The use of cross sectional data such as that used in this study presents problems which should be noted at the outset. First, there is the

implicit assumption that Group A with less income or intake (or anything else) will behave like Group B with more income or intake when, sometime in the future, Group A achieves the same income or intake levels that Group B enjoys today. In a context of rapid technological change, increasing options on expenditures, improved marketing facilities increasing the amount and variety of available foods, and significant changes in relative prices, all of which exist in Punjab, this may be a questionable assumption. More basic are the problems of using point in time measures (of say intake or parasitic infection) to explain variations which have emerged over a life time (i.e. size of the child). In addition, variation among children is simply a less accurate indicator of any variable than variations in the individual child over time. Thus, attempts to use cross sectional data in such analysis, results in the explanation of considerably less of the variation in the dependent variable, or in statistical terms, lower R^2's.

Nonetheless the alternative to cross section information is the collection of time series data, assuming it doesn't presently exist, through longitudinal studies. As valuable as such studies are, they by definition take years to carry out; time which may not be available to the planner with a strict time constraint. This would suggest that although time series studies are vital for precision in estimating the effects of these variables, there may be value in sharpening the tools of cross section analysis to permit a more rapid approximation of these effects for use in the planning process.

Having identified the primary determinants of nutritional status, it was proposed to project the relevance of alternative interventions

utilizing to the extent possible a previously developed nutrition planning model. This discussion is contained in Chapter 6.

The Locale and Sample

The study was conducted in the Indian state of Punjab, long the breadbasket of Northern India and today a leading grain surplus area in South Asia. With a recent reorganization of North Indian states, Punjab today numbers roughly 15 million persons and is largely dominated by persons of the Sikh religion.[1/] The population of rural Punjab is divided into three main groups: the Jats, traditionally the land-owning class or caste and clearly the predominant group in terms of resources and power; the Ramdasias or landless agricultural laborers, most of them Hindu "outcastes" or as Gandhi called them, "Harijans" in recent generations; and a third, smaller group designated "Others" representing a broad array of "service occupations": shopkeepers, barbers and teachers, some of whom are Hindu. Economically this more heterogeneous group falls between the Jats and Ramdasias.

Although clearly leading the rest of India agriculturally, Punjab itself is geographically heterogeneous with resulting economic disparities. Ludhiana District in the central part of the State represents one end of the Punjab economic spectrum with highly concentrated technological change in agriculture and major investment in irrigation. On the other end of the spectrum lies Ropar District in Eastern Punjab, an area

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1/ A reformist offshoot of Hinduism in the 16th century, Sikhism evolved from a pacifist sect to a highly militant one under pressure from Moghul rulers. Largely devoid of complex Hindu ritual and mythology, Sikhism follows the teachings of ten Gurus or prophets and a holy book called the Guru Granth Sahib. Followers of Sikhism are clearly distinguished by their unshorn hair, turbans and steel bracelets.

demographically similar to Ludhiana but considerably behind in all agricultural production indices. These differences are clearly indicated in Table 1 which compares the two districts, Punjab State and India by several indices of agricultural development (wheat and corn yields) and innovation (irrigation and area under new seed varieties). In each case the Ludhiana figure lies well above the Punjab State average, while Ropar lies below it, and all three lie well above the All-India figures.

Table 1. Indices of Agricultural Output and Innovation for Ludhiana and Ropar Districts, Punjab State, and India[a]

Index	Ludhiana District	Ropar District	Punjab State	India
Wheat yield per acre (pounds)	2,712	1,717	1,998	1,076
Corn yield per acre (pounds)	1,892	1,103	1,294	862
Percentage of cultivated acreage irrigated	83.0	27.8	74.0	22.0
Number of tractors (1966)	1,625	140		
Percentage wheat cultivation area under high yielding varieties	86.1	43.6	68.6	18.0
Percentage corn cultivation area under high yielding varieties	12.3	3.2	9.7	3.0

[a]Data compiled from Government of Punjab, Statistical Abstract of Punjab, 1970.

In order to permit eventual comparative analysis of these two ends of the spectrum, or of what might be called initial and advanced stages of the "Green Revolution", it was decided to carry out the study in Ropar District and subsequently to compare these findings with those of the

ongoing research of Johns Hopkins University at the Narangwal Rural Health Research Center (RHRC) in Ludhiana District.[2/] The area chosen is a contiguous rural one surrounding and within a five mile radius of the small (population 9,000) market town of Morinda. The area includes 17 villages and a total population of roughly 13,000 persons.[3/]

Rather than selecting a sample of children along some predetermined lines, it was decided to collect information on every available child in these villages from the age of 6 through 24 months. In total, information was collected on 523 children. With respect to coverage, the effort was between 90 and 95 percent effective. In each village there were a few cases of families out visiting maternal in-laws or mothers unwilling to participate in the study. For purposes of consistency the analysis was limited to 496 children for whom all information was available. The numerical breakdown of these children by caste and age group is as follows:

Caste:	Jats	209
	Ramdasias	194
	Others	93
	Total	496
Age:	6-11 months (6 month period)	163
	12-17 months (6 month period)	157
	18-24 months (7 month period)	176
	Total	496

2/ Some comparative analysis is contained in this study. More will be possible upon completion of the extensive data collection and analysis at Narangwal.

3/ Two villages, Bhateri and Himatpur, fall just over the border into neighboring Patiala District. Those in Ropar District are Badwali, Chaklan, Chitamla, Chitamli, Datarpur, Dhangrali, Doomsheri, Khant, Mankheri, Manpur, Marauli , Ramgarh Mandan, Rangian, Rattangarh-Kalheri, and Saheri. The average population per village was roughly 750 persons.

Much of the data was collected through an interview with the child's mother using the data collection form which is reproduced as Appendix I. These interviews conducted in Punjabi by the author, his wife, and Mrs. Gurdial Kaur, a locally posted paramedical extension agent, lasted approximately 30 minutes each. In addition, each child was weighed and measured, and a subsequent visit was made to collect a stool sample for laboratory analysis. This analysis was carried out by the Post Graduate Institute of Medical Research and Training in Chandigarh, the capital city of Punjab.

In the sections below, the variables examined in this study are presented, and the means of collecting and quantifying them are discussed. The actual findings are presented in the following chapter.

Nutritional Status

Nutritional status as defined and discussed in Chapter 1 is estimated using anthropometric measures. Although, ideally, one might desire clinical and biochemical measures as well, neither were feasible given the nature and time frame of the research. Nonetheless, the anthropometric measures probably provide the best single means of assessing the extent and, more important, gradations of protein-calorie malnutrition. There seems to be general agreement on the reliability and importance of growth, the variable actually measured over time by anthropometry, as an index of nutritional status (33). Growth also has been considered "the severest test of nutritional sufficiency" (26).

Nutritional status was assessed through the weight and height information collected for each child. These individual weights and heights then were compared with the so-called "Harvard Standards" (62). Although on the surface U. S. references might appear inapplicable for children

in low income countries, there is in fact considerable validity in their use. Comparative analysis seems to indicate clearly that the growth of healthy children in low income countries, at least in the early years, closely approximates these U. S. standards, thus ruling out the likelihood of significant genetic differentials biasing the use of such standards. Jelliffe (34) reports evidence from many parts of the world to the effect that well nourished infants and preschool age children attain at least weight levels closely approximating these standards. Jackson (33) found these same similarities by superimposing on U. S. growth curves the growth patterns of normal children from different countries. On the basis of surveys in seventeen low income countries conducted by the U. S. Interdepartmental Committee on Nutrition for National Defense (ICNND), Woodruff states that "infants and preschool children in most areas of the world have growth characteristics that are nearly the same under optimal environmental conditions. Racial and genetic factors probably play only a small part in the relative growth failure in many of the populations studied" (65).[4/]

Weights and heights were compared with the Harvard Standards[5/] by three parameters:

4/ None of this, however, negates the value of preparing reference growth curves for specific ethnic groups. Such caste and sex-specific standards for the Punjab currently are being prepared by Dr. DeSweemer of the Johns Hopkins Department of International Health and will be a valuable aid in all future endeavors of this kind.

5/ Like most studies of this kind, including that of Johns Hopkins at Narangwal, this study uses the Harvard Standards as presented in the WHO monograph on the Assessment of Nutritional Status of the Community (34) which, for young children, pools the sexes. The validity of such a procedure lies in the absence of significant male-female differences in the Harvard Standards for this age group. At no point do sex-specific weight references differ from the uniform standard by more than four-tenths of a pound or one-fifth of an inch.

weight for age: the weight of the child as a percentage of the reference weight for children of his age

height for age: the height of the child as a percentage of the reference height for children of his age

weight for height: the weight of the child as a percentage of the reference weight for children of his height.

In addition, recognizing the limitations of using any one of the above as a single measure of nutritional status, four other indices arbitrarily were constructed using combinations of these parameters. These indices are defined below:

Index	Definition
Nut. Stat. #1	An average of the three percentages
Nut. Stat. #2	An average of the weight for age and height for age percentages
Nut. Stat. #3	Multiplication of the square roots of the weight for age and height for age percentages
Nut. Stat. #4	Multiplication of the cube root of the height for age percentage by the cube root squared of the weight for age percentage

Each of these indices plus the three basic parameters are used alternatively as proxies for nutritional status in the analysis.

Nutrient Intake

Nutrient intake was estimated for each child through the use of the 24-hour recall method. Mothers were asked to indicate the amount of each food actually ingested by the child during the preceding 24 hour period, through the use of sample foods, the ingested portion of which the mother was asked to transfer into commonly used vessels. These vessels were

standardized in advance for each commodity by volume and weight. In the case of non-breast milk or milk-tea combinations, special care was taken to account for the universal practice of milk dilution. Similar care also was practiced in accounting for pulses which are served in a variety of consistencies. Translation of these food items into nutrients was then done using the tables of The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets, published by the Indian Council of Medical Research (4).

Breast milk quantities were calculated using quantities by age of the child as determined empirically in earlier research carried out by the Indian National Institute of Nutrition (56). That research estimated the breast milk intake of 184 infants and children in different stages of lactation and from different parts of India using the so-called test-feeding technique. Each child and its mother were admitted to a hospital for a 24-hour period. The child was weighed nude before and after every breast feeding, the total difference in weights representing the amount of milk ingested during the 24-hour period. A previously weighed diaper was tied on the baby permitting adjustments for any urine or stool voided during the feeding.

In spite of efforts made in the present study to ascertain whether or not the flow of breast milk was normal and to adjust accordingly, this estimate by definition lacks precision. It does not appear, however, to bias the figures for the sample as a whole in one direction or the other. Given the alternatives of (a) taking weight measurements after each breast feeding for each child over a 24 hour period or longer, or (b) leaving breast milk out of the nutrient estimates altogether, use of the existing estimates by age appeared to be the most sensible approach.

A large body of literature exists on the subject of estimating nutritional intake and points out the shortcomings of each approach. There is no effort here to defend the efficacy of the 24-hour recall method which clearly suffers from problems of memory lapses and the desire of the respondent to impress according to what he suspects are ulterior motives of the study by underestimating (when he suspects potential welfare) or overestimating (when he believes status is important). Nonetheless, finding it unfeasible on the one hand to carry out lengthy (and not always unbiased) food weighings in the home, and inadequate on the other to rely purely on rough food groupings (such as that used by national sample surveys) or Guttmann scaling, the 24-hour recall emerged as the most sensible approach.

One serious problem encountered in 24-hour recall measurement is that of seasonality. Unless the survey covers several seasons, changes in consumption over the year may lead to major biases. Although this is believed to be a less serious problem among very young children, an effort was made to carry the survey over two parts of the year. Roughly the first half of the 523 children were reached during the monsoon season, considered to be the latter part of the "lean" period as categorized by the Narangwal RHRC (36). The second half was reached during the winter, found to be the "fat" period.

In addition to the 24-hour recall data, information was collected on the age any supplementary milk or solid food feeding was initiated and the age of terminating breast feeding in the case of entirely weaned children.

The food intake of each child was translated into calories, protein, vitamin A and iron. These four food constituents are related to what

repeatedly have been cited as India's primary nutritional deficiencies by the Indian Council of Medical Research, the (Indian) National Nutrition Advisory Committee and the (Indian) Food and Nutrition Board. Actual intakes were then related, according to the child's age, to the "Daily Allowances of Nutrients for Indians," adopted by the Indian Council of Medical Research.

It should be noted that these standards are allowances rather than requirements. Allowances, which are set higher than requirements, serve as goals for planning and include a margin above and beyond physiological requirements to allow for variation among individuals, to permit the achievement of full growth potential, and to provide a buffer against common stress. Thus, individuals whose diets do not meet all nutrient allowances are not necessarily suffering from malnutrition.

In order to provide a single measure of nutritional intake for use in the analysis, the percentages of recommended allowance figures for calories, protein, vitamin A and iron were combined into the following two nutrient intake indices. Although somewhat arbitrary, these indices would seem to be rough approximations of the relative importance accorded these food constituents with respect to their effect on the nutritional status of young children.

Nut. Int. 1:	Calories = 40
	Protein = 30
	Vitamin A = 15
	Iron = 15
Nut. Int. 2:	Calories = 45
	Protein = 25
	Vitamin A = 5
	Iron = 25

These two indices and the percentage of recommended allowance figures for calories alternatively were used as proxies for the nutritional intake variable in the analysis.

Infection and Disease

Three measures of infection and disease--disease history, diarrheal infection, and parasitic infection--were examined independently and then looked at a composite weighted infection index. The three independent measures are discussed below.

1. Disease history - A disease history score was derived from information collected on the incidence of those major diseases capable of affecting a child's nutritional status, i.e. smallpox, measles, skin eruptions (impetigo, rubella, chicken pox), dysentery and pneumonia. A score of 0 indicated no major illnesses while a score of 5 indicated five or more major illnesses.

2. Diarrheal infection - Similarly an index measuring the frequency and severity of diarrhea was constructed using a series of interview questions. The index ran from 0 (low frequency and severity) to 7. A child with almost no history of diarrhea was given a rating of 0. A child who had suffered from diarrhea 90 percent of its life or more was given a rating of 5. Two points were added if the child at any point in its life suffered from severe diarrheal infection as evidenced by blood or mucous in the stool.

3. Parasitic infection - The stool samples, collected from 96 percent of the original sample of 523 children, were used to test for evidence of parasitic infection. This laboratory analysis also permitted an estimation of the extent of parasite load where parasites were found.

Economic Status

Income and wealth were calculated as separate variables to permit both a stock and flow dimension of economic status. Of these the wealth variable was the more satisfactory with respect to precision of calculation, but the income one proved a better explanatory variable in the multiple regression analysis.

The income calculation was made on a per month basis for the nuclear family of each child in the study. In the case of salaried service persons this was a relatively easy procedure. For landless agricultural laborers an effort was made to calculate the total monetary value of wages and payment in kind (usually calculated on a per day basis) for an estimated number of days worked in an average month. Problems in this calculation included (1) the fact that wages differ significantly during harvest and non-harvest seasons, and (2) the less easily quantified components of reimbursement, e.g. landless laborers often are permitted to glean the fields after harvest. For the landed agriculturalists estimates were made of the monetary value of production minus the agriculture-related costs. One problem here is the necessary adjustment for that portion of production consumed by the family, an amount which otherwise would represent an expenditure from net income. Given these problems, the income calculation necessarily was less precise than might have been desired.[6/]

The wealth measure, on the other hand, was calculated in a fashion which, if not exact, probably is quite effective in giving a wealth

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6/ An attempt was made by Dr. Robert Parker of the Johns Hopkins group to assess income more exactly for a small part of the Narangwal sample through precise quantification of each factor affecting it. The interview time on this question alone often exceeded three hours.

ranking of the families in the sample. The calculation was made using a slight modification of an economic index developed by the Narangwal RHRC. Since final weightings for the index were not established by the RHRC at the time of this analysis, the weights used were those suggested by Mr. George Immerwahr, an RHRC consultant, again with minor modifications. The index assigned weights to such factors as size and construction of dwelling, number of animals, mechanical possessions, land and non-land related income. The index used is presented in Appendix II.

Mothers' Beliefs and Education

A beliefs index was developed on the basis of a series of pretested questions on mothers' beliefs pertaining to the nutritional and health status of their children. These questions asked mothers to state their beliefs on the ideal age to introduce supplementary milk and solid food and the adjustments that should be made to the child's diet in the event of diarrhea or fever, and to explain the cause of nutritional marasmus (a known disease with an equivalent word in the Punjabi language). These questions are included under section D on the data collection form in Appendix I.

The beliefs index was constructed using a scale of 1 (beliefs detrimental to the child's health) to 4 (beneficial beliefs). Information also was collected on the literacy and education of the mothers.

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In addition to the above variables basic demographic information was collected on age, sex, family size, the number of liveborn children who have died in the family, and caste. Difficulties always are encountered in collecting accurate age information on persons living in rural areas of low-income countries. These problems, of course, are less serious

for a young child whose entire lifetime is within the easily accessible memory of his parents. Nonetheless, it is necessary even in assessing the ages of young children to be quite persistent in placing the birth in relation to known seasons and festivals. Gross errors usually could be caught by visual inspection of the child (including the number of his teeth). Sometimes birth dates thus ascertained were compared with birth records kept in each village by the "chowkidar" or watchman, but such records often proved unreliable.

CHAPTER 4

THE SAMPLE CHILDREN: A STATISTICAL PROFILE AND GENERAL DISCUSSION

This chapter, using the data from the micro study, presents a quantitative description of the sample children according to the variables introduced in the preceding chapter. It includes, where appropriate, a general discussion of the variables as they relate to this part of Punjab.

Although Punjabi villages have been well described elsewhere (46,66) a few brief comments may be appropriate here. As in other low income countries, these villages are largely self-contained, concentrated units surrounded by agricultural holdings and generally linked to the nearest main road by a dirt road. The village itself is a maze of narrow paths of dirt or burnt brick, which often are bordered by mud walls, and which wind around houses, a few wells (each serving a particular portion of the village), numerous mud storage structures, a temple, a school (education of boys and girls usually is conducted separately), a small wheat grinding unit, and a few one-room shops. These paths, which become virtual streams during the monsoon, might at any given daylight moment be occupied by a bullock cart filled with agricultural produce, farm implements or bags of fertilizer, a hand-pushed vegetable cart, a half dozen water buffalo being herded to the nearby pond by a nine year old boy with a longer stick, a few goats ambling aimlessly or tethered in a grassy patch, a group of noisy school children with their wooden writing slates, and a few girls of seven or eight carrying younger siblings on their hips.

Residential dwellings usually are grouped according to caste with a clear-cut differentiation at least of Jat and Ramdasia households. The former generally are constructed of a combination of brick and mud, contain

one or two rooms sometimes with electrical outlets, a roofed section for animals, and an inner courtyard where fodder and fuel are stored, where the cooking is done and where most of the woman's day is spent. The Jat family is likely to have it's own private water pump.

Ramdasia dwellings almost always are smaller mud huts with dirt or dung floors and thatched roofs. Often these dwellings stand in a row with common side walls and roofs. Unlike her Jat counterpart, the Ramdasia woman spends a considerable portion of the day away from the home, often gathering fodder for the animals or, during harvest seasons working in the fields. During her absence from the home her younger children generally are entrusted to older daughters, or in some cases, a paternal grandmother.

Social-Demographic Information

The discussion of the sample children begins with basic social-demographic information, and then proceeds to the major variables. As seen in the previous chapter, Jats (42 percent) and Ramdasias (39 percent) constitute the bulk of the sample children. The heterogeneous grouping of "Other" children make up the remainder. As would be expected by the geometry of population growth, there are slightly more persons, proportionately, in the younger age group. Of the sample children, 52.8 percent are male, a figure almost identical with that found at Narangwal (53.0 percent among children aged 0-4) (36).

As seen in Table 2 the average child has over two live siblings, slightly but not statistically significantly higher among Ramdasias than Jats. The average number of liveborn children who died in the Ramdasia families, however, was over 70 percent higher than in Jat families. This would be consistent with the Narangwal RHRC data which found the infant

(0-12 months) mortality rate to be 128 per 1000 live births for Jats and 179 per 1000 for Ramdasias (36).

Table 2. Number of Live and Dead Siblings Per Sample Child

Group	Average number of live siblings	Average number of liveborn dead siblings
Jats	2.16[a]	0.49**
Ramdasias	2.36	0.85
Others	2.08	0.53
Total	2.22	0.64

a/ Not significantly different from the Ramdasia figure at the .95 level of statistical significance.
** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

Family income ranged from Rs. 50 ($7) to Rs. 1450 ($193) per month with a mean of Rs. 241 ($32). Mean family income figures by caste are presented in Table 3. The mean per capita income was Rs. 46 ($6) per month. The wealth index ranged from 40 to 1400 with a mean of 243. In spite of the largely coincidental similarity in range and mean values of the income and wealth variables, the correlation between them was only .738 (Perfect correlation is + or - 1.0).

Table 3. Average Monthly Income of the Nuclear Families of Sample Children

Group	Average monthly family income	
Jats	Rs. 336	($45)**
Ramdasias	Rs. 150	($20)
Others	Rs. 218	($29)
Total	Rs. 241	($32)

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

Nutritional Status

As discussed in the previous chapter, weights and heights of the children were compared with the Harvard Standards by three parameters: weight for age, height for age, and weight for height. The means of each of these are presented by caste grouping in Table 4.

Table 4. Mean Anthropometric Measures of Sample Children[a] by Caste Grouping

Group	Weight as percentage of reference weight for age	Height as percentage of reference height for age	Weight as percentage of reference weight for height
Jats	79.2**	93.8**	87.8**
Ramdasias	73.5	91.7	85.5
Others	77.5	92.9	87.3
Total	76.6	92.8	86.8

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.
a/ Measurements as percentages of Harvard Standards.

In Table 5 this information for the sample children is presented by age group. As would be expected, children in the youngest group, 6-11 months, come closest to the reference measures for their age and height. Presumably the 0-5 month group would be highest of all. Then with the onset of the weaning period, the inadequacy of breast feeding alone and the syndrome of weanling diarrhea, the child's growth deviates sharply from the reference. The table would appear to suggest that during the second year the child's weight once again moves parallel with the reference weight parameters (although at a much lower level) while his height continues to fall relative to the height for age reference.

Table 5. Mean Anthropometric Measures[a/] of Sample Children by Age Group

Age group	Weight as percentage of reference weight for age	Height as percentage of reference height for age	Weight as percentage of reference weight for height
6-11 months	82.3**	95.4**	90.6**
12-17 months	73.9	92.3	84.8
18-24 months	73.8	90.7	85.1
Total	76.6	92.8	86.8

** Significantly different from the 18-24 month age group at the .95 level of statistical significance.
{ Indicates figures significantly different at the .95 level of statistical significance.
a/ Measurements as percentages of Harvard Standards.

The weight for age measure is the basis for the frequently used "Gomez Classification" of nutritional status (27) which groups children as follows:

Normal	: over 90 percent of reference weight for age
1st degree malnutrition:	76 to 90 percent of reference weight for age
2nd degree malnutrition:	60 to 75 percent of reference weight for age
3rd degree malnutrition:	below 60 percent of reference weight for age

Traditionally for 1st degree cases normal extension or outpatient care is considered adequate, while 2nd degree cases require more intensive care, e.g. a nutrition rehabilitation center, and 3rd degree cases require hospitalization (6).

The division of children according to the Gomez Classification in Table 6 indicates highly significant differentials in weight for age

between the landowning, economically advantaged Jats and the landless Ramdasias. It is in fact these differentials that the regression analysis, discussed in Chapter 5, attempts to explain. The table further reveals the extent of serious malnutrition existing in this area. Bengoa's review of community survey literature in low income countries (7) found the point prevalence of 3rd degree malnutrition within a range of 0.5 to 4.6 percent. The figure here is 8.3 percent with the Ramdasia average 12.3 percent. Similarly, Bengoa found on the average 25 percent of the children in these studies suffering from 2nd degree malnutrition, while the figure here is 39.5 percent.[1/]

Table 6. Breakdown of Caste Groupings by Gomez Classification[a/]

Group	Normal (91-100% of reference weight for age)	1st degree malnutrition (76-90%)	2nd degree malnutrition (60-75%)	3rd degree malnutrition (Below 60%)
	percent	percent	percent	percent
Jats	19.6	41.6	35.2	3.6
Ramdasias	6.9	35.8	45.1	12.3
Others	20.8	31.3	37.5	10.4
Total	14.8	37.3	39.5	8.3

a/ Percentage of reference weight for age using the Harvard Standards.

The figures also suggest considerably lower nutritional status than do those collected by the Narangwal RHRC in a cross section survey of four Ludhiana District villages in 1967 (36). That study found 5 percent

1/ The Jat figures roughly would resemble Gomez breakdowns elsewhere if there were about 15 percent more Jats in the 1st degree category and 15 percent fewer in the 2nd degree one.

suffering from 3rd degree, 10 percent with 2nd degree, and 35 percent with 1st degree malnutrition. These 1967 figures presumably reflect economic disparities between Ludhiana and Ropar Districts which have existed for many years, rather than "Green Revolution" effects (relating largely to the introduction of new seed varieties) which would not have been measurable that early.

An interesting article by Seoane and Latham (60) presents a means of utilizing height for age and weight for height measures in cross section data to assess the time frame of malnutrition among children with low weight for age. This technique divides these children into the following three groups, each calling for somewhat different interventions.

A. Current acute short duration malnutrition indicated by low weight for age and weight for height but normal height for age. The normal height (a better measure of protein-calorie malnutrition than weight for extended time periods) suggests recent, short duration deficiencies.

B. Past chronic malnutrition indicated by low weight for age and height for age but normal weight for height. Jelliffe (35) refers to this group as suffering from nutritional dwarfism.

C. Current long duration malnutrition indicated by low percentages on all three indices.

To permit a grouping into these categories, those children below 80 percent weight for age (62.7 percent of the sample) were classified using adequacy dividing points of 95 percent for the height for age measure and 90 percent for the weight for height measure. The resulting breakdown was:

Group A - 11.7 percent of the sample

Group B - 14.1 percent

Group C - 74.2 percent

indicating that relatively few presently malnourished children were adequately nourished in the past, and conversely that most children with previous malnutrition are still malnourished.

Food and Nutrient Intake

On the basis of the 24-hour recall information, several generalizations can be made about feeding practices in this area, all of which appear consistent with those found in the Narangwal and Khanna studies.

Food intake - As in most low income areas which have escaped excessive contact with the industrialized world, prolonged breast feeding remains the norm in rural Punjab. Except for the rare case of maternal death or severe illness, all children up to the age of 6 months are breast fed. Of infants between 6 and 12 months, 91.6 percent were breast fed. The percentage then dropped to 82.1 percent for those between 13 and 18 months, and to 63.7 percent between 19 months and 2 years. Breast feeding often continued to the age of 3 years and in some cases beyond.[2/]

Feeding of diluted buffalo, cow or goat milk usually is introduced during the first 6 months after birth. Often this milk is fed in a mixture with tea and processed or unrefined sugar in varying proportions. In fact for these children as a whole, the quantity of tea consumed is second only to milk as a component of the diet. Of the infants aged 6 to 12 months, 77.8 percent received some supplementary milk. Of the 13 to 18 month age group, 93.1 percent received supplementary milk, and 95.1 percent between 19 and 24 months.

2/ The median duration of breast feeding reported by Wyon and Gordon (66) was 26 months.

Delay in the introduction of solid food, a phenomenon discussed in Chapter 2, was the norm regardless of economic or social class. Almost no children received solid food before the age of 6 months. Between 6 and 12 months, 49.3 percent received some supplementary food. This is roughly consistent with the finding in Khanna (66) that 53 percent of all children at 11 months were receiving solid food. Of the children aged 13 to 18 months in this study, 87.5 percent were receiving solid food as were virtually all of the children (98.1%) between 19 months and 2 years. Of course, the quantity and quality of this food varied enormously as will be seen below.

Of the children who did consume some solid food (76 percent of the total sample) the average age of initiating this feeding was 10.5 months. This is an underestimate for the 6-24 month age group as a whole, but not a major one since most of those in the sample who were not consuming solid food were between 6 and 10 months of age. As indicated in Table 7 the average ages of initiating solid food among "Other" and Jat children respectively were 9.8 and 10.5 months, as opposed to 10.8 months for Ramdasias. This would argue against the hypothesis sometimes voiced that poorer mothers (in this case the Ramdasias), who spend much of the day in the fields or collecting fodder for animals, tend to provide solid food earlier as a matter of convenience.

Solid food fed to these children almost always is adult food. Rarely are foods prepared specifically for children. The solid food usually fed first to the child and that consumed most regularly is the wheat chapatti[3/] dipped in one of a wide variety of pulses or vegetables. Following the

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3/ A flat unleavened bread baked on a hot griddle and somewhat resembling a tortilla.

Fall harvest there is also considerable consumption of corn by these children. Rice is less often consumed. A wide range of fruits are fed depending on the season, but to only about a third of the children.

Table 7. Consumption of Solid Food Among Sample Children by Caste

Group	Percent receiving solid food	Average age of initiating solid food (months)
Jats	76.6[a]	10.5[a]
Ramdasias	73.7	10.8
Others	80.6	9.8
Total	76.2	10.5

a/ Not significantly different from the Ramdasia figure at the .95 level of statistical significance.

Average daily food consumption figures for these children are presented in Table 8. The figures clearly indicate the quantitative inadequacy of the diets of these children, and will be examined further in the discussion of caloric deficiencies. Jat-Ramdasia differences are

Table 8. Average Daily Food Consumption of Sample Children by Food Group and Caste

Group	Supplementary milk (gms.)	Cereals (gms.)	Pulses (gms.)	Fruits (gms.)	Vegetables (gms.)	Sugar (gms.)
Jats	210**	26	9	15	9	17
Ramdasias	155	26	8	13	7	18
Others	192	24	6	15	12	16
Total	185	26	8	14	9	17

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

statistically insignificant with the striking exception of supplementary milk intake. This significant difference also is reflected in Table 9 showing the sources of calories, by percentage, for the children by caste groups. Given the status connotation of milk in Punjab as elsewhere and its high relative price, these caste differences in milk consumption would seem to suggest an income relationship. The lower income Ramdasia mother who cannot afford as much supplementary milk for her child makes it up by breast feeding the child somewhat longer and providing a larger proportion of the child's calories with cereals. Because of the caloric density of the cereals, she may in fact be allocating her resources more effectively than her Jat counterpart with respect to the child's nutrient intake. Some Jat mothers may believe they are meeting their feeding responsibilities to the child by providing this high-status, expensive milk, when in reality, given the quantitative inadequacy of the diet, they better could use their resources for cereal preparations.

Table 9. Sources of Calories Among Sample Children by Caste

	Percentage of calories from:							
Group	Breast milk	Supplementary milk	Cereals	Pulses	Fruits	Vegetables	Sugar[a/]	Total
Jats	43.8**	29.7**	11.4	3.5	1.5	0.8	7.8**	98.5%
Ramdasias	50.0	22.6	12.3	3.7	1.2	0.7	8.9	99.4%
Others	45.6	28.2	12.0	2.7	1.3	0.9	8.0	98.7%
Total	46.5	26.6	11.9	3.4	1.3	0.8	8.2	98.7%

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.
a/ Refined and unrefined.

In Table 10 the sources of calories for the children are presented by age group. Here, as would be expected, one finds a highly significant decrease in the percentage of calories coming from breast milk as age increases. Over two-thirds of the calories in the 6-11 month age group come from breast milk, while it accounts for only slightly over one-fourth in the 18-24 month group. In the older groups, as can be seen, the calories are made up for with the other foods, most notably by supplementary milk and cereals. In the case of supplementary milk, these children appear to level off their consumption (as a percentage of total calories) during the second year, while cereal and pulse consumption continue to increase.

Interestingly, pulses, which have received considerable attention by nutritionists, constitute only 3.4 percent of the calories consumed by children in this age group. Given the particularly low income elasticity of consumption for pulses among this age group (discussed in Chapter 5) it is unlikely that increased pulse production, lower pulse prices, or income increments per se will have a major effect on their pulse consumption.

Table 10. Sources of Calories Among Sample Children by Age Group

	Percentage of calories from:						
Age group	Breast milk	Supplementary milk	Cereals	Pulses	Fruits	Vegetables	Sugar[a]
6-11 months	69.5**	19.5**	3.9**	0.8**	0.4**	0.2**	5.6**
12-17 months	45.4	28.1	11.6	3.0	1.2	0.9	8.7
18-24 months	26.3	31.9	19.5	6.2	2.3	1.3	10.3
Total	46.5	26.6	11.9	3.4	1.3	0.8	8.2

** Significantly different from the 18-24 month age group at the .95 level of statistical significance.

{ Indicates figures significantly different at the .95 level of statistical significance.

a/ Refined and unrefined.

Nutrient intake - As discussed in the previous chapter, this food information was converted into calories, protein, vitamin A and iron, which in turn were compared with the official Indian daily allowances. Table 11 presents the average percentages of nutrient allowances by caste.[4/] Table 12 presents the percentage of each caste group falling into four percentile of allowance classifications.

Table 11. Average Percentages of Nutrient Allowances[a/] by Caste Grouping for Sample Children

Group	Calories	Protein	Vitamin A	Iron
Jats	63.6**	87.0	86.1	38.0
Ramdasias	59.2	83.3	83.2	35.1
Others	60.7	85.5	85.6	36.8
Total	61.3	85.3	84.9	36.7

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

a/ Nutrient intake compared with "Daily Allowances of Nutrients for Indians" prepared by the Indian Council of Medical Research, 1968.

As indicated in these tables, the most serious nutrient deficiencies among this age group are those of iron (average intake 36.7 percent of the allowance with just over 4 percent having adequate intake)[5/] and calories (average intake 61.3 percent of the allowance with 7.5 percent having adequate intake). The average vitamin A intake was 84.9 percent

4/ Given the lack of an obesity concern in this study, intakes exceeding 100 percent of allowance were recorded as 100 percent of allowance.

5/ The exceedingly low iron intakes are consistent with the Narangwal RHRC finding that 80 percent of the hemoglobins of children examined were below 10 gm. % (36).

Table 12. Breakdown of Caste Groupings by Percentage of Nutrient Intake Allowances[a]

	Calories				Protein			
	100% of allowance	76-99%	51-75%	50% + below	100%	76-99%	51-75%	50% + below
Jats	10.9%	16.1%	45.5%	27.5%	57.8%	16.1%	19.9%	6.2%
Ramdasias	5.2	14.4	43.8	36.6	45.1	19.2	28.5	7.3
Others	4.5	18.0	42.7	34.8	45.7	25.0	22.8	6.5
Total	7.5	15.8	44.3	32.4	50.6	19.0	23.8	6.7

	Vitamin A				Iron			
	100%	76-99%	51-75%	50% + below	100%	76-99%	51-75%	50% + below
Jats	43.2%	31.4%	19.1%	6.4%	4.8%	7.6%	17.1%	70.5%
Ramdasias	38.5	34.1	18.5	8.8	4.7	3.7	15.1	76.6
Others	35.1	43.3	17.5	4.1	2.2	5.6	18.9	73.3
Total	39.8	34.7	18.6	6.9	4.3	5.7	16.7	73.4

a/ Nutrient intake compared with "Daily Allowances of Nutrients for Indians" prepared by the Indian Council of Medical Research, 1968.

of allowance[6/] (39.8 percent had adequate intake), and the average protein intake was 85.3 percent of allowance (50.6 percent having adequate intake).

With respect to the caloric deficiency there is some possibility that the ICMR caloric allowance used as a reference may in fact be too generous. This is suggested by Table 22 in Chapter 5 indicating that "normal" children in terms of the Gomez classification (over 90 percent of reference weight for age) meet only 65 percent of the ICMR caloric allowance. Even allowing for higher references to provide necessary buffers against stress and infection, the ICMR allowance may err on the high side. Alternatively there is the possibility that caloric intake was generally underestimated for this group. This is somewhat less likely unless the breast milk intake estimates used in the study seriously underestimate the actual breast milk intake of these children.

Unless the caloric allowance is grossly overestimated, however, (and even if food intake is overestimated which would increase protein as well as caloric intake) the findings would tend to substantiate the hypothesis frequently voiced to the effect that protein deficiencies in this part of the world are a subset of a broader protein-calorie malnutrition. Where protein deficiency exists it appears to be largely the result of caloric deficiency and the burning up of otherwise utilizable protein for energy. Using the ICMR allowances, there was no case of a child ingesting adequate calories (i.e. enough food) but inadequate protein. The "enough calories means adequate protein" argument sometimes is made for the population as

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6/ This vitamin A figure is almost four times higher than that (22.1% of allowance) found by the (Indian) National Institute of Nutrition (28) among preschool age children in the Hyderabad area of South India where vitamin A deficiency is particularly serious and debilitating. The average percentage of the recommended iron allowance found among the Hyderabad group (33.7%) was similar to that found in this study (36.7%).

a whole, but rarely for this critical age group, given their much higher proportionate requirements for protein. The findings here would suggest, again assuming the validity of the caloric allowance, that at least in this part of India, even this age group would not be excluded from the generalization.7/

Among certain population groups in low income countries, such a conclusion might be questionable. It has been suggested, for example, that where the quality of protein consumed is particularly low, a higher intake of protein will be required. Similarly, it has been argued that the presence of major infection increases physiological requirements for protein. Both of these factors have been taken into account by the Indian Council of Medical Research in setting its allowances. Beyond this, however, neither the protein quality nor the infection factor present particular problems for this population group. As indicated in Tables 9 and 10, so large a proportion of food intake comes from breast and supplementary milk that the quality of the protein consumed would be quite high. Similarly, as will be seen below, the absence of major parasitic infestation eliminates the need to adjust protein allowances on this count.

Interestingly, the nutrient intake findings in this study are similar to those found in a recent study of preschool age children (0 to 5 years old) conducted under the auspices of the Indian Council of Medical Research (ICMR) in five parts of India (Hyderabad, Vellore, Poona, Bombay, Delhi, and Calcutta) (28). Using the same ICMR standards as employed here, that study found 92 percent of the children deficient in calories (92.5

7/ While true in Punjab and perhaps in India as a whole, this relationship is unlikely to exist in those parts of the world dependent on low protein food staples, notably sub-Sahara Africa.

percent in this study) and 35 percent deficient in protein (49.4 percent in this study -- the differential presumably explained in part by the younger age group studied here). These results have important implications for intervention as will be seen in Chapter 6.

As suggested earlier, the lack of major Jat-Ramdasia differences with respect to nutrient intake would be explained partially by the Jats' heavy reliance on supplementary milk as opposed to other foods with higher caloric density relied upon by Ramdasias.

The most important effect of age on food intake relates to iron intake. Because of the much larger quantities of cereal they consume, iron intakes of children in the 18-24 month age group are roughly twice that of children between 6 and 11 months of age.

Infection and Disease

As discussed earlier, three indices were used to measure infection and disease. The findings with respect to each are discussed separately below.

1. Disease history - Table 13 presents the average number of major diseases for each caste group. As seen, the average for the sample children as a whole is below 1. The Ramdasia figure is significantly higher than the Jat average.

2. Diarrheal infection - Table 14 presents information on diarrheal infection using the index of frequency and severity described in Chapter 3. The mean rating for the children as a whole of just below 2 suggests that the average child has suffered from diarrhea about 25 percent of his life but has not suffered from severe dysentery. Again the Ramdasia figure is significantly higher than that of the Jats.

Table 13. Disease History Rating of Sample Children

(0 = no major illness; 5 = five or more major illnesses)

Group	Medical experience rating
Jats	0.84**
Ramdasias	0.99
Others	0.82
Total	0.89

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

Table 14. Diarrheal Infection Index for Sample Children

(7 = high frequency and severity; 0 = low frequency and severity)

Group	Diarrheal infection rating
Jats	1.74**
Ramdasias	2.29
Others	1.95
Total	1.99

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

In Table 15 this information is presented by age group. The figures indicate that diarrheal infection increases significantly during the first half of the second year, and continues to increase during the 18-24 month period though at a lower rate of increase.

3. Parasitic infection - One of the more surprising results of the study, although consistent with the findings of the Narangwal RHRC, was the virtual absence of hookworm, roundworm or other important parasites. Analysis of stool samples revealed only one case of roundworm and

Table 15. Diarrheal Infection Index by Age Group for Sample Children

(7 = high frequency and severity; 0 = low frequency and severity)

Age group	Diarrheal infection rating
6-11 months	1.48**
12-17 months	2.17
18-24 months	2.32
Total	1.99

** Significantly different from the 18-24 month age group at the .95 level of statistical significance.
{ Indicates figures significantly different at the .95 level of statistical significance.

no hookworm. At the same time 32.1 percent of the samples contained giardia.[8/] Interestingly as shown in Table 16 the point prevalence of giardia was higher among Jats (32.2 percent) than among Ramdasias (29.6 percent) and highest of all among the "Others" (37.2 percent). This presumably is explained by the ingestion (by Jats and "Others") of larger quantities of food, the primary carriers of this cyst. Ramdasias were also lower in the point prevalence of severe giardia which afflicted 5.5 percent of the entire sample.

The point prevalence of giardia found in this sample was almost twice that found for a comparable age group by the Narangwal RHRC (18 percent). The Narangwal data further indicates that giardia prevalence tends to increase with age in the early years of childhood (36).

8/ A unicellular flagellate which lodges in the intestinal tract and, like an intestinal parasite, adversely affects absorption. The extent of malabsorption resulting from giardia is unclear.

Table 16. Prevalence of Giardia Among Sample Children

Group	Percent with giardia	Percent with severe giardia (2+ or higher)
Jats	32.2[a]	7.5[a]
Ramdasias	29.6	5.1
Others	37.2	9.6
Total	32.1	5.5

a/ Jat and Ramdasia figures not significantly different from one another at the .95 level of statistical significance.

Mothers' Beliefs and Education

As stated earlier, mothers of the sample children were asked a series of questions designed to determine their beliefs relating to the nutritional and health status of their children. Questions sought the mothers' conception of the ideal age to initiate supplementary feeding, the appropriate dietary response to infection, and the cause of nutritional marasmus.

On the average, mothers believed solid food should be introduced near the age of one year, although the range of answers varied from six months to two years. Virtually all mothers responded that solid food should be removed during bouts of diarrhea or fever. Suggested cures ranged from breast milk or tea alone to locally procured homeopathic medicines and visits to religious figures known as sianas. Fifty-six percent of the mothers attributed marasmus (a known disease with an

equivalent word in the Punjabi language)[9] in whole or in part to the casting of an evil shadow by a person or spirit. This concept does not appear inconsistent with larger belief patterns in these villages or with the remedies selected.

Parents bringing their marasmic child to a siana might be given one of the following prescriptions:

(a) The green stick ritual - A green twig full of sap is waved over the child's head with an appropriate Sanskrit incantation. The twig is then thrown some distance away. When the twig dries, the child will be cured. If the magic doesn't work, the twig will grow and the child will die.[10] To minimize the likelihood of a reverse transfer of this life force, the parents and child must avoid for three months the spot where the twig lies.

(b) The seven wells ritual - This longer duration prescription calls for the mother to take her child to seven particular wells in seven different villages on seven consecutive full moon nights (one a month). She waits at the well until the moon is at its zenith, then repeats an incantation to the spirit of the well to the effect of "bring water into my child and make it live". After this the mother bathes the child in the water of that well.

(c) Purification by excrement - Cow dung periodically is rubbed on the back of the child. After sufficient rubbing the mother removes what she believes are worms and which in fact probably is a thin outer layer of skin.

9/ The word "soka", literally translates "dried up".
10/ This "transfer effect" is common in anthropological literature from many parts of the world.

A more medically-oriented siana and some practitioners of ayurvedic medicine[11] might prescribe dried goat liver, actually an excellent source of needed vitamins, iron, and some essential amino acids, but usually prescribed in inadequate quantities. One ayurvedic practitioner was found whose entire business is the treatment of marasmic children.[12]

As indicated in Table 17, belief in the shadow concept was highest among the "Others" group (61.3 percent) which contains a large number of Hindus with considerably more ritualism and superstition than normally associated with Sikhism. Fifty-nine percent of the Ramdasias believe in the shadow concept as opposed to 50.2 percent of the Jats.

Table 17. Mothers' Beliefs in Casting of Shadow Cause of Marasmus

Group	Percentage attributing shadow as cause of marasmus
Jats	50.2**
Ramdasias	59.3
Others	61.3
Total	55.8

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

With this information a beliefs index was constructed using a scale of 1 (beliefs detrimental to the child's health) to 4 (beneficial beliefs).

11/ An indigenously developed Indian practice of medical treatment based in part on herbal cures.

12/ These and other interesting anthropological findings are included in presently unpublished papers by D. N. Kakar of the Narangwal Rural Health Research Center.

As shown in Table 18 the average for the entire sample was 2.42, with Jats slightly higher (2.41) than Ramdasias and "Others" (2.37).

Table 18. Nutrition and Health Beliefs Index for Mothers

(4 = beliefs beneficial to child's health;
1 = beliefs detrimental to child's health)

Group	Beliefs index
Jats	2.46[a]
Ramdasias	2.41
Others	2.37
Total	2.42

a/ Not significantly different from the Ramdasia figure at the .95 level of statistical significance.

The Jat-Ramdasia differential here and with respect to belief in the shadow concept, probably is explained in part by significant differences in literacy. As indicated in Table 19, 31 percent of the Jat mothers were literate as opposed to only 7.7 percent of the Ramdasia mothers. The 22.6 percent literacy figure for the sample as a whole is less than half that (48 percent) found by the Narangwal RHRC among a comparable age group of mothers.

Table 19. Literacy of Mothers of Sample Children

Group	Percentage literate[a/]
Jats	31.1**
Ramdasias	7.7
Others	34.4
Total	22.6

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

a/ In any language.

CHAPTER 5

ANALYSIS AND RESULTS

In the previous chapter, a statistical profile of the sample population was presented using measures of nutritional status and a wide range of explanatory variables. We now can examine the relationships among these factors in terms of the analytical framework introduced in Chapter 3. The analysis basically is a two step process: first, weighing the effects of food intake and infection, the direct determinants of nutritional status[1/]; second, identifying the relative importance of a range of indirect determinants on food intake and infection respectively. The two steps are accomplished using ordinary least squares (OLS) multiple regression analysis[2/] supplemented by tabular presentations of the pertinent relationships.

Estimating Determinants of Nutritional Status

The first step in the analysis is the estimation of the effects of food or nutritional intake and infection on nutritional status. The nutritional status (NUT STAT) measures, defined in Chapter 3, were used as the dependent variable. As independent variables the two nutritional intake (NUT INT) indices and calories (CALOR) alternatively were used to represent intake. Infection was represented by diarrheal infection (DIAR), giardia (GIAR) and disease history (DISEASE) and by the infection index (INFEC) of these three.

1/ As will be seen below, other variables were found to have an independent effect on nutritional status and therefore also are included in this first step.

2/ An attempt to bring these equations into a simultaneous model using the technique of two stage least squares failed to yield meaningful results because of instability caused by particularly low R^2's in two of the equations.

The nutritional status variable which proved best explained by nutritional intake and infection was NUT STAT #1, the straight average of the weight for age, height for age and weight for height percentages. NUT STAT #3 and NUT STAT #4, multiplication of the square roots and cube by cube squared roots respectively of height for age and weight for age, were the next best nutritional status variables. The fact that NUT STAT #1 resulted in higher R^2's than the indices of weight and height for age combinations and higher than any single anthropometric measure indicates that each of the anthropometric measures adds something important to that NUT STAT #1 index.

After NUT STAT #1,[3/] 3 and 4, the nutritional status variables emerged as follows in order of their R^2's: NUT STAT #2 (the average of weight and height for age), weight for age, weight for height, and height for age.

Between the two nutritional intake indices, NUT INT #1 (calories = 40, protein = 30, iron and vitamin A = 15) proved to be a more successful explanatory variable than NUT INT #2 (calories = 45, protein and iron = 25, vitamin A = 5). However, the insertion of calories alone as the nutritional intake variable was better than either. This would be explained both by the great variation in caloric intake and by the general shortage in calories which adversely affects the utilization of other nutrients, and which at this level apparently overwhelms in both a physiological and a statistical sense the other deficiencies.

Among the three infection measures, when used together, diarrheal infection proved to be the most significant by a wide margin. Neither

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3/ Hereafter simply referred to as nutritional status, or NUT STAT in the equations.

Table 20. Estimation of Equations for All Sample Children Using Ordinary Least Squares With Coefficients Expressed as Elasticities

1. NUT STAT = 89.704 + .054 CALOR** - .033 DIAR** - .004 GIAR + .004 DISEASE - .072 AGE** (R^2 = .240)
(4.651) (-6.788) (-1.574) (1.039) (-7.117)

2. NUT STAT = 89.047 + .050 CALOR** - .032 DIAR** - .004 GIAR + .004 DISEASE - .072 AGE** + .011 INCOME** (R^2 = .248)
(4.275) (-6.559) (-1.548) (1.004) (-7.211) (2.236)

3. NUT STAT = 92.092 + .041 CALOR** - .027 DIAR** - .002 GIAR - .001 DISEASE - .068 AGE** + .010 INCOME** - .031 SEX** (R^2 = .369)
(3.865) (-5.965) (-0.962) (-0.276) (-7.404) (2.027) (-9.692)

4. CALOR = 46.815 + .065 INCOME** + .179 BELIEF** + .022 FAM SZ + .002 CASTE 1 - .005 CASTE 2 - .023 SEX* - .003 INFEC (R^2 = .067)
(2.635) (4.160) (0.813) (0.108) (-0.298) (-1.731) (-0.157)

5. CALOR = 50.854 + .033 WEALTH + .184 BELIEF** - .010 FAM SZ - .00[illegible] CASTE 1 - .009 CASTE 2 - .024 SEX* - .004 INFEC (R^2 = .057)
(1.359) (4.246) (-0.423) (-0.010) (-0.553) (-1.786) (-0.193)

6. DIAR = 1.947 + .010 INCOME - .047 BELIEF + .152 FAM SZ** - .053 CASTE 1 + .056 CASTE 2 + .049 SEX - .144 CALOR (R^2 = .037)
(0.146) (-0.378) (2.010) (-1.100) (1.261) (1.299) (-1.112)

7. INFEC = 21.870 - .017 INCOME + .038 BELIEF + .073 FAM SZ - .040 CASTE 1 + .026 CASTE 2 + .032 SEX - .017 CALOR (R^2 = .019)
(-0.281) (0.363) (1.149) (-0.983) (0.696) (1.011) (-0.157)

t values in parentheses
* statistically significant at the .90 level
** statistically significant at the .95 level

giardia nor disease history were found to be statistically significant determinants. Nor did giardia appear as a significant determinant of diarrheal infection. Disease history failed to emerge as significant, presumably because the incidence of major disease among surviving children in this age group is relatively low. When the infection index was used in place of the three components, the result was a more highly significant coefficient than any individual component but a lower R^2 than when the three components were used together in an equation.

In addition to food intake and infection, the differences in the anthropometric measures found for different age groups within the sample (Table 5) suggested that age itself explained a portion of the variation in nutritional status and therefore should be included as an independent variable in the equation.

Using the best index for each variable this first set of relationships for the population as a whole is stated in equation 1 of Table 20. The coefficients for each of the independent variables are presented as elasticities to facilitate their usage. The first equation would be interpreted as follows: Holding diarrheal infection, giardia, disease history and age constant, a one percent increase in caloric intake would improve nutritional status by .054 percent.[4/] Then holding calories, giardia, disease history and age constant, a one percent increase in diarrheal infection would result in a .033 percent decrease (because of the minus sign) in nutritional status. Similarly, the effects of a one percent change in giardia, disease history or age on nutritional status, holding the others constant, are indicated by the magnitude and signs of

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4/ Similarly, a decrease of one percent in caloric intake would result in a decrease in nutritional status by .054 percent.

their coefficients. The t values are noted parenthetically below the coefficients, and asterisks mark the levels of statistical significance. In the first equation, caloric intake, diarrheal infection and age are significant at the .95 level of statistical significance.

The R^2 of .240 indicates that the independent variables (on the right side of the equal sign) in this equation explain 24 percent of the variation found in nutritional status among the sample children. Although cross section analysis, inherently, seems to be characterized by low R^2's, an attempt was made to incorporate other possible explanatory variables into the equation. In equation 2, the addition of per capita income raised the R^2 to .248. This means that above and beyond the effects of income on caloric intake and infection (which will be examined later in this chapter) and hence indirectly on nutritional status, there is a statistically significant independent effect of income on nutritional status. Reasons for such a relationship will be discussed below.

In equation 3 the sex variable was added to those in the previous equation, boosting the R^2 to .369. The increase in the R^2 and the high statistical significance of the variable suggest the major importance of the sex variable in the analysis. Each of the significant variables in this third equation will be examined separately below.

Equation 3 is estimated separately for Jats and Ramdasias as equations 1 in Table 21. Although the same variables prove statistically significant, there are three important differences. First, the coefficients for the calorie variable indicate that caloric intake is a far more important determinant of nutritional status among Ramdasias than among Jats. Hence, increases in food consumption are likely to result in greater improvement in the nutritional status of Ramdasia children who

Table 21. Estimation of Equations for Jat and Ramdasia Children Using Ordinary Least Squares With Coefficients Expressed as Elasticities

JATS

1. NUT STAT = 94.378 + .029 CALOR* - .027 DIAR** - .002 GIAR - .003 DISEASE - .057 AGE** + .003 INCOME - .029 SEX** (R^2 = .376)
(1.839) (-4.472) (-0.712) (-0.615) (-4.168) (0.377) (-6.168)

RAMDASIAS

1. NUT STAT = 88.367 + .063 CALOR** - .029 DIAR** + .001 GIAR + .008 DISEASE - .078 AGE** + .006 INCOME - .028 SEX** (R^2 = .345)
(3.533) (-3.412) (0.234) (1.270) (-5.028) (0.652) (-5.032)

JATS

2. CALOR = 49.838 + .053 INCOME + .173 BELIEF** - .075 FAM SZ - .011 SEX + .006 INFEC (R^2 = .051)
(1.349) (2.695) (-0.116) (-0.545) (0.225)

RAMDASIAS

2. CALOR = 46.786 + .089 INCOME* + .129 BELIEF* + .039 FAM SZ - .052 SEX** + .005 INFEC (R^2 = .069)
(1.799) (1.727) (0.786) (-2.342) (0.171)

JATS

3. DIAR = .802 + .203 INCOME + .153 BELIEF + .196 FAM SZ + .136 SEX** - .070 CALOR (R^2 = .041)
(1.498) (0.346) (1.559) (2.085) (-0.308)

RAMDASIAS

3. DIAR = 3.885 - .418 INCOME** - .238 BELIEF + .006 FAM SZ - .045 SEX + .001 CALOR (R^2 = .063)
(3.097) (-1.249) (0.058) (-0.780) (.004)

t values in parentheses
* statistically significant at the .90 level
** statistically significant at the .95 level

consume less food to begin with, and for whom inadequate food intake is a more limiting factor. Second, age is somewhat more important among Ramdasias than Jats, suggesting that Ramdasia children depart more sharply from the anthropometric standards during the latter half of the first year and during the second year than do the Jat children. Finally, although statistically significant for neither group, the independent effects of income on nutritional status are greater among Ramdasias than among Jats.

Another way of looking at the relationships between these explanatory variables and nutritional status for the population as a whole is presented in Table 22 which breaks down the sample population by Gomez classification groupings. Although such a tabular breakdown does not address the matter of causality implied by multiple regression analysis, it does illustrate dramatically the differences in the explanatory variables associated with differences in nutritional status (in this case using the weight for age proxy). The table indicates that "normal" children consume 25 percent more calories than those with 3rd degree malnutrition, have less than a third of the diarrheal infection, and have had about a third as much major disease. In addition, the "normal" children average 5½ months younger than those with 3rd degree malnutrition and their incomes are roughly 50 percent higher. Even more striking are the sex differences. While females constitute 19 percent of the normal children, they account for over 87 percent of those with 3rd degree malnutrition. Similarly Ramdasias constitute less than 20 percent of the normal cases, but almost 60 percent of the 3rd degree cases.

Returning now to Table 20 we will examine in more detail the primary direct determinants of nutritional status for the population as a whole (those with statistically significant coefficients in equation 3), namely caloric intake, diarrheal infection, age, income and sex.

Table 22. Tabular Profile of Sample Children by Gomez Classification Grouping

Gomez grouping	Number of cases	Average age (months)	Percentage female	Percentage Jat	Percentage Ramdasia	Average number of live siblings	Average number of dead siblings
Normal (over 90% of "Harvard" reference weight for age)	73	10.5**	19.2**	54.8	19.2**	2.4	0.5**
1st degree malnutrition (76-90%)	181	14.8	34.8	46.4	37.6	2.2	0.6
2nd degree malnutrition (60-75%)	202	16.1	60.4	37.7	44.1	2.2	0.6
3rd degree malnutrition (below 60%)	40	16.1	87.5	20.0	57.5	2.6	1.1
Total	496	14.8	47.2	42.1	39.1	2.2	0.6

Gomez grouping	Average percentage of caloric allowance	Average number of major diseases	Average diarrheal infection rating a/	Average mother's belief's index rating b/	Average percentage literacy of mothers	Average monthly income of child's family	Average monthly per capita income
Normal (over 90% of "Harvard" reference weight for age)	65.0**	0.5**	1.1**	2.4	36**	Rs. 285 ($38)**	Rs. 53 ($7.06)
1st degree malnutrition (76-90%)	63.1	0.8	1.7	2.5	22	Rs. 245 ($33)	Rs. 47 ($6.27)
2nd degree malnutrition (60-75%)	60.4	1.0	2.2	2.4	21	Rs. 231 ($31)	Rs. 44 ($5.87)
3rd degree malnutrition (below 60%)	51.8	1.4	3.5	2.2	13	Rs. 192 ($26)	Rs. 34 ($4.53)
Total	61.3	0.9	2.0	2.4	23	Rs. 241 ($32)	Rs. 46 ($6.13)

** Significantly different from the 3rd degree malnutrition figure at the .95 level of statistical significance.
{ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.
b/ 4 = beliefs beneficial to child's health; 1 = beliefs detrimental to child's health.

Determinants of Caloric Intake

Having determined the significance of caloric intake as a determinant of nutritional status, particularly among the Ramdasias, we can proceed to identify the determinants of caloric intake, as we will do subsequently with diarrheal infection. In equations 4 and 5 of Table 20, caloric intake is expressed as a function of per capita income (equation 4) or wealth (equation 5) plus beliefs, family size (FAM SZ), caste (two dummy variables to express three castes, with CASTE 1 being Jats and CASTE 2 Ramdasias), sex (again a dummy variable where 0 = males and 1 = females), and the infection index. In spite of particularly low R^2's for these, and for the infection equations which follow, several determinants prove statistically significant. The most significant determinant for the population as a whole is beliefs, followed by income. The wealth index used as an explanatory variable in equation 5, failed to prove statistically significant, in spite of the fact that it appeared more satisfactory with respect to precision of calculation than income. This would seem to suggest that food consumption, at least that given to young children, is more significantly affected by short-run income flows than by non-liquid, accumulated assets. Sex emerges as a significant determinant of caloric intake, but only at the .90 level of statistical significance.

More revealing is the estimation of equation 4 separately for Jats and Ramdasias as presented in equations 2 of Table 21. For the Jats, beliefs is clearly the most important determinant suggesting that interventions solely designed to affect their belief patterns probably would have significant effects on their food intake. Among the Ramdasias, beliefs is a less important determinant while income is a more important one than among the Jats. This would seem to suggest that unlike the Jats, the

Ramdasia family probably requires income supplementation before it can take full advantage of information dissemination programs.

While sex is not a significant determinant of caloric intake among Jats, it is a highly significant one among Ramdasias where major differentials in caloric intake exist between male and female children. As will be discussed later in a discussion of the sex variable, such a differential is closely related to the income constraint affecting this group.

The relationship between food intake and income, introduced above, is a critical one with major policy implications. As noted in Chapter 2, there probably is no more important determinant of food intake for the population as a whole than income. Among the 6-24 month age sample population, however, the effects of income are somewhat less clear. Though a statistically significant determinant of caloric intake for the sample population as a whole, and presumably a prerequisite at the low end of the income spectrum, the coefficients estimated for the income variable are far lower than would be expected for the population as a whole. The relationship is clarified somewhat by looking at income elasticities of demand (or more accurately, of consumption) for food items and nutrients among the sample children broken down into 6 month subgroups in Table 23. For purposes of rough comparison these elasticities are accompanied by total expenditure elasticities of demand for all age groups in rural India.[5/] Among the young children the amounts of pulses, fruits and vegetables are

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5/ The differences in meaning of these two sets of figures should be noted, however. For the sample children the elasticities are derived from quantities of food consumed among different per capita income groups, while the other elasticities are derived from expenditures on food purchased among different per capita total expenditure groups. In addition, somewhat different statistical functions are used in estimating the two sets of elasticities. Nonetheless, the essential meaning is similar and rough comparisons are not unwarranted.

Table 23. Income Elasticities of Consumption[a] and Total Expenditure Elasticities of Demand Among Sample Children by Age Group and for All India (Rural) Respectively

Item	Income elasticities of consumption among sample children aged: 6-11 months	12-17 months	18-24 months	Total sample children	Total expenditure elasticities of demand for all age groups[b] in rural India
Supplementary milk	.159	.176	.282	.242	1.66
Cereals	-.160	-.099	.011	.010	0.50
Pulses	-.107	.178	-.073	.026	0.71
Fruits	-.049	-.077	.009	.036	1.43
Vegetables	.470	.232	.115	.218	0.69
Calories	.070	.041	.082	.071	
Protein	.045	.033	.034	.042	
Vitamin A	.013	.036	.065	.035	
Iron	-.055	-.057	.020	.012	

a/ Using the double-log function: $\log C_i = a + b \log Y$

where:

C_i = per capita daily consumption of a particular item

Y = per capita income

b/ Calculated by Sinha (61) using the log-log inverse function:

$$\log E_i = a - \frac{b}{X} + C \log e X$$

where:

E_i = per capita expenditure on a particular item

X = total per capita expenditure (as a proxy for income)

using 1957-58 data from the 13th Round of the (Indian) National Sample Survey.

so small and their consumption so erratic among these children that the elasticities are less meaningful than those for supplementary milk and cereals. The figures are given, nonetheless, to permit comparison with the all-age group figures.

The figures[6/] indicate clearly that the effects of income per se on the food consumption of the young children are far less pronounced than for the population as a whole. The income elasticities of consumption for calories, even among the 18-24 month age group with a lesser dependence on breast milk, is only .082 meaning that if a family somehow succeeded in doubling its income (assuming everything else, including prices remained constant) their child's caloric intake would increase by only 8 percent. (The increase in an adult's caloric intake might be 10 times that great.) The young child's protein, vitamin A and iron intake would increase by even less. This would suggest that, for the sample population as a whole, a simple income supplement program unaccompanied by other interventions is unlikely to have a major effect on their food intake.

At the same time the elasticities indicate that income becomes an increasingly important determinant of supplementary milk and cereal intake (representing 75 percent of non-breast milk calories) as the children get older. In the case of cereals, their use among lower income groups as a partial substitute for larger quantities of higher status, more expensive supplementary milk account for the negative cereal elasticities among the youngest age groups. This also would explain the negative elasticities for iron, largely a function of cereal intake.

6/ The milk elasticity of .242 would be interpreted as follows: "A 10 percent increase in income would result in a 2.42 percent increase in milk consumption."

Finally the income-food intake relationship can be examined in the per capita income group breakdowns and frequency distributions presented as a group in Appendix III. Tables III-1, 2, 3, 5, 7 and 9 give data for each of five per capita income groups, while Tables III-4, 6, 8 and 10 present the same information pooling the two top income groups and the two bottom ones respectively.[7/] Tables III-3 and 4 indicate the positive although irregular effects of income on calories, protein and vitamin A intakes. Iron intake, again because of its largely cereal source, is not significantly affected by income. The frequency distributions presented in Tables III-7 and 8 indicate, nonetheless, the extent of the calorie and hence nutritional intake problem even among the highest income groups. Table III-8 using the pooled income groups indicates that in the high income group only 35 percent attain over 76 percent of their caloric allowance, while 20 percent meet 45 percent of the allowance or less. Thus, there is little question of the need for nutritional improvement even among children of economically advantaged families in this area.

The important male-female differentials in these tables will be examined in the discussion of the sex variable below.

Determinants of Diarrheal Infection

As indicated in equations 1-3 in Table 20, the one infection variable to emerge as a significant determinant of nutritional status was diarrheal

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7/ It should be noted that, ideally, grouping by total expenditure would be preferable to income grouping in such tables, since total consumption expenditure, and hence expenditure on children, could be financed not only from current income, but also from past savings and borrowings. In fact, the considerable amount of dissaving among the lowest income group may result in their spending as much as the next group up. Nonetheless, the income groupings, particularly the pooled figures, probably represent a reasonable proxy for total expenditure.

infection.[8] The variable proved highly significant, even more so than caloric intake. Estimating, in turn, the determinants of diarrheal infection resulted in the same low R^2's encountered in the caloric intake equations, probably suggesting the need for more sensitive measures of environmental conditions, water supply and food preparation procedures, preferably using time series data. Nonetheless, the equations reveal several interesting findings.

Equation 6 in Table 20 examines the determinants of diarrheal infection for the population as a whole. The primary determinant to emerge in this equation is family size. The high positive correlation with diarrheal infection would indicate either that the spread of diarrheal infection is facilitated by the crowding found in densely populated households, or that parents tend to provide less good care to later born children. Either conclusion would add still another dimension to the set of population-nutrition relationships presently being explored in many countries. Interestingly, as seen in equations 3 of Table 21 the family size determinant is far more important among Jats than Ramdasias. This would be consistent with either explanation of the family size-diarrheal infection relationship. If the spread of infection hypothesis is valid, the differentials are likely to be greater among the Jats whose households and level of environmental sanitation, while hardly ideal, are far more infection-free than those of Ramdasia families. It would be reasonable to assume that environmental conditions among Ramdasias are so poor to begin with, and the frequency and severity of diarrheal infection already so high,

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8/ Nonetheless, the infection index of diarrhea, giardia and disease history was used as a dependent variable in equation 7 of Table 20. Because of the lack of any statistical significance in the equation, discussion in the text is limited to equation 6 using diarrheal infection alone as the dependent variable.

that the addition of more children would have an umimportant additive effect. If the less-good-care-to-later-born-children hypothesis is valid, one could assume that Jats have the resources which permit such differentials. As will be suggested in the following sections, the low income Ramdasia woman at present may not be in a position to provide adequate care to a young child, even if these are only a small number of children to care for.

The other important finding in equations 3 of Table 21 is the far greater effect of income on diarrheal infection among Ramdasias than among Jats. To deal with this relationship and the ensuing analysis, it probably would be useful to think of income among Ramdasias as both a resource and a time factor. As discussed earlier, the Ramdasia woman, although usually living amidst abject poverty, is, unlike most of her Jat counterparts, a fully employed person. During sowing and harvest seasons she works in the fields. Throughout the year she collects fuel and fodder and cares for the animals above and beyond her household duties. When the income of a Ramdasia family increases, the increment will not only increase the woman's purchasing power but will at a certain level permit her to dispense with many of her responsibilities outside of the home and increase the time she has for herself and her children. This has major implications for child health. Child illness is even under the best circumstances a difficult process. Recurring diarrheal infection is among the most problematic. For the harried Ramdasia mother it is well-nigh an impossible one. In such a situation, income alone is unlikely to be a panacea. Responses to questions on the treatment of diarrheal infection indicate that a general lack of knowledge on this subject is pervasive.[9/]

9/ This lack of a major differential in beliefs and knowledge pertaining to diarrheal infection would explain the absence of a significant beliefs coefficient in these equations.

The existence of considerable diarrheal infection among upper income groups as indicated by the frequency distributions in Tables III-9 and 10, would further support the contention that more than income is necessary to deal effectively with the problem. Nonetheless the upper income Ramdasia woman with more time to devote to the problem apparently is able to deal more effectively with it even lacking adequate knowledge.

The Age Variable

The importance of the age variable, as discussed earlier, simply indicates the increasing severity of malnutrition problems as children progress beyond the age of six months. As noted earlier, these children are plagued by the combination of increased nutritional intake requirements which cannot be met with breast milk alone, and the debilitating syndrome of weanling diarrhea, so well described by Gordon, Chitkara and Wyon (29). The significance of this age variable reinforces the contention made in Chapter 1 of the need to focus the thrust of intervention programs on children of this age. The closer to the six month age group the program can come, the greater effect it is likely to have.

Income as a Proxy

The significance of per capita income as a determinant of nutritional status independent of its effects on food intake and infection (and hence on nutritional status) would seem to suggest that the income variable here represents other variables not explicitly measured in the study but highly related to income. Three such variables would seem to be most plausible:

a. Pre-natal environment - The height and weight of the child's mother (primarily a function of environmental factors during her lifetime) and her food intake during pregnancy (particularly when her height and weight are substandard) are likely to affect the birthweight of the child.

Here, as in industrialized nations, one finds significantly lower birthweights among lower income groups.

b. Demand breast feeding - Ramdasia mothers who spend a large part of each day out of the home are less available for breast feeding than are their Jat counterparts. Even if the Ramdasia mothers fed an equal quantum of breast milk during a 24 hour period, the fact that this is accomplished through fewer feedings[10/] probably makes it somewhat less efficient. In actuality, however, the Ramdasia mother probably feeds a smaller quantum of breast milk, particularly during the sowing and harvest seasons, leading to what Jelliffe refers to as "breast starvation" (35).

c. Psychological effects of a mother's presence - Although least easy of all to quantify, the psychological effect of a mother's presence may explain some of the variation in growth (54, 64).[11/]

The Sex Variable

In terms of equation 3 in Table 20, the most statistically significant determinant of nutritional status is sex. In other words, a child's sex per se would more consistently account for variations in nutritional status than any of the other variables. Similarly, sex has emerged as a determinant, although less statistically significant of caloric intake for the population as a whole, and of diarrheal infection among Jats. Thus, the sex variable clearly represents a critical determinant in the analysis and requires careful examination.

10/ Bailey (5) refers to this phenomenon of breast feeding when the mother gets a chance as "opportunity feeding" as opposed to "demand feeding".

11/ An excellent discussion of the relationship of these factors to anthropometric measures should be published shortly by Dr. DeSweemer of the Johns Hopkins Department of International Health.

To aid in this examination the major variables are broken down by caste and sex in Table 24. As seen in this table the most significant sex differences are in the anthropometric measures used as proxies for nutritional status. The magnitude of these differentials reinforces the highly significant coefficient of the sex variable in equation 3 of Table 20, indicating an important effect of sex on nutritional status independent of its effects on caloric intake and infection. There may be two explanations for such an effect. First, it is likely that the establishment of India-specific or Punjab-specific reference growth curves, like those in other low income parts of the world, would provide somewhat greater differentials in the reference growth curves of males and females even for this age group than do the Harvard standards. At the same time the greater premium placed on sons than on daughters clearly results in major differentials in their care and upbringing[12/]. Some of these differences discussed below are picked up by the data. Others relating to such factors as extra time, attention and affection devoted to male children are not accounted for statistically, yet might have major effects on child growth.

These differences reflect an economic as well as a cultural premium placed on living sons, with roots deep in Indian tradition, yet reinforced by present-day realities. Sons represent an economic asset to their parents as a bread winner and a source of social security. Daughters are considered unproductive and an expensive economic drain, particularly the cost of the dowry when they marry[13/].

12/ Our own experience in Punjab paralleled that of the Narangwal RHRC which spent "an inordinate proportion of time saving baby girls."

13/ Conversations recorded by Dr. Helen Gideon while collecting information on family size as part of the Khanna Study (66) are particularly revealing. After realizing that she was receiving information only on male children, she confronted the next woman with the dilemma and was told, "Of course, we have girls; you only asked about children and said nothing about girls."

Table 24. Tabular Profile of Jat and Ramdasia Sample Children by Sex-Caste Groupings

	Sex-caste group			
	Jat male	Jat female	Ramdasia male	Ramdasia female
Number of cases	111	98	98	96
Average percent reference weight for age	84.2	73.5	77.8	69.0
Average percent reference height for age	95.5	91.8	93.4	89.9
Average percent reference weight for height	90.1	85.3	87.0	84.0
Average percent of caloric allowance	64.4	62.7	62.6	55.7
Average percent of protein allowance	86.1	88.0	84.9	81.7
Average percent of vitamin A allowance	89.7	81.9	86.0	80.4
Average percent of iron allowance	35.1	41.3	37.5	32.7
Percent breast fed	84	70	87	82
Percent receiving supplementary milk	88	93	91	80
Percent receiving solid food	72.1	81.6	79.6	67.7
Average age of initiating solid food (months)	10.5	10.3	10.5	11.1
Average supplementary milk consumption (gms.)	204	217	164	146
Average cereal consumption (gms.)	22	31	27	25
Average pulse consumption (gms.)	8.5	8.7	6.2	9.3
Average vegetable consumption (gms.)	10.8	7.1	9.2	4.4
Average fruit consumption (gms.)	15.7	14.5	15.7	10.0
Average number of major diseases	0.91	0.75	1.08	0.89
Average diarrheal infection rating	1.52	1.98	2.38	2.21

⌣ Indicates figures significantly different at the .95 level of statistical significance.

The most serious male-female differentials in the explanatory variables occur at the lower end of the income spectrum, among the Ramdasias. This indicates the severe resource and time constraint at that income level resulting in serious consequences for the young female child who often is not particularly wanted in the first place. Only with increases in income and time, adequate for the woman to meet what are, to her, higher priority responsibilities, is she likely to turn her attention to the female child. When resources and time are no longer serious constraints, as in the case of many Jat families, the young girl can be cared for adequately, although there still will be male-female differences in the quality of that care, and, interestingly, in the length of breast feeding. Apparently both Ramdasia and Jat mothers feel obliged to breast feed male children somewhat longer, believing it will increase the likelihood of their survival and well-being.

The sex-caste differential is most dramatically illustrated in the case of food intake. Table 24 indicates that except for vitamin A and vegetable intake, the feeding of Jat females largely compensates for the shorter breast feeding noted above. The Jat female child consumes almost as many calories, more protein, more iron, more supplementary milk and more cereal than the Jat male. The Ramdasia female child not only is breast fed for a shorter time period than the Ramdasia male, but consumes less supplementary milk and less solid food, begins consuming solid food later, and receives less of each of the nutrients. The relationship similarly is seen in Tables III-1 to 4 in Appendix III. Although more erratic, they indicate that while roughly equalling the males with respect to food intake among upper income groups, female children are far less well off at the low end of the income spectrum.

The sex differences in diarrheal infection and disease among Ramdasias might appear to contradict the conclusion that male-female differences are greatest among lower income groups. According to Table 25, Ramdasia females actually have slightly less major disease and diarrheal infection that Ramdasia males. In fact, it is likely that the malnourished Ramdasia female stricken with a major disease or with severe diarrheal infection simply does not survive. This contention would be supported by the much higher infant mortality rates for females (196 per 1000) than for males (125 per 1000) found by the Narangwal RHRC (36). Among low income families these differences would be even more pronounced. Thus, a Ramdasia female child who remains in the sample would likely have somewhat less frequent and severe diarrheal infection, although more than her Jat counterpart, and probably would not have had more than one major disease.

Discussion

The above analysis demonstrates rather strikingly the difficulties in dealing uniformly with different socioeconomic groups, even within a narrow age group. The health of a young Jat child probably approximates the norm for children of his age in low income countries as a whole, although male-female health differentials may be somewhat greater in Punjab. His caloric intake is low, and this, coupled with diarrheal infection, limits his physical growth. His family is, on the average, economically better off than similarly placed families in other low income countries. Yet, though his mother has both the resources and the time, she lacks the facilities in her rural surroundings to translate this income and time into major health improvement for the child. Evidence from Calcutta (30) suggests that were she living there or in other urban centers her family income would be a far more significant determinant of her child's well-being.

This would seem to suggest that only where facilities exist which permit easy translation of improved income into such advantages as better health care and advice, improved environmental sanitation and perhaps better education, are income increments likely to make much of a difference in a child's food intake and his health.

Were such facilities, in the form of clinics or education programs, available to the Jat mother living in the Morinda area, she probably would be in a position to benefit significantly from them. Coming from a landed family she is somewhat more worldly than her Ramdasia counterpart, she may have studied in a school for a few years, she may be literate or at least have a literate husband, and she has both the resources and the time to put into practice the messages of a feeding demonstration program or health clinic. Perhaps most important, she is not living on the edge of poverty and therefore, like her husband faced with new seed varieties or fertilizer, is somewhat more willing to innovate.

For the Ramdasias the situation is quite different. The child in a Ramdasia family is considerably more malnourished, often reaching the point where survival depends on escaping a bout of measles or severe diarrhea. If the child is a girl, the situation is that much worse. The child spends much of the day in the care of an older sibling while its mother is working outside of the house. In some extreme cases the family simply lacks the resources to provide even minimal care for the child. More often its mother lacks the time to deal explicitly with the need. From her own experience and that of her neighbors, she knows that giving her child supplementary food probably will result in a severe attack of diarrhea which she would just as soon avoid. If her child is a girl, there are that many more priorities which must be met first.

Providing education alone to women in such circumstances is virtually doomed from the start. The annals of well-meaning educators are filled with episodes of neatly arranged demonstrations attended only by the well-to-do. The educators track down the lower income mother and deliver their message to a nodding, acquiescent woman who then totally ignores it. The educator throws up her hands in horror and stomps away to write another report about the ignorant villager.

In fact, the Ramdasia woman and her counterparts in other societies rarely can afford the leisure of visits to a demonstration program or health clinic. Furthermore, being more reticent and fatalistic and less worldly than the Jat mother, she is far less willing to take the initiative often required for such participation. Should she actually attend the clinic or demonstration she is unlikely to fully understand the message. And if she does understand the message, she is unlikely to have the resources, time or security to translate this information into practice. Finally, even if the mother can get past the child's first few years without income supplements by reallocating existing resources with the aid of newly acquired education, how is she to deal with the increasing expenses of feeding and caring for a child as it grows older and until it becomes a productive unit? Should the child be a girl, in this society a less productive unit, with the major expense of a dowry in her mid-teens, the question becomes that much more ominous.

In sum, one probably could conclude that any intervention would have a far greater positive effect on the Jat child than on the Ramdasia, and have the ultimate effect of further widening existing differentials.

CHAPTER 6

CONCLUSIONS AND INTERVENTIONS

On the basis of the analysis presented in the preceding two chapters the following conclusions might be drawn about this population of young children in rural Ropar District near Morinda:

1. The extent of malnutrition in this population, in spite of its location on the outskirts of the "Green Revolution," is more serious than that found in most other parts of the low-income world. It also is more severe than that found in the heart of the Indian "Green Revolution" (Ludhiana District) although nutritional status of the comparable age population in that area is seriously substandard. While all groups are affected, the two most severely malnourished subgroups of young children in both areas are the Ramdasias and the females.

2. When anthropometric measures are used to measure nutritional status in cross section analysis, nutritional intake (at a point in time) and infection are both highly significant determinants. Among Ramdasia children whose nutritional intake is lower and a more severely limiting factor, this intake variable is a more important determinant of nutritional status than among Jats.

3. Another important explanatory variable of differences in nutritional status is age which is inversely related. Beyond the age of about six months the children become increasingly vulnerable to protein-calorie malnutrition and weanling diarrhea, and begin to depart sharply from the reference anthropometric standards.

4. Beyond these, income has a significant effect on nutritional status independent of its effects through food intake and infection.

This effect probably reflects such income-related, growth affecting factors as pre-natal environment (largely a function of the weight, height and nutritional intake of the child's mother), demand as opposed to opportunity breast feeding throughout the child's lifetime, and perhaps the psychological advantage to the child of the mother's presence.

5. Finally, sex has a significant effect on nutritional status, independent of its effect on food intake and infection. This might be partly attributable to insufficient sex differentials in the reference standards used. It also would be explained by the premium placed on living sons in this society, and the resulting difference in the quality of care and in the affection given to male and female children, factors not fully accounted for in the other explanatory variables.

6. Caloric intake is, by a wide margin, the most important component of nutritional intake. It emerges, in fact, as a better explanatory variable than weighted indices of calories, protein, vitamin A and iron. In terms of the deficiencies per se, the most serious are calories (average 61.3 percent of allowance) and iron (36.7 percent of allowance) although there would seem to be some question about the validity of at least the caloric allowance. Protein deficiency appears less serious and not a significant problem independent of the calorie one. Similarly, vitamin A deficiencies do not appear as serious as in other parts of India.

7. Among both Jats and Ramdasias, caloric intake is a function both of beliefs and income, although the variables as a whole explain little of the variation in caloric intake. Among Jats, beliefs clearly is most important suggesting that interventions solely designed to affect these belief patterns would have significant effects on food intake. Among Ramdasias, beliefs is less important than among Jats but income more

important suggesting that the income problem in these families probably has to be addressed before education programs can have the desired effects At the same time, as indicated by particularly low income elasticities of consumption, income supplementation alone will have a limited effect on the overall problem of inadequate food intake for the children as a whole in this age group.

While sex is not a significant determinant of caloric intake among Jats, it is important among Ramdasias where major differentials in caloric intake exist between male and female children. Given particularly tight income constraints, plus major demands on the time of a Ramdasia woman, coupled with the much higher premium placed on male children, even near-adequate feeding of a young female child is the exception rather than the norm.

8. The beliefs measured and found to be a significant determinant of caloric intake particularly among Jats, related to mothers' views on the optimal age of food supplementation, her dietary response to infection, and her beliefs on the cause of a Punjabi language equivalent of nutritional marasmus. The practice of delayed solid food supplementation emanates from the association of such supplementation with diarrheal infection and gastrointestinal disorders in general, and the association of these, in turn, with child mortality.

9. Diarrheal infection is, again by a wide margin, the most important component of infection. Neither disease history nor giardia proved significant. As in the case of caloric intake little of the variation in diarrheal infection is explained by variables in this study, and probably requires more sensitive measures of environmental sanitation, water supply, and food preparation practices. While income has an insignificant

effect on diarrheal infection among Jats, it is highly significant among Ramdasias. For the sample population as a whole, family size is the most important determinant of diarrheal infection, suggesting either that the spread of diarrheal infection is facilitated by the crowding found in more densely populated households, or that parents tend to provide less good care to later born children. Diarrheal infection and disease is higher among Ramdasia males than females, probably suggesting that the malnourished female, stricken with severe diarrhea or disease, is less likely to survive.

10. In general, because of a greater availability of time and resources coupled with somewhat less fatalism and a more basic sense of security, the Jat mother and hence the Jat child (who also suffers from malnutrition) are likely to derive higher benefits from any intervention program than will their Ramdasia counterparts. For the Jat woman, most of the preconditions would seem to be met for the effective translation of her income and time into improved health for her children once the facilities to permit such translation (education programs, health clinic or other interventions) are established. For the Ramdasia, largely bypassed by the development process, these preconditions generally have not been met.

Intervention Strategies

To the extent possible the discussion of interventions will be carried out in the context of a nutrition planning model developed by Levinson and Call (37) for the U. N. Protein Advisory Group in 1970. The relevant portion of that model, for our purposes, permits the comparison of alternative nutrition intervention programs or program proposals by rough estimation of their benefits or their effectiveness and of their costs according

to a particular objective. Generally such an objective is cast in terms of economic efficiency. As discussed in Chapter 1, however, there is virtually no empiricism on which to support an economic efficiency base. Alternatively one could employ an equity objective either with respect to economic class, or perhaps as in this case, with respect to sex. Even here, however, one encounters major difficulties in quantifying benefits for a particular economic class or sex. Given these difficulties it probably makes sense to select a somewhat narrower objective such as decreasing malnutrition-related mortality or meeting a specific nutritional deficiency (e.g. low iron intake) or a particular nutritional disease (e.g. prevalence of nutritional marasmus in a population).

Direct benefits of a proposed program then would be measured in terms of its projected effectiveness in meeting that specific objective. Beyond the direct benefits with respect to the nutrition objective, the indirect multiplier effects of a proposed program on other development sectors or goals must be considered. A school feeding program even with negligible direct nutrition effects might be justified on the basis of increased school registration and performance. A labor-intensive dairy or fruit and vegetable program may not be the best means of meeting, say, vitamin deficiencies, but might be justified on the basis of their positive effects on income-generating employment (with, perhaps, increased nutritional benefits in the long run). Similarly, nutrition intervention programs might have multiplier effects on agricultural or industrial productivity or on family planning motivation.

On the cost side one first would examine direct production, distribution and administrative costs of a proposed program. It might also be necessary to isolate and examine the foreign exchange component of the

costs. Beyond these, one would examine the expected consumer acceptability of a program, its expected speed of implementation (with calculations using a discount rate), and its viability, each of which could substantially affect the real cost of a program. Finally one would project the program's political effects which could be a benefit or a cost.

On the basis of projected or actual data, a proposed program would be measured by each of these benefit (or effectiveness) and cost criteria. It then would be necessary to assign appropriate weights to each of the criteria based on their perceived political and socioeconomic importance (weights which in actuality usually are assigned by political leadership). Having assigned such weights, the benefits or effectiveness and costs of the alternative program proposals can be compared.

Although no such quantitative cost-benefit or cost-effectiveness analysis is undertaken in this study, it nonetheless is possible to examine the relevance of certain types of interventions in the context of the criteria outlined above. This discussion constitutes the remainder of the chapter.

The fact that the food intake problem among this group relates more to calories and beliefs than say to protein and availability would eliminate at the outset a number of interventions which have been considered or attempted in other areas. For example, although any of these conceivably might be justified on other grounds or for other groups, the primary needs of this group would not suggest the development of protein supplements or the production of oilseed or fish protein concentrates or of single cell protein from petroleum or algae. In terms of the above-discussed cost-benefit model, the direct benefits to the target group of such interventions would be too small to warrant their consideration.

Similarly, neither the production of synthetic amino acids nor the development of cereal strains with higher protein or better amino acid profiles would seem to be a priority here.

Since the availability of particular food commodities does not appear to constitute an important constraint to improved nutritional status among this group, the utilization of price policy as an intervention to aid this group would similarly seem out of place. Neither would commonly employed positive price policies[1/] have a beneficial longer run effect on the objective of improving the economic status of low income groups. In general, these positive price policies have an income transfer effect from the consumer to the producer. The result is a welfare improvement in the agricultural sector at the expense of a decline in urban welfare. Within the urban sector, increases in food prices will most seriously affect low income groups, who spend a larger percentage of their incomes on food. Within the agricultural sector, since benefits of a positive price policy are in proportion to sales, they will accrue to the large producer who markets the bulk of his goods rather than to the small subsistence farmer who markets little or nothing (49). Thus, while a positive price policy may increase production of desirable commodities and hence be a sensible course of action under certain conditions, it will not often, in and of itself, improve the nutritional well-being of urban and rural low income groups in greatest need of assistance. On the contrary, it may well adversely affect their welfare. In the context of the model, commonly employed price policy would have low direct benefits and potentially very high costs including the need for scarce administrative resources with particularly

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1/ A policy maintaining support or incentive prices for food producers.

high opportunity costs. In addition, it has a negative multiplier effect on the process of economic transformation or the transfer of resources from the agricultural to the industrialized sector, a general requisite for economic growth (48).

As noted earlier, virtually any nutrition intervention program initiated in this area is likely to have a significantly greater beneficial effect on Jat children than on Ramdasias. At the same time, the malnutr tion problem among Jat children is a serious one and probably deserving of attention even if the interventions employed have a less significant effect on the Ramdasias. The interventions discussed in the following sections are likely to fall into this category. They are followed by some comments on the Ramdasia problem per se and the prerequisites needed to bring about viable change for that group.

Information Dissemination

In terms of intervention the problems of inadequate food intake, delayed food supplementation, diarrheal infection and beliefs, each of which exists at all points on the economic spectrum, might best be addressed as a group. If so, this might suggest some combination of information dissemination, geared initially at the Jats, and the provision of a specially prepared easily digested weaning food. Both are exceedingly difficult. In fact to date there have been few if any successes in either on anything beyond a demonstration scale in terms of significantly affecting the nutritional status of those in need among this age group.

Ideally what is called for is the effective dissemination of a rather simple message, perhaps as simple as "If you want to increase the likelihood of your child's survival and improve his health, you must begin giving him solid food at the age of 4 to 6 months, even if this results initially

in some diarrheal upset. To decrease the chances of severe diarrhea, feed him a well cooked easily digestible food such as 'dahlia' (porridge) or 'halwa' made from sooji (samolina) and 'ghee' (unrefined butter)."[2] Secondary messages, equally simple, might stress hygiene and in some cases inoculations.[3] They also could emphasize the need for increased food consumption by women in their last trimester of pregnancy. Again, to the extent any of these messages are directed at the Ramdasias, they should take into account the severe resource and time limitations of that group.

There is evidence from Narangwal, Khanna, and our own study that on a small scale this message can be effectively disseminated with rather dramatic results in the case of malnourished children. The question is how best to disseminate it on the massive scale required. Traditionally, two basic approaches have been available for such a purpose, the person to person extension approach and the mass media one. The former has been undertaken as part of U. N.-assisted Applied Nutrition Programs and by government extension agents, health clinics, and voluntary agencies. In some cases it is incorporated into the formal education curriculum. Ideally it permits firsthand demonstrations, firsthand responses to expressions of scepticism, and the necessary followup.

The critical questions to be answered in the case of "person to person" information dissemination are two. First, what is the cost and

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2/ The fat content of the diets of these children probably has to be increased. Given the bulk constraint on diets of young children, such a source of concentrated calories would clearly be desirable.

3/ Information collected in this study on inoculations indicated that virtually all children were vaccinated against smallpox and about half received BCG inoculations against tuberculosis (the latter depending almost solely on whether or not the local inoculation unit reached the child's village). No other inoculations were given. A child's inoculation history was not significantly related to belief patterns or disease history.

time period necessary to reach the bulk of the population in a medium or large sized low income country? While nutrition rehabilitation centers have had considerable success in Haiti, the cost of similarly reaching the pre-school age population of India, for example, would exceed 1.5 billion dollars.

The second question is the effectiveness of such intervention as measured by the ultimate criterion of improved nutritional status. Equally important are the carryover effects over time and space. Does the mother who has received such education continue to observe the recommended practices a year later? Does she observe them with her subsequent children? Does she effectively pass the knowledge to her neighbor or must the neighbor also be reached directly? Unfortunately few nutrition education programs gather such information, which would be of considerable value in refining existing programs and designing new ones.

Mass media efforts are carried out through newspapers and magazines, cinema, billboards, radio, television, and through messages on everything from buses and rickshaws to calendars and yo-yos. Operating on a "mass" basis they circumvent the basic problems of cost and time cited above in relation to person to person efforts. While many mass media initiatives may lack the human, personal approach of more traditional nutrition education, others may provide it more effectively through the broadcast speech of a prime minister or important religious figure. Furthermore, mass media efforts are usually undertaken by groups better capable of communicating than traditional nutrition educators. They must of course be provided with the right messages -- as they sometimes haven't been -- if this communication is to have the desired effect.

The primary questions to be answered by advocates of increased investment in the mass media approach would be the following:

1. How much does the approach depend on the skills or sophistication of the lowest income groups in need of the assistance? Where literacy is required these groups automatically would be largely eliminated in rural Punjab. Similarly, Westernized techniques of selling a product or concept which might have considerable appeal to the communicators and to the well educated segments of the population might well bypass most of the lower income group in rural Punjab for whom the communication was intended (24, 35).

2. What is the cost of introducing large scale but decentralized broadcasting or television capable of reaching the bulk of the populace but still keeping the messages relevant and in the right language or dialect?

3. While presumably capable of successful motivation if handled intelligently, how effective are the media (television aside) in disseminating the techniques of new practices to an illiterate populace?

4. Can low income groups translate the messages into improved practice and well-being without income increments, or will they merely widen their expectations gap with possible social and political consequences (25.

With respect to the cost-benefit model, person-to-person extension efforts would have potentially high benefits assuming adequately skilled extension personnel plus sufficient income among the recipients. On the other hand, such programs imply high costs (particularly the opportunity costs of trained extension personnel) and lengthy implementation periods. Mass media efforts might have somewhat lower direct benefits but involve lower costs and more rapid implementation. In terms of actual programs,

person-to-person and mass media efforts actually constitute two ends of a spectrum with many possible points in-between. Among them are such entities as under-five clinics serving one or several villages and requiring minimal staffing. Equipped to provide uncomplicated health care and utilizing simple height-weight charts, such units can claim many of the advantages of the extension effort at lower cost.

In the context of rural Punjab, the level of overall economic growth coupled with the existence of a rather impressive network of extension services would suggest the possibility that a well planned, well financed and highly focussed information dissemination program largely utilizing existing facilities could be successful in reaching the Jat mother and her child. With respect to health extension there presently exists a cadre of public health nurses, lady health visitors and village attendants who already provide basic health and family planning services to a portion of the population. By significantly increasing the number of such persons (probably accomplished without major difficulty if their status and salaries were made commensurate with their responsibilities) and providing training in the effective dissemination of the message, this group could begin to have an effect on the problem. Similarly, the network of materna child health centers and family welfare planning centers currently being geared up to provide improved family planning services could also be an instrument for the dissemination of this message.

With respect to mass media, the major instrument presently available is the radio. Of the families whose children were included in this study 47 percent own radios, almost all of them Jats. Although only slightly over a third (36 percent) of the mothers in these radio owning families listen to the existing "women's programs" which include information on

child care and family planning, the time spent listening to such programs proved a significant determinant of beliefs which, in turn, was found to be the primary factor affecting the nutritional intake of children. One wonders what kind of impact might be possible if these programs were improved and made more attractive while, at the same time, means were found to increase the availability and decrease the cost of transistor radios in these areas.[4/] Beyond radios there is room for considerable imagination in reaching the target audience through mobile film shows, and many of the same techniques effectively used in selling everything from soap and cooking oil to cigarettes and batteries in rural India.

Weaning Foods

It is possible that efforts to disseminate the child care message would be facilitated if accompanied by the distribution of food. If the food were a precooked, easily digestible weaning food, it also might aid directly in alleviating the nutritional intake problem. Finally, if family planning centers were among its distribution outlets, the availability of food might considerably strengthen the effectiveness and drawing power of these centers. Success in population control in turn, aside from its obvious importance to overall development, would, according to these findings have a positive effect in decreasing infection among children of this age group. There already is a sizeable body of evidence that children from smaller families eat better. Though that relationship failed to emerge in this study, it probably would be found among slightly older children whose food consumption is less affected by family belief patterns.

4/ In addition to their utility for information dissemination (and in spite of their noise) it is generally accepted that the existence in rural areas of such mechanized items, representing a tangible means of translating earnings into satisfaction, serve as a necessary component of the earnings incentive (48).

There have been numerous efforts in low income countries to commercialize such food products supposedly geared to nutrition, and more specifically protein, problems. During the past two decades, and beginning with dried skimmed milk, numerous such products have been developed and marketed with such an orientation: Vitascy in Hong Kong, Pro-Nutro in South Africa, Incaparina in Central America, Fafa in Ethiopia, Laubina in Lebanon, Saci in Brazil, and many others. Other processed foods, particularly baby foods, have been promoted in these countries on nutritional grounds but make no pretext of aiming for other than the middle and upper income markets.

A wide range of problems has faced producers of such products but one basic one has faced them all. This in simplest terms is the conflict between nutritional impact and profits. The fact that the two have been mutually exclusive in virtually all such efforts represents the basic dilemma facing this type of intervention. In Punjab as elsewhere the disposable incomes of economically disadvantaged groups in these countries are often inadequate to afford even the regional food staple. In the production of a processed food, even with negligible margins, the cost of the raw materials represents no more than a third to a half, and usually much less, of the total product cost, which is dictated by costs of processing and packaging in these countries and by the normal marketing costs involved in any commercialization. This leaves the product well beyond the reach of most of those who need it.

It would seem apparent, therefore, that if such a product, in this case a processed weaning food, is considered desirable the market mechanism alone is unlikely to suffice. If it is desirable to commercialize such a product at all, and it may well be, this would have to be done

through government subsidy and control. In terms of its non-commercial production and distribution the government's role seems reasonably clear. The basic need is to institutionalize the feeding into the domestic food distribution system where this has not yet been done. Where this is not done, low income countries will remain dangerously dependent on existing international assistance in child feeding, which in and of itself is problematic and which, if withdrawn, might leave little if any structure remaining. Mechanisms to accomplish this usually needn't be developed from scratch. Where governments are actively engaged in the buying and selling of food commodities, particularly as the supply of these commodities begins to exceed effective demand, portions of government stocks might automatically be earmarked for child feeding. Beyond this, an agricultural planning body projecting supply requirements to meet domestic demand, buffer stock and export needs, could without major complication add a fourth category, namely, child feeding requirements. Within this larger framework there may be a role for the local food processing industry.

Looking at weaning foods per se in the context of the cost-benefit model, the extent of their direct benefits would seem to be dependent on their cost, the effectiveness of their distribution, and the efforts made to overcome initial consumer resistance. Given the belief patterns noted in this part of Punjab it is unlikely that the introduction of such a weaning food would meet with much receptivity unless coupled with an effective motivational effort. If such production permitted reasonable profits it could become a relatively viable program. More likely, however, a weaning food production and distribution program resulting in significant nutritional benefits to this age group not only would preclude

profit margins but would entail major, recurring government expense. On the other hand, an effective distribution, aside from its direct benefits, could as noted above have the important multiplier effect of strengthening the institutions used to distribute it.

Iron Supplementation

Even though the specific effects of low iron intake on the morbidity, mortality and general health of these children may be difficult to isolate with precision, the extent of severe iron intake deficiency found in Chapter 4 suggests the need for explicit intervention. The problem might be addressed by an enlarged network of extension personnel and health centers through the distribution of iron and folic acid supplements to women and children. This already has been undertaken in parts of India with some success. Given the dimensions of the problem and its existence in severe form well beyond the target group, however, it may be useful to consider the iron fortification of a food item such as salt (44) consumed by the entire population. Such fortification, in terms of the cost-benefit model would have potentially high benefits for those in the target populace who regularly consume solid food. It would have no effect on exclusively breast-fed or supplementary milk fed infants. Given the major iron deficiencies existing in other population groups, such mandatory fortification could have direct health benefits well beyond the target group. Production, distribution and administrative costs would be relatively low, and assuming no adverse effects on the appearance or taste of the salt, acceptability should be high permitting relatively rapid implementation.

The Ramdasia Problem

As indicated earlier, most of the interventions discussed above are likely to have a more significant effect on the Jat child than on the

Ramdasia[5/]. Such programs can be justified on the basis of the significant malnutrition found among Jat children and the expectation that reasonably efficient programs will bring about major improvement in their well-being. But what about the Ramdasia child and his even more severe malnutrition problem?

To assume that slightly more resources or more governmental commitment behind such programs will, in and of themselves, meet the needs of these children, is, as discussed in the previous chapter, probably unrealistic. Even if the services were available the Ramdasia woman is unlikely to have the resources, time, or basic sense of security to take advantage of them. And even if she should express receptivity there is little assurance she will be able to fully avail of existing programs. In the usual case where demand for scarce services exceeds supply, they usually end up going to the more economically advantaged. In addition, where such programs are controlled by existing rural elites there may be little effort to extend these services to the poor. An evaluation of the Indian Applied Nutrition Program, currently underway, has found considerable evidence of the difficulties involved in reaching the intended poor when programs at the local level were controlled by these rural elites.

As seen in the Chapter 5 analysis, the most basic and limiting constraint facing the Ramdasia child is income. Both with respect to food intake and infection, income increases are necessary both to provide resources and to permit the child's mother more time at home. The potency of any other intervention directed at this group is likely to be minimal until this basic limiting factor is addressed.

5/ Free weaning food distribution and salt fortification might be exceptions.

The major developmental thrust in rural Punjab, namely technological change in agriculture, probably has had little if any positive effect on this problem. While new seed varieties and multiple cropping have increased the demand for agricultural labor, the consolidation of holdings by landowners (meaning less intensive cultivation) and the increase in mechanization probably have had a somewhat offsetting effect. Meanwhile, there has been major economic advantage to the landowning Jats, thus widening previous economic differentials.

To some extent the problem could be addressed through an increase in labor intensive income generating employment. This would include not only rural works schemes and small scale industrial developments (e.g., brick kilns or agricultural implement manufacturing) but also labor intensive milk production and fruit and vegetable cultivation (50)[6/]. While such efforts might well have the important effect of reducing the number of non-participants in the growth process, it would still leave largely unaffected the major population group at the bottom of the economic spectrum.

Stated simply, neither the range of alternative nutrition intervention programs nor the available means of generating income through employment is likely to have the desired effect on the most economically disadvantaged. Programs attempting to reach the Ramdasias through these means are not only

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6/ If the Ramdasia child's nutritional status suffers significantly during harvest and sowing seasons because the mother, needed in the fields, is absent for much of the day, it may be worse if additional employment opportunities for which she is eligible are created. It is likely, however, that even the Ramdasia woman's income elasticity of demand for leisure is sufficiently high that once her family income level has reached a tolerable point she would opt to follow the ways of her Jat counterpart and spend increasingly more time at home. In addition, increasing technological change in agriculture will have the longer run effect of evening out seasonal labor requirements, and by leveling off the peak sowing and harvest seasons, reduce the need for woman labor.

likely to be unsuccessful, but might have the negative effect of permitting complacency in regard to the basic plight of these highly disadvantaged, and largely ignored enclaves. One can only conclude that the plight of the poorest poor will continue unless and until they themselves become substantially involved in the income growth and development process. Until they are permitted active political participation in the processes of change and development which surround them, there is little likelihood these persons will be able to take advantage of such change or restructure it in ways necessary to ameliorate their own condition and that of their children in some viable fashion.

In conclusion, the study would seem to suggest two rather different approaches to the malnutrition problem. For the landed Jats (and probably for most of the heterogeneous "others" group and even a small portion of higher income Ramdasias) a program of information dissemination related to child care and feeding probably would be the single most important intervention. Such information dissemination might be facilitated by a weaning food distribution which, in turn, could strengthen the outlets selected for such distribution, among them family planning institutions. For the Ramdasia, a substantial improvement in his economic position appears to be a prerequisite for viable improvement in the nutritional status of his children. Only when this basic income constraint is overcome, are his children likely to be able to derive significant benefits from the kinds of nutrition intervention programs discussed in this chapter. Such economic betterment, in turn, probably requires rather basic changes in social and political organization through which the poor can restructure and more fully avail themselves of the opportunities inherent in the development process.

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APPENDIX I

DATA COLLECTION SHEET

Number _____

A. General Information

Name of village _____ Patti or Vehra _____

Name of child _____

Name of child's father _____

Age of child (months) _____ Date of birth _____

Sex: M / F (circle) Caste: Jat / Ramdasis (or Harijan)/ Other _____ (specify) (circle)

Weight _____ Height _____

B. Demographic

List living children by age and sex

	Sex	Age
1.		
2.		
3.		
4.		
5.		

No. of liveborn children who died _____

To be filled in later:

Nutritional intake per 24 hours: Calories _____ _____
Protein _____ _____
Vitamin A _____ _____
Iron _____ _____

Parasite measure _____

Medical experience rating _____

Family wealth index _____ Family income _____

Beliefs index _____ Inoculations index _____

C. Medical

		Circle	At what age (months)
Has child had:	Smallpox (Bara mata)	Yes No	_____
	Measles (Khasra)	Yes No	_____
	Other matas (Impetigo, Rubella, Chicken pox)	Yes No	_____
	Severe diarrhea (dysentery, or stools with blood or mucous)	Yes No	_____
	Pneumonia	Yes No	_____

Does child have a smallpox scar? Yes No

Does child have a BCG scar: Yes No

Does child have diarrhea now? Yes No

On how many days during past 7 days has child had diarrhea? _____

How much diarrhea has the child had during its life?

Circle: almost none 10% of time 25% 50% 75% 90%

D. Mother's Beliefs and Education

In your opinion, at what age should child be given supplementary milk?_____ solid food?_____

What would you do to the child's diet if child had

diarrhea? _____

fever? _____

mata or typhoid? _____

What is the cause of marasmus (soka)? _____

Does explanation involve evil spirits or shadows? Yes No (circle)

What should be done if child has soka? _____

Years of schooling of mother_____ Literacy (any language) Yes No (circle)

No. of days during past 7 days that mother listened to a women's program on the radio (12:30 afternoon, 7:30 evening, 11:30 Sunday)_____

E. Child Feeding

Is child breast fed? Yes No (circle) If no, at what age was breast feeding stopped? _____

Is the amount of breast milk normal? Yes No (circle) If no, explain _____

Does the child receive supplementary milk? Yes No (circle)

If yes, at what age was it started? _____

Does the child receive solid food? Yes No (circle)

If yes, at what age was it started? _____

If yes, why is it that some other mothers don't give solid food? _____

If no, why is it that some other mothers give solid food? _____

Was food given in the past 24 hours normal for the child? Yes No (circle)

If no, explain _____

Are any vitamin pills consumed by the child? Yes No (circle) If yes, which _____

Food consumed by child yesterday

Item	Volume	Weight	Calories	Protein	Vitamin A	Iron

F. Family Wealth Index

Father's occupation _____

1. Housing (circle)

Walls: All brick / Mixed / All mud

Floor: Paved / Dung / Other _____ (specify)

Roof: Brick / Thatched / Other _____ (specify)

Total number of rooms _____ Electricity in house Yes / No

2. Animals

Oxen _____ (number) Cows _____ Buffalo _____

Camels _____ Other, specify _____

3. Sanitation

Water source	Drinking	Other uses	Ownership	Jt. ownership
Open well				
Hand pump				

Distance of drinking water source from kitchen (in yards) _____

4. Mechanical possessions (Yes or No) (Put fraction if joint ownership)

Bicycle _____ Radio _____ Sewing machine _____

Cart _____ Persian wheel _____ Borewell _____

Thrasher _____ Mechanical fodder cutter _____

Sugar cane crusher _____ Other (specify) _____

5. Economic Status

House owned: Yes / No

Land owned: Cultivatable

	kub / pub / ki / a
Rented in	
Rented out	
Sharecropped in	
Sharecropped out	

Income from other than one's own land

Source	Cash	Kind	
			D / M / Y
			D / M / Y
			D / M / Y

Total income _____ D / M / Y

APPENDIX II

FAMILY WEALTH INDEX

House walls: Brick = 20 Mixed = 15 Mud = 10

House floor: Paved = 10 Mixed = 6 Dung = 2

House roof: Brick = 20 Mixed = 17 Thatched = 15

Rooms: 20 per room

Electricity: Yes = 12 No = 0

multiply by $\frac{1}{2}$ if house is not owned

Animals: Ox = 5 Cow = 3 Buffalo = 5

Camel = 5 Other = 1

Source of drinking water: Open well = 2 Hand pump = 10

Source of water for other uses: Open well = 2 Hand pump = 10

multiply by:
ownership = 1
part ownership = 2/3
not owned = 1/3

Possessions: Bicycle = 2 Radio = 1 Sewing machine = 2

Cart = 5 Persian wheel = 10 Bore well = 50

Thrasher = 20 Mechanical fodder cutter = 10

Fodder cutter = 2 Sugar cane crusher = 5

Land owned: Acre = 40 Kucha Bigha = 8 Pucca Bigha = 4 Kila = 32

Income from other than family-owned land: Divide annual income in rupees by 140

APPENDIX III

PER CAPITA INCOME GROUP BREAKDOWNS AND FREQUENCY DISTRIBUTIONS

Table III-1 Tabular Profile of Male Children by Per Capita Income Groups

	Monthly per capita income				
	Rs. 24 and below (Jats=6.3% Ramdasias=81.3%)	Rs. 25-39 (Jats=22.0% Ramdasias=47.5%)	Rs. 40-50 (Jats=55.6% Ramdasias=27.8%)	Rs. 51-75 (Jats=52.1% Ramdasias=25%)	Rs. 76 and above (Jats=75.5% Ramdasias=7.5%)
Number of cases	48	59	54	48	53
Average percent reference weight for age	77.7**	79.6	83.2	83.3	84.4
Average percent reference height for age	93.7**	93.4	94.9	95.2	95.9
Average percent reference weight for height	86.5**	88.7	90.0	89.5	89.8
Average percent of caloric allowance	62.3	55.0	63.6	68.3	66.8
Average percent of protein allowance	84.0	79.3	87.0	89.3	88.7
Average percent of vitamin A allowance	85.3	83.1	89.2	87.6	91.1
Average percent of iron allowance	36.3	32.3	34.6	38.8	37.2
Percent breast fed	85.4	89.8	81.5	79.2	81.1
Average daily supplementary milk consumption (gms)	191	124	182	234	223
Average daily cereal consumption (gms)	25	21	24	26	24
Average number of major diseases	1.17	1.00	0.89	0.65	1.09
Average diarrheal infection rating[a]	2.65**	2.17	1.85	1.46	1.28

** Significantly different from the "Rs. 76 and above" figure at the .95 level of statistical significance.
⏟ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.

Table III-2 Tabular Profile of Female Children by Per Capita Income Groups

	Monthly per capita income				
	Rs. 24 and below (Jats=7.5% Ramdasias=77.4%)	Rs. 25-39 (Jats=25.5% Ramdasias=52.7%)	Rs. 40-50 (Jats=45.0% Ramdasias=27.5%)	Rs. 51-75 (Jats=60.0% Ramdasias=24.4%)	Rs. 76 and above (Jats=82.9% Ramdasias=9.8%)
Number of cases	53	55	40	45	41
Average percent reference weight for age	69.5	69.2	71.2	74.2	71.8
Average percent reference height for age	90.1	90.1	90.9	91.5	91.3
Average percent reference weight for height	84.3	83.2	83.7	86.7	84.7
Average percent of caloric allowance	53.2**	60.4	55.3	63.6	66.4
Average percent of protein allowance	77.4**	86.9	85.8	85.6	91.2
Average percent of vitamin A allowance	82.5	79.0	77.6	87.9	84.8
Average percent of iron allowance	34.1	39.7	42.3	35.1	38.6
Percent breast fed	88.7	69.1	65.0	82.2	75.6
Average daily supplementary milk consumption (gms)	116**	188	156	216	247
Average daily cereal consumption (gms)	25	28	33	28	27
Average number of major diseases	0.91	0.98	0.78	0.64	0.68
Average diarrheal infection rating[a]	2.36	2.44	1.70	1.49	2.49

**Significantly different from the "Rs. 76 and above" figure at the .95 level of statistical significance.
⌣ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.

Table III-3 Tabular Profile of All Sample Children by Per Capita Income Groups

	Monthly per capita income				
	Rs. 24 and below (Jats=6.9% Ramdasias=79.2%)	Rs. 25-39 (Jats=23.7% Ramdasias=50%)	Rs. 40-50 (Jats=51% Ramdasias=27.7%)	Rs. 51-75 (Jats=55.9% Ramdasias=24.7%)	Rs. 76 and above (Jats=78.7% Ramdasias=8.5%)
Number of cases	101	114	94	93	94
Average percent reference weight for age	73.4**	74.6	78.1	78.9	78.9
Average percent reference height for age	91.8**	91.8	93.3	93.4	93.9
Average percent reference weight for height	85.3	86.0	87.3	88.2	87.6
Average percent of caloric allowance	57.6**	57.6	60.0	66.0	66.6
Average percent of protein allowance	80.5**	83.0	86.5	87.5	89.8
Average percent of vitamin A allowance	83.8	81.1	84.2	87.7	88.3
Average percent of iron allowance	35.1	35.9	37.9	37.0	37.8
Percent breast fed	87.1	79.8	74.5	80.6	78.7
Average daily supplementary milk consumption (gms)	151**	155	171	225	233
Average daily cereal consumption (gms)	25	24	27	27	26
Average number of major diseases	1.03	0.99	0.84	0.65	0.92
Average diarrheal infection rating[a]	2.50**	2.30	1.79	1.47	1.81
Average mother's beliefs index rating[b]	2.27	2.41	2.43	2.46	2.55

** Significantly different from the "Rs. 76 and above" figure at the .95 level of statistical significance

⌣ Indicates figures significantly different at the .95 level of statistical significance.

a/ 7 = high frequency and severity; 0 = low frequency and severity.

b/ 4 = beliefs beneficial to child's health; 1 = beliefs detrimental to child's health.

Table III-4 Tabular Profile of Lower and Upper Per Capita Income Groups by Sex

	Monthly per capita income					
	Males		Females		All Children	
	Rs. 39 and below (Jats=15.0% Ramdasias=62.6%)	Rs. 51 and above (Jats=64.4% Ramdasias=15.8%)	Rs. 39 and below (Jats=16.7% Ramdasias=64.8%)	Rs. 51 and above (Jats=70.9% Ramdasias=17.4%)	Rs. 39 and below (Jats=15.8% Ramdasias=63.7%)	Rs. 51 and above (Jats=67.4% Ramdasias=16.6%)
Number of cases	107	101	108	86	215	187
Average percent reference weight for age	78.7	83.9	69.4	73.1	74.0	78.9
Average percent reference height for age	93.5	95.6	90.1	91.4	91.8	93.7
Average percent reference weight for height	87.7	89.7	83.7	85.7	85.7	87.9
Average percent of caloric allowance	58.3	67.5	56.9	64.9	57.6	66.3
Average percent of protein allowance	81.4	89.0	82.2	88.3	81.8	88.6
Average percent of vitamin A allowance	84.1	89.4	80.7	86.4	82.4	88.0
Average percent of iron allowance	34.1	38.0	36.9	36.8	35.5	37.4
Percent breast fed	87.9	80.2	78.7	79.1	83.3	79.7
Average daily supplementary milk consumption (gms)	154	228	153	231	153	229
Average daily cereal consumption (gms)	23	25	27	28	25	26
Average number of major diseases	1.08	0.88	0.94	0.66	1.01	0.78
Average diarrheal infection rating[a]	2.38	1.40	2.40	1.97	2.39	1.64
Average mother's beliefs index rating[b]	-	-	-	-	2.34	2.50

~~ Indicates figures significantly different at the .95 level of statistical significance.

a/ 7 = high frequency and severity; 0 = low frequency and severity.

b/ 4 = beliefs beneficial to child's health; 1 = beliefs detrimental to child's health.

Table III-5 Frequency Distribution of Gomez Classification Groupings by Per Capita Income and Sex

Per capita monthly income	Percent normal (over 90% of "Harvard" reference weight for age)	Percent with 1st degree malnutrition (76-90%)	Percent with 2nd degree malnutrition (60-75%)	Percent with 3rd degree malnutrition (below 60%)
		ALL CHILDREN		
Rs. 24 and below	9.7	29.1	51.5	9.7
Rs. 25 - 39	11.6	33.0	41.1	14.3
Rs. 40 - 50	18.1	38.3	35.1	8.5
Rs. 51 - 75	16.1	44.1	35.5	4.3
Rs. 76 and above	19.1	35.1	43.6	2.1
		MALES		
Rs. 24 and below	14.0	40.0	42.0	4.0
Rs. 25 - 39	14.0	47.4	36.8	1.8
Rs. 40 - 50	30.2	41.5	24.5	3.8
Rs. 51 - 75	25.0	50.0	25.0	0
Rs. 76 and above	30.2	43.4	26.4	0
		FEMALES		
Rs. 24 and below	5.7	18.9	60.4	15.1
Rs. 25 - 39	9.1	18.2	45.5	27.3
Rs. 40 - 50	2.4	34.1	48.8	14.6
Rs. 51 - 75	6.7	37.8	46.7	8.9
Rs. 76 and above	4.9	24.4	65.9	4.9

Table III-6 Frequency Distribution of Gomez Classification Groupings for Lower and Upper Per Capita Income Groups by Sex

Per capita monthly income	Percent normal (over 90% of "Harvard" reference weight for age)	Percent with 1st degree malnutrition (76-90%)	Percent with 2nd degree malnutrition (60-75%)	Percent with 3rd degree malnutrition (below 60%)
		ALL CHILDREN		
Rs. 39 and below	10.7	31.2	46.0	12.1
Rs. 51 and above	16.6	39.6	39.6	3.2
		MALES		
Rs. 39 and below	14.0	43.9	39.3	2.8
Rs. 51 and above	27.7	46.5	25.7	0
		FEMALES		
Rs. 39 and below	7.4	18.5	52.8	21.3
Rs. 51 and above	5.8	31.4	55.8	7.0

Table III-7 Frequency Distribution of Percentage Caloric Intake Allowance by Per Capita Income and Sex

Per capita monthly income	Percentage ingesting 76 - 100% of allowance	Percentage ingesting 59 - 75% of allowance	Percentage ingesting 46 - 58% of allowance	Percentage ingesting 45% of allowance and below
		ALL CHILDREN		
Rs. 24 and below	17.5	23.3	32.0	27.2
Rs. 25 - 39	14.9	27.2	30.7	27.2
Rs. 40 - 50	15.2	35.9	28.3	20.7
Rs. 51 - 75	37.9	18.9	18.9	24.2
Rs. 76 and above	32.3	32.3	19.4	16.1
		MALES		
Rs. 24 and below	25.0	25.0	29.2	20.8
Rs. 25 - 39	13.6	20.3	32.2	33.9
Rs. 40 - 50	19.2	44.2	21.2	15.4
Rs. 51 - 75	41.7	22.9	14.6	20.8
Rs. 76 and above	30.2	35.8	22.6	11.3
		FEMALES		
Rs. 24 and below	10.9	21.8	34.6	32.7
Rs. 25 - 39	16.4	34.5	29.1	20.0
Rs. 40 - 50	10.0	25.0	37.5	27.5
Rs. 51 - 75	34.0	14.9	21.3	29.8
Rs. 76 and above	35.0	27.5	15.0	22.5

Table III-8 Frequency Distribution of Percentage Caloric Intake Allowance for Lower and Upper Per Capita Income Groups by Sex

Per capita monthly income	Percentage ingesting 76 - 100% of allowance	Percentage ingesting 59 - 75% of allowance	Percentage ingesting 46 - 58% of allowance	Percentage ingesting 45% of allowance and below
		ALL CHILDREN		
Rs. 39 and below	16.1	25.3	31.3	27.2
Rs. 51 and above	35.1	25.5	19.1	20.2
		MALES		
Rs. 39 and below	18.7	22.4	30.8	28.0
Rs. 51 and above	35.6	29.7	18.8	15.8
		FEMALES		
Rs. 39 and below	13.6	28.2	31.8	26.4
Rs. 51 and above	34.5	20.7	18.4	26.4

Table III-9 Frequency Distribution of Diarrheal Infection Groupings by Per Capita Income and Sex

Per capita monthly income	Percentage with low frequency and severity	Percentage with low-moderate frequency and severity	Percentage with high-moderate frequency and severity	Percentage with high frequency and severity
		ALL CHILDREN		
Rs. 24 and below	20.8	15.8	32.7	30.7
Rs. 25 - 39	22.8	21.1	24.6	31.6
Rs. 40 - 50	26.6	22.3	34.0	17.0
Rs. 51 - 75	40.9	19.4	25.8	14.0
Rs. 76 and above	28.7	23.4	28.7	19.2
		MALES		
Rs. 24 and below	16.7	14.6	37.5	31.3
Rs. 25 - 39	22.0	22.0	30.5	25.4
Rs. 40 - 50	27.8	18.5	33.3	20.4
Rs. 51 - 75	39.6	20.8	25.0	14.6
Rs. 76 and above	37.7	32.1	18.9	11.3
		FEMALES		
Rs. 24 and below	24.5	17.0	28.3	30.2
Rs. 25 - 39	23.6	20.0	18.2	38.2
Rs. 40 - 50	25.0	27.5	35.0	12.5
Rs. 51 - 75	42.2	17.8	26.7	13.3
Rs. 76 and above	17.1	12.2	41.5	29.3

Table III-10 Frequency Distribution of Diarrheal Infection Groupings for Lower and Upper Per Capita Income Groups by Sex

Per capita monthly income	Percentage with low frequency and severity	Percentage with low-moderate frequency and severity	Percentage with high-moderate frequency and severity	Percentage with high frequency and severity
		ALL CHILDREN		
Rs. 39 and below	21.9	18.6	28.4	31.2
Rs. 51 and above	34.8	21.4	27.3	16.6
		MALES		
Rs. 39 and below	19.6	18.7	33.6	28.0
Rs. 51 and above	38.6	26.7	21.8	12.9
		FEMALES		
Rs. 39 and below	24.1	18.5	23.2	34.3
Rs. 51 and above	30.2	15.1	33.7	20.9

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Probably the primary factor contributing to the rapid and effective conduct of the field work was our good fortune in being able to work with Mrs. Gurdial Kaur, a highly skilled, remarkably dedicated medical paraprofessional holding the barely descriptive title of Lady Health Visitor in the Morinda area of Ropar District, Punjab. Clearly the future of Punjab's health depends far more on these women than on those much higher paid but largely irrelevant officials who, in the words of Solzhenitzen "preside over the inauguration of undertakings...and then reappear to officiate over their deaths or to crown their achievements."

With the help of Gurdial Kaur we were able not only to collect the information presented here, but also to provide certain health services

to the children in this critical age group. Although accurate accounting is difficult in the absence of an explicit evaluation we were able to get rid of, at least for a few months (but probably an important few months at that age), most of the giardia infection and also, surprisingly, bring about significant improvement in all but one case of frank marasmus.

If this study contributes anything to our knowledge of the malnutrition problem among young children, it is in large part because of the solid base of Punjab health and nutrition information painstakingly collected over the years by Johns Hopkins and Harvard Universities. Results of the Harvard work, to which I refer frequently in the text, have been published in The Khanna Study by Drs. John Wyon and John Gordon. I was fortunate in having Dr. Wyon's counsel both at the beginning and conclusion of the field work.

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I've saved Satinder Levinson for last because her contributions have been so special. She was up before sunrise for our trips to the villages, did much of the interviewing, and spent endless hours with me in data

compilation and card sorting. One of my lasting memories will be of the two of us checking columns of figures (in the true spirit of research) by flashlight during the blackout imposed by the Indo-Pakistan war. These are her people, and it is to her that this study is dedicated.

to Sati

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SUMMARY

Widespread recognition of the importance of combating malnutrition among young children in low income countries has increased the need for systematic planning to permit the development of effective strategies to deal with the problem. Such country or regional planning might be thought of as a three step process. The first assesses the dimensions and magnitude of the problem. Step two seeks to identify the relative importance of the determinants of malnutrition. Where malnutrition exists, how much of the problem is due to income levels or relative prices of important commodities, to what extent is parasitic infection a limiting factor, how important are belief patterns relating to health and nutrition? The final step then attempts, through some form of cost-benefit or cost-effectiveness analysis, to find the optimum means of affecting those determinants which prove most limiting.

This study addresses primarily the second step of the process through an analysis of 496 children in the critical 6-24 month age group, the period of highest malnutrition-related mortality and the time of origin for any mental debilitation which occurs among the survivors. The study was carried out in 17 villages in Ropar District of Punjab in Northern India surrounding the small market town of Morinda, an area on the periphery of, or in an early stage of the so-called "Green Revolution".

Using multiple regression analysis on cross section data the study attempts to identify the primary direct determinants of nutritional status and then, in turn, to examine these determinants in terms of a series of socioeconomic explanatory variables. Nutritional status was measured using anthropometric measures. Food intake was assessed using the 24-hour recall method, after which the foods consumed were translated into calories,

protein, vitamin A, and iron. Infection was measured by the child's disease history, the frequency and severity of his diarrheal infection, and by the extent of parasitic infection assessed through the laboratory analysis of stool samples. Belief patterns were measured on the basis of answers to a series of questions relating to optimum age of food supplementation, dietary response to infection, and the cause of a Punjabi language equivalent of nutritional marasmus. In addition to the above, basic social-demographic data was collected, and a stock (wealth) and flow (income) measure of economic status was estimated for the family of each child.*

The study found the extent of malnutrition among these children, in spite of their location on the outskirts of the Green Revolution, particularly serious--more serious than in most other parts of the low-income world. Almost half were suffering from 2nd or 3rd degree malnutrition using the Gomez classification.

With respect to food intake, the most serious deficiencies were of calories (average 61.3 percent of allowance) and iron (36.7 percent of allowance) although there may be some question regarding the validity of the caloric allowance. Protein deficiency is less serious and not a significant problem independent of the calorie one. Similarly vitamin A deficiencies do not appear as serious as in other parts of India. In terms of infection, diarrhea proved considerably more important for children of this age than either their disease history or giardia (the only parasite-like infection found in this population).

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* A more detailed summary of the analytical results of the study is found at the beginning of Chapter 6.

Variation in nutritional status among the young children was explained both by differences in their caloric intake and the extent of their diarrheal infection. Variation also was explained by three other variables:

a. Age - From about the age of 6 months, as breast feeding alone becomes inadequate and with the onset of the syndrome of weanling diarrhea, children begin to depart sharply from the standards.

b. Sex - The much higher premium placed on living sons in this society is reflected in the better care and attention devoted to them, particularly at the low end of the economic spectrum.

c. Such non-quantified factors as pre-natal environment, demand vs. opportunity breast feeding, and the psychological effect of a mother's presence, all of which would be closely related to economic status.

The determinants of caloric intake and diarrheal infection, and hence the means of addressing them differ significantly between children of Jat (landowning) and Ramdasia (landless agricultural laborer) families. While malnutrition exists in both groups the most critically affected are the Ramdasias. For the Jats, the most important determinant of food intake is belief patterns suggesting that an information dissemination program addressing these beliefs could well prove an effective intervention. Among the Ramdasias, estimation of the determinants of both caloric intake and diarrheal infection suggests that the factor most critically inhibiting improvement in their nutritional status is income. The income problem relates both to the availability of resources and to the mother's time. For the Ramdasia woman, required by economic necessity to spend a major portion of the day working outside of her home, the adequate care of a young child is seriously problematic. If the child is a girl, the case is that much more serious.

In terms of interventions, it is likely that the Jat child will derive higher benefits from virtually any intervention program than will the Ramdasia. For the Jat woman, most of the preconditions would seem to be met for the effective translation of her income and time into improved health for her children once the facilities to permit such translation (education, programs, health clinics, or other interventions) are established. For the Ramdasia, largely bypassed by the development process, these preconditions generally have not been met.

To positively affect the nutritional status of Jat children a program of information dissemination related to child care and feeding probably would be the single most important intervention. Such information dissemination might be facilitated by a weaning food distribution which, in turn, could strengthen the outlets selected for such distribution, among them family planning institutions. For the Ramdasias, a substantial improvement in their economic position appears to be a prerequisite for viable improvement in the nutritional status of their children. Only when this basic income constraint is overcome, are these children likely to be able to derive significant benefits from specifically nutrition intervention programs. Such economic betterment, in turn, probably requires rather basic changes in social and political organization through which the poor can restructure and more fully avail themselves of the opportunities inherent in the development process.

CHAPTER 1

INTRODUCTION AND PERSPECTIVE

The planning and implementation of programs to combat malnutrition in low income countries is, at best, a complex undertaking. Perhaps nowhere else in the development process does an area of undertaking cut across so many disciplines, so much subject matter. Further, given the relative infancy of international concern with the subject, we lack precision in identifying and quantifying the developmental benefits of better nutrition and hence effectively bidding for scarce resources. Finally, while there are widely differing schools of thought on the segment of the population to address, the best means of reaching it and the cost, there is remarkably little empiricism on any of this. These problems coupled with what often seem to be the unmanageable dimensions of the problem, not only have complicated the nutrition planning process but also, undoubtedly, have served as a deterrent to major investment in this area.

Nonetheless, malnutrition is becoming a matter of increasing concern in low income countries both as a major source of mortality and sickness, and as a serious drain on developmental efforts to achieve human resource potential. The mortality rate among children aged one to four in low income countries ranges from roughly 20 to 80 times higher than in industrialized ones (11,57). Probably over half of the deaths in this age group could be considered malnutrition-related. FAO contends that "malnutrition is the biggest single contributor to child mortality in the developing countries" (22). Berg has compiled Latin American data indicating that malnutrition is an underlying or associated cause of between 52 and 70 percent of all deaths between the ages of one and four (11).

Further, those malnourished children who survive may be physically and mentally debilitated, perhaps irreparably.

On purely humanitarian grounds the case would appear sufficiently convincing. Yet, in the context of scarce budgetary resources, and in competition even with advocates of solutions to other human needs (insufficient food on a macro level, communicable diseases, and inadequate shelter), the humanitarian case for combatting malnutrition has not fared particularly well. As a result, the nutrition advocate during the past decade has begun to examine the developmental implications of malnutrition. He has begun to examine the hypothesis that malnutrition-caused mental and physical debilitation may limit the utilization of a country's existing educational capacity and adversely affect productivity. He also has advanced an argument suggesting that high child mortality rates, in large part a function of malnutrition, provide a disincentive for social security-conscious parents to practice family planning.

More recently, advocates of these positions have been joined by critics of the overall patterns of development which have emerged in low income countries during the past few decades. These critics note that investment-oriented development programs in many of these countries essentially have excluded major segments of their populations and that concerns with income distribution and employment, though frequently voiced, seldom have been addressed explicitly. Consequences have been both economic (un- and underemployment probably representing the first limiting factor in the development process in many countries) and political (disruptive violence being a natural outgrowth of major income differentials and large scale unemployment). The equity problems inherent in these patterns of development often are reflected in widespread malnutrition. Conversely, nutrition

intervention emerges as a meaningful, attractive and visible component of broader strategies designed to reorient these development processes.

Thus, not withstanding the difficulties, the development of strategies to combat malnutrition is likely to become an increasingly important pursuit of planning commissions in low income countries.

It has been suggested elsewhere (15) that the nutrition planning process basically involves a threefold investigation. The first level involves identification in a particular geographic area of the nutrition problem in terms of food availability and intake, and in terms of physical, clinical and biochemical measurements. This first step in the analysis also should provide at least a general idea of the population target group to be addressed.

All too often the process of investigation ends with this first step after which program decisions are made according to the interests of existing administrative and technical entities. Further levels of analysis are clearly necessary, however, to provide some basis for rational investment decisions. A second level of the investigation would identify the determinants or causal factors of malnutrition among a target group, while a third level would attempt, through cost-effectiveness analysis, to find the optimum means of positively affecting these determinants.

This study is concerned primarily with the second level of the investigation: identification of the determinants of nutritional status or health and their relative importance. The phrasing of the sentence poses the thorny conceptual problem arising here; namely the question of whether we are dealing with nutritional status or with health. At first glance it may appear that the types of measurements used to quantify so-called "nutritional status" (i.e., clinical, biochemical or, as in this

study, anthropometric measurements) are actually measures not only of nutrition but also of diarrheal and parasitic infection and the individual's disease history. This would seem to suggest that, at least for the young child, such measures are in reality a measure of overall health.

Looked at another way, however, it could be argued that the health of an individual is a complex set of highly interrelated constituent elements including mental health, disease and nutritional status. In such a context nutritional status would not be defined simply as a measure of food intake, but rather as the extent to which food constituents are physiologically absorbed or utilized. The extent of this absorption will depend significantly on the presence or absence of infection and disease as well as on the food consumed. Clinical, biochemical and anthropometric measures serve to quantify this nutritional status variable as thus defined (although, in some cases, such measures for a young child might also serve as a reasonable proxy for his overall health). Using such a conceptualization, infection and disease, aside from their effects on the nutritional status component of health, are independent components of health in their own right along with numerous other health components which have little or no effect on nutritional status. A child contracting diarrheal infection today could not be considered in good health even though the infection has not yet affected his nutritional status as defined here.

The case for isolating this nutritional status component of overall health for analysis is twofold. First, there is reason to believe, at least in low income countries, that the nutritional status component of health among young children is the most important component of overall health status, often more important than the others combined, and a major

determinant of the severity of virtually all the others. Second, there is the more practical consideration that while ideally the nutritional status component might best be addressed as part of an overall health approach (in the same way that inadequate food, housing and education might best be jointly addressed as manifestations of poverty in industrialized nations), there is little evidence this is happening or that it will happen on the scale required.[1/] To date the vast majority of health directed efforts in these countries have been medical, usually curative, in nature. In part it was the success of these measures which pointed up the vital, but relatively untouched matter of nutritional status. The medical groups quantified the magnitude of the problem but seldom addressed it, in large part because the interventions called for usually were non-medical. It soon became evident that if this problem were to be addressed -- and its dimensions and implications demanded it -- the problem would have to be addressed by a group other than the traditional medically-oriented one and with a very different set of tools. Thus, the analysis in this study is designed not so much for the medical or public health professions per se (although there is major overlap into the public health field) as for this new group attempting to address nutritional status specifically.

Nutritional status will be examined through a micro study designed to estimate the primary determinants and where possible their interaction for a particular population group. The study rests on the assumptions that, (1) malnutrition has negative effects on economic growth and social

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1/ Interestingly, one of the few places where this is being done is at Narangwal by the Rural Health Research Center (RHRC) whose work is discussed throughout this study.

well-being, and (2) combatting this problem has some valid claim on the budgetary resources of the area. The seriousness of the malnutrition will speak for itself.

Not actually part of the second level of investigation, but necessary for its undertaking is a determination of the target group to be addressed. Cases can and have been made for different groups depending on the circumstances. The target group in a highly labor intensive economy that is not labor surplus could be the adult working populace, particularly with respect to its caloric deficiency. Alternatively, in situations of food scarcity coupled with high fertility rates, the primary problem might be maternal malnutrition, perhaps reflected in a high proportion of low birthweight infants. In most low income countries, however, the primary nutritional target should be the preschool age child. Both the mental debilitation and family planning motivation arguments noted earlier suggest the preschool age child as the target. Similarly the equity argument would have sympathy with a concentration on this group as a highly meaningful and visible object of concern.[2/] More specifically, these arguments probably point to the child between 6 and 24 months of age. Studies of mental growth indicate that malnutrition-caused debilitation, where it occurs, traces back to this critical 18 month period. Similarly, Wyon and Gordon's findings in India (66) add further empirical evidence that the major bulk of preschool age, malnutrition-related mortality occurs within this age period. Their study, conducted in Ludhiana District of Punjab, found a

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2/ One must assure, however, that these visible kinds of intervention accompany and not substitute for change in existing patterns of development. Otherwise they will represent nothing but a palliative, and probably have the effect of delaying the day of reckoning on the larger issue.

particularly high mortality rate during the first month of age (averaging between 70 and 80 deaths of liveborn children per 1000 live births) resulting largely from birth-associated difficulties or diseases such as tetanus. During the next four months, the mortality rate decreased to about 30 deaths per 1000 live births. Between 6 and 11 months, with the onset of more severe malnutrition and weanling diarrhea, the mortality rate increased sharply to 50 for males and close to 70 for females per 1000. The rate remained almost as high for the 12-17 month age group, then began to drop regularly with age. The 24-29 month age group had a mortality rate of only about 10 per 1000. In terms at least of the hypothesized developmental returns on nutrition investment then, this 6-24 month age group would appear to constitute the primary target. On this basis it has been selected as the age group addressed in the micro study.

The following chapter presents a general discussion of the determinants usually believed to affect the nutritional status of the target group. Chapter 3 presents the methodology utilized in examining these determinants in the micro study, and Chapters 4 and 5 examine the results found. Chapter 6 presents conclusions and a discussion of appropriate interventions.

CHAPTER 2

THE DETERMINANTS OF NUTRITIONAL STATUS

This chapter provides a brief, general examination of those determinants usually believed to affect the nutritional status of young children. The following chapters will examine the extent to which these factors are in fact important determinants for children in the micro study. The discussion here is limited to those factors which, unlike religion or genetic traits, lend themselves to intervention.

Conceptually, these determinants might be classified into direct and indirect factors. Basically, the nutritional status of a child is determined by (1) his food intake, and (2) the presence or absence of disease and infection, the direct determinants. These two, in turn, are functions of such factors as family purchasing power (involving income, commodity prices and the cost of other demands on a family budget), the nutrition and health beliefs of the child's mother, the nutritional content of the foods consumed, the presence or absence of health care and non-family feeding programs, plus numerous environmental and social phenomena. These determinants presented diagramatically in Figure 1 are considered separately below.

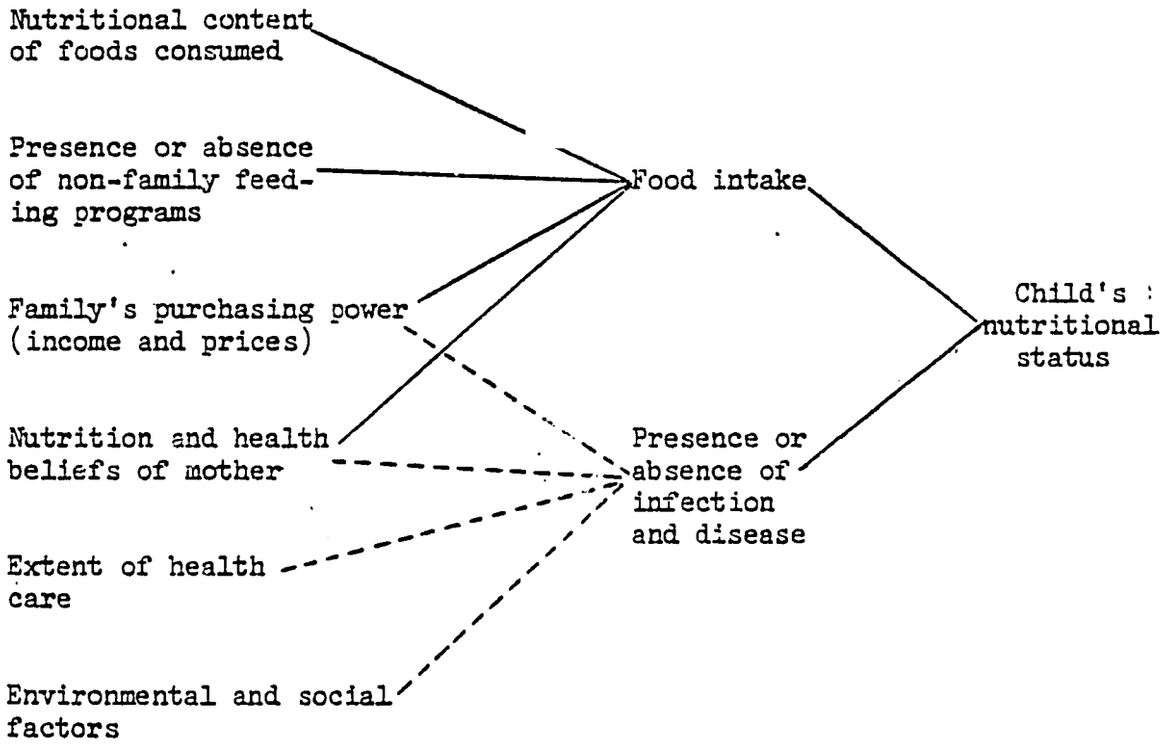
Family Purchasing Power

A family's purchasing power depends basically on (1) its wealth and income position, (2) the relative prices of food commodities it buys, and (3) the cost of other demands on its budget, particularly necessities that require cash. Thus, at least conceptually, increasing a family's purchasing power or real income for nutritional purposes can be accomplished by augmenting income flows to the family, by reducing the prices

of food it consumes, or by subsidizing its other budgetary necessities, i.e. housing, schooling, health, or clothing, thereby releasing additional funds for food purchase. The third approach suggests that existing government financing of education, health centers, and low-cost housing provides a secondary benefit to food consumption and hence nutrition.

Income and prices, the primary components of purchasing power, are discussed separately below and in the ensuing discussion.

Figure 1. DETERMINANTS OF A CHILD'S NUTRITIONAL STATUS



Income: Probably no other single factor has so major an effect on the components of nutritional status for the population as a whole in low income countries as income. Examination of cross section food consumption data in these countries (21) reveals highly significant differences in food consumption patterns along the income spectrum. Three

trends appear to be almost universal, none of which is particularly surprising. The first, commonly referred to as Engel's law, finds that as income rises the percentage of that income allocated to food declines but that absolute expenditures rise.[1/] A second trend is that the proportion of total calories supplied by carbohydrate staples (cereals and tubers) decreases and is replaced by more expensive animal or vegetable commodities as income increases (8). A third trend is that within food groups there is a shift toward processed, more expensive items and varieties.

In nutritional terms the third trend, usually involving payment for various marketing services, may have a negative effect. The literature abounds with examples of shifts from brown rice to polished rice, high extraction to low extraction flour, and cane to refined sugar as income increases (9). On balance, processed foods in general probably represent a nutritional minus where lost nutrients are not restored.

In terms of overall nutritional effect, however, these negative effects of income are entirely outweighed by the positive effects of the first and second trends. While part of the increase in absolute expenditure suggested by the first trend results in the purchase of more expensive items, the increase will almost invariably result in the ingestion of more food, hence more calories, thereby overcoming a major, often limiting, nutritional obstacle (23). In surveys that have examined caloric intake explicitly, a clearly positive linear relationship of calories with income emerges (53).

1/ The exception lies with the lowest income groups in most countries. Though the percentage of their incomes spent on food is quite high (60 to 80 percent) the absolute expenditures are still so low that the first income increments usually result in a still higher percentage spent on food.

While the amount of food consumed increases with income, so does the variety as suggested by the second trend. Diets based on cereals, plantains, roots or tubers gradually become more diversified, and legumes, fruits and vegetables, milk, and other sources of animal protein become more important in terms of total calories. With reference to some foods, notably legumes, consumption increases with the first income increments and then levels off. More often, however, consumption of nutritious foods increases more or less linearly along the income spectrum. Monthly family expenditures on milk, for example, increase 50-fold from the lowest to the highest income groups in India (as compared with an 8-fold increase in cereal expenditures) (31). These differences are best reflected in income elasticities of demand[2/] for the commodities. In general, the more nutritious items are those with the highest elasticities (although there is no evidence whatever that the relationship is causal). In Asia and the Far East (excluding Japan) the elasticities of vegetables, meat and eggs are estimated at 0.9, 1.5, and 2.0 respectively, while the elasticity of cereals is 0.5. In the Near East, Africa, and Latin America the elasticities are somewhat lower but in almost the same proportions[3/] (20).

While for the population as a whole increases in income almost automatically are translated into larger quantities and a higher quality of food and hence improved nutritional status, the relationship for the target

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2/ The percentage increase in consumption of a food as income increases by 1 percent. Thus consumption of a food with an income elasticity of demand of .6 will increase by 0.6 percent as income increases by 1 percent.

3/ As a rule, these elasticities decrease as income increases and tend to be higher in rural than in urban areas (48).

6 to 24 month old population is less clear. Although prior studies focusing exclusively on this target group have been few and those rarely income specific, it has been suggested (66) that even in cases where available food is adequate to meet the young child's requirements, his difficulty in digesting and absorbing solid adult foods (preparation of specific foods for children among lower income groups in these countries is a rarity) often results in solid foods being withheld.

Commodity prices: Income is, of course, a relative concept, which takes on a specific meaning only in the context of its inherent purchasing power. This depends on food prices which, together with income, clearly affect the consumer's purchases and hence the child's diet. While some might argue that availability should be included here along with price, availability is actually built into the price concept since any existing item becomes available at some price. In the case of "on the farm" consumption of goods that never reach the market, the "price" of the item becomes its imputed value or opportunity cost; in other words the amount of money the family "sacrifices" by not selling the item. Basically price is a function of the supply of and the demand for particular commodities and of their transfer costs.

Nutritional Content of Food Commodities

A family's income and the prices of food commodities, to a significant extent, will dictate the amount of particular commodities purchased. The child's nutritional status then will depend in large part on the nutritional content of these commodities. Frequently the commodity itself implies a certain nutritional value although differences within commodity groups or even among varieties of a given commodity can be significant. The food's nutritional content might also be affected by ecological

factors or by processing between points of production and consumption.

Traditions and Beliefs

Almost regardless of the aforementioned factors, food consumption always has been based to an extent on preconceived beliefs relating to foods and their functions and on traditional preparation and consumption practices. In some cases these beliefs and processes have obvious validity relating to the health value of the item. In others the practice may support a basic cultural tenet of the population group and thus be equally valid (16,47). In still other cases, in both non-industrialized and industrialized countries, where such validity cannot be ascertained, these practices have been, rightly or wrongly, attributed to ignorance.

Practices relating to the feeding of young children have been under particular surveillance in recent years. Two such practices emerge as being notably significant. The first involves the critical period of weaning where problems are numerous. In some cases breast feeding continues well beyond six months but without supplementation. Elsewhere the milk is supplemented but with foods low in essential nutrients. Where more nutritious items are explicitly withheld, they sometimes reflect underlying association of these items with intestinal parasites or diarrhea. When weanling diarrhea does occur, any protein rich foods that were consumed are often withheld or solid foods are withheld altogether, a practice that further exacerbates the problem.

To some these practices simply reflect ignorance. Probably more accurate is Wyon and Gordon's contention that behavior is based on empirical experience. In many cases a mother recognizing the increased incidence of diarrheal infection when supplemental foods are given and recognizing the incidence of mortality from the infection, makes a

conscious, seemingly sensible decision to withhold such foods. What she will fail to recognize, largely because it is so undramatic, is the much higher mortality rate resulting from protein-calorie malnutrition and the child's inability to resist infection when supplemental foods are withheld (66).

The preceding set of practices or malpractices are usually attributed to tradition. Yet tradition is not always the culprit. Frequently problems arise as a direct result of abandoning traditions, often as a result of direct exposure to more industrialized regions. The prime example is the cessation of breast feeding in several parts of the low income world. Substituted is higher priced commercially bottled milk or powdered concentrate. All too often the higher price results in the use of inadequate quantities. Just as often the concentrate is reconstituted with unclean water. In either case the nutritional and health consequences are serious (35).

Infection and Disease

Even if the right foods are available to the child, they may not have their full effect upon his nutritional status if he suffers from other health problems, particularly gastrointestinal infection. Such infection can lower nutritional status or precipitate malnutrition in several ways. It can reduce food intake through loss of appetite. It results in loss of nitrogen, hence requiring increased protein consumption thereafter. Where the infection is the result of intestinal parasites, such as hookworm, the blood loss from the intestinal tract frequently leads to anemia. Finally, where the infection causes diarrhea, absorption of nutrients in the intestine will be reduced. Where protein levels already are low, diarrheal disease can precipitate kwashiorkor

(40,58). In addition, it has been well established that common childhood diseases like measles can have a drastic effect, either precipitating severe malnutrition or having a much higher degree of severity in the chronically underfed child.

The child also may be affected by the nutritional status of his mother during pregnancy and lactation, although findings here are less clear. In general, the quality of breast milk, with the exception of its thiamine content, does not appear to be affected significantly by the mother's nutritional status. However, in times of severe food shortage the quantity of milk secreted might be reduced.

Non-Family Feeding

In much of the world the preceding five factors are the primary determinants of a target group's nutritional status. For increasing numbers of children in many countries, however, there is a sixth determinant in the form of food received outside the home. In most cases such feeding represents a government initiative, at times supported with international assistance. Such feeding may appear to be more an intervention than a determinant, but its widespread prevalence at present probably qualifies it for the latter category as well.

The micro study presented in the following chapters looks at food intake, infection and disease, income and wealth, and beliefs as the primary categories of determinants. Given the cross sectional, geographically concentrated nature of the study, there was no variation in commodity prices or in the nutritional content of foods, hence these variables could not be examined. Non-family feeding also was eliminated as a variable since no program aimed at this group presently exists in

this area. Of course, the inability to quantify the effects of these variables by no means eliminates them as appropriate for intervention, and we accordingly shall return to them in the final chapter.

Although less easily affected the study also looks at family size, caste and sex to ascertain their importance relative to the other determinants.

CHAPTER 3

METHODOLOGY

The Study Objective and Research Design

The micro study was designed to identify the actual importance of the variables discussed in the preceding chapter as determinants of nutritional status among a group of children aged 6 to 24 months in rural North India. To carry out such an analysis it was proposed to collect, from a rather large sample of children of this age, information on various measures of nutritional status and on a wide range of potentially direct and indirect determinants of such status, to quantify these variables, and to examine their relationship through so-called ordinary least squares multiple regression analysis.

The general model originally envisaged for this analysis closely resembles the diagram in Figure 1 and will be elucidated further in Chapter 5. In the first equation, nutritional intake and infection are expressed as determinants of nutritional status. In the second and third equations, nutritional intake and infection become dependent variables explained by a series of socioeconomic variables plus each other. This would give us the following three equation model:

Nutritional Status = f (Nutritional intake, Infection)

Nutritional Intake = f (Economic status, Family size, Sex, Caste, Mother's beliefs, Infection)

Infection = f (Economic status, Family size, Sex, Caste, Mother's beliefs, Nutritional intake)

The use of cross sectional data such as that used in this study presents problems which should be noted at the outset. First, there is the

implicit assumption that Group A with less income or intake (or anything else) will behave like Group B with more income or intake when, sometime in the future, Group A achieves the same income or intake levels that Group B enjoys today. In a context of rapid technological change, increasing options on expenditures, improved marketing facilities increasing the amount and variety of available foods, and significant changes in relative prices, all of which exist in Punjab, this may be a questionable assumption. More basic are the problems of using point in time measures (of say intake or parasitic infection) to explain variations which have emerged over a life time (i.e. size of the child). In addition, variation among children is simply a less accurate indicator of any variable than variations in the individual child over time. Thus, attempts to use cross sectional data in such analysis, results in the explanation of considerably less of the variation in the dependent variable, or in statistical terms, lower R^2's.

Nonetheless the alternative to cross section information is the collection of time series data, assuming it doesn't presently exist, through longitudinal studies. As valuable as such studies are, they by definition take years to carry out; time which may not be available to the planner with a strict time constraint. This would suggest that although time series studies are vital for precision in estimating the effects of these variables, there may be value in sharpening the tools of cross section analysis to permit a more rapid approximation of these effects for use in the planning process.

Having identified the primary determinants of nutritional status, it was proposed to project the relevance of alternative interventions

utilizing to the extent possible a previously developed nutrition planning model. This discussion is contained in Chapter 6.

The Locale and Sample

The study was conducted in the Indian state of Punjab, long the breadbasket of Northern India and today a leading grain surplus area in South Asia. With a recent reorganization of North Indian states, Punjab today numbers roughly 15 million persons and is largely dominated by persons of the Sikh religion.[1/] The population of rural Punjab is divided into three main groups: the Jats, traditionally the land-owning class or caste and clearly the predominant group in terms of resources and power; the Ramdasias or landless agricultural laborers, most of them Hindu "outcastes" or as Gandhi called them, "Harijans" in recent generations; and a third, smaller group designated "Others" representing a broad array of "service occupations": shopkeepers, barbers and teachers, some of whom are Hindu. Economically this more heterogeneous group falls between the Jats and Ramdasias.

Although clearly leading the rest of India agriculturally, Punjab itself is geographically heterogeneous with resulting economic disparities. Ludhiana District in the central part of the State represents one end of the Punjab economic spectrum with highly concentrated technological change in agriculture and major investment in irrigation. On the other end of the spectrum lies Ropar District in Eastern Punjab, an area

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1/ A reformist offshoot of Hinduism in the 16th century, Sikhism evolved from a pacifist sect to a highly militant one under pressure from Moghul rulers. Largely devoid of complex Hindu ritual and mythology, Sikhism follows the teachings of ten Gurus or prophets and a holy book called the Guru Granth Sahib. Followers of Sikhism are clearly distinguished by their unshorn hair, turbans and steel bracelets.

demographically similar to Ludhiana but considerably behind in all agricultural production indices. These differences are clearly indicated in Table 1 which compares the two districts, Punjab State and India by several indices of agricultural development (wheat and corn yields) and innovation (irrigation and area under new seed varieties). In each case the Ludhiana figure lies well above the Punjab State average, while Ropar lies below it, and all three lie well above the All-India figures.

Table 1. Indices of Agricultural Output and Innovation for Ludhiana and Ropar Districts, Punjab State, and India[a]

Index	Ludhiana District	Ropar District	Punjab State	India
Wheat yield per acre (pounds)	2,712	1,717	1,998	1,076
Corn yield per acre (pounds)	1,892	1,103	1,294	862
Percentage of cultivated acreage irrigated	83.0	27.8	74.0	22.0
Number of tractors (1966)	1,625	140		
Percentage wheat cultivation area under high yielding varieties	86.1	43.6	68.6	18.0
Percentage corn cultivation area under high yielding varieties	12.3	3.2	9.7	3.0

a/Data compiled from Government of Punjab, Statistical Abstract of Punjab, 1970.

In order to permit eventual comparative analysis of these two ends of the spectrum, or of what might be called initial and advanced stages of the "Green Revolution", it was decided to carry out the study in Ropar District and subsequently to compare these findings with those of the

ongoing research of Johns Hopkins University at the Narangwal Rural Health Research Center (RHRC) in Ludhiana District.[2/] The area chosen is a contiguous rural one surrounding and within a five mile radius of the small (population 9,000) market town of Morinda. The area includes 17 villages and a total population of roughly 13,000 persons.[3/]

Rather than selecting a sample of children along some predetermined lines, it was decided to collect information on every available child in these villages from the age of 6 through 24 months. In total, information was collected on 523 children. With respect to coverage, the effort was between 90 and 95 percent effective. In each village there were a few cases of families out visiting maternal in-laws or mothers unwilling to participate in the study. For purposes of consistency the analysis was limited to 496 children for whom all information was available. The numerical breakdown of these children by caste and age group is as follows:

Caste:	Jats	209
	Ramdasias	194
	Others	93
	Total	496
Age:	6-11 months (6 month period)	163
	12-17 months (6 month period)	157
	18-24 months (7 month period)	176
	Total	496

2/ Some comparative analysis is contained in this study. More will be possible upon completion of the extensive data collection and analysis at Narangwal.

3/ Two villages, Bhateri and Himatpur, fall just over the border into neighboring Patiala District. Those in Ropar District are Badwali, Chaklan, Chitamla, Chitamli, Datarpur, Dhangrali, Doomsheri, Khant, Mankheri, Manpur, Marauli , Ramgarh Mandan, Rangian, Rattangarh-Kalheri, and Saheri. The average population per village was roughly 750 persons.

Much of the data was collected through an interview with the child's mother using the data collection form which is reproduced as Appendix I. These interviews conducted in Punjabi by the author, his wife, and Mrs. Gurdial Kaur, a locally posted paramedical extension agent, lasted approximately 30 minutes each. In addition, each child was weighed and measured, and a subsequent visit was made to collect a stool sample for laboratory analysis. This analysis was carried out by the Post Graduate Institute of Medical Research and Training in Chandigarh, the capital city of Punjab.

In the sections below, the variables examined in this study are presented, and the means of collecting and quantifying them are discussed. The actual findings are presented in the following chapter.

Nutritional Status

Nutritional status as defined and discussed in Chapter 1 is estimated using anthropometric measures. Although, ideally, one might desire clinical and biochemical measures as well, neither were feasible given the nature and time frame of the research. Nonetheless, the anthropometric measures probably provide the best single means of assessing the extent and, more important, gradations of protein-calorie malnutrition. There seems to be general agreement on the reliability and importance of growth, the variable actually measured over time by anthropometry, as an index of nutritional status (33). Growth also has been considered "the severest test of nutritional sufficiency" (26).

Nutritional status was assessed through the weight and height information collected for each child. These individual weights and heights then were compared with the so-called "Harvard Standards" (62). Although on the surface U. S. references might appear inapplicable for children

in low income countries, there is in fact considerable validity in their use. Comparative analysis seems to indicate clearly that the growth of healthy children in low income countries, at least in the early years, closely approximates these U. S. standards, thus ruling out the likelihood of significant genetic differentials biasing the use of such standards. Jelliffe (34) reports evidence from many parts of the world to the effect that well nourished infants and preschool age children attain at least weight levels closely approximating these standards. Jackson (33) found these same similarities by superimposing on U. S. growth curves the growth patterns of normal children from different countries. On the basis of surveys in seventeen low income countries conducted by the U. S. Interdepartmental Committee on Nutrition for National Defense (ICNND), Woodruff states that "infants and preschool children in most areas of the world have growth characteristics that are nearly the same under optimal environmental conditions. Racial and genetic factors probably play only a small part in the relative growth failure in many of the populations studied" (65).[4/]

Weights and heights were compared with the Harvard Standards[5/] by three parameters:

4/ None of this, however, negates the value of preparing reference growth curves for specific ethnic groups. Such caste and sex-specific standards for the Punjab currently are being prepared by Dr. DeSweemer of the Johns Hopkins Department of International Health and will be a valuable aid in all future endeavors of this kind.

5/ Like most studies of this kind, including that of Johns Hopkins at Narangwal, this study uses the Harvard Standards as presented in the WHO monograph on the Assessment of Nutritional Status of the Community (34) which, for young children, pools the sexes. The validity of such a procedure lies in the absence of significant male-female differences in the Harvard Standards for this age group. At no point do sex-specific weight references differ from the uniform standard by more than four-tenths of a pound or one-fifth of an inch.

weight for age: the weight of the child as a percentage of the reference weight for children of his age

height for age: the height of the child as a percentage of the reference height for children of his age

weight for height: the weight of the child as a percentage of the reference weight for children of his height.

In addition, recognizing the limitations of using any one of the above as a single measure of nutritional status, four other indices arbitrarily were constructed using combinations of these parameters. These indices are defined below:

Index	Definition
Nut. Stat. #1	An average of the three percentages
Nut. Stat. #2	An average of the weight for age and height for age percentages
Nut. Stat. #3	Multiplication of the square roots of the weight for age and height for age percentages
Nut. Stat. #4	Multiplication of the cube root of the height for age percentage by the cube root squared of the weight for age percentage

Each of these indices plus the three basic parameters are used alternatively as proxies for nutritional status in the analysis.

Nutrient Intake

Nutrient intake was estimated for each child through the use of the 24-hour recall method. Mothers were asked to indicate the amount of each food actually ingested by the child during the preceding 24 hour period, through the use of sample foods, the ingested portion of which the mother was asked to transfer into commonly used vessels. These vessels were

standardized in advance for each commodity by volume and weight. In the case of non-breast milk or milk-tea combinations, special care was taken to account for the universal practice of milk dilution. Similar care also was practiced in accounting for pulses which are served in a variety of consistencies. Translation of these food items into nutrients was then done using the tables of The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets, published by the Indian Council of Medical Research (4).

Breast milk quantities were calculated using quantities by age of the child as determined empirically in earlier research carried out by the Indian National Institute of Nutrition (56). That research estimated the breast milk intake of 184 infants and children in different stages of lactation and from different parts of India using the so-called test-feeding technique. Each child and its mother were admitted to a hospital for a 24-hour period. The child was weighed nude before and after every breast feeding, the total difference in weights representing the amount of milk ingested during the 24-hour period. A previously weighed diaper was tied on the baby permitting adjustments for any urine or stool voided during the feeding.

In spite of efforts made in the present study to ascertain whether or not the flow of breast milk was normal and to adjust accordingly, this estimate by definition lacks precision. It does not appear, however, to bias the figures for the sample as a whole in one direction or the other. Given the alternatives of (a) taking weight measurements after each breast feeding for each child over a 24 hour period or longer, or (b) leaving breast milk out of the nutrient estimates altogether, use of the existing estimates by age appeared to be the most sensible approach.

A large body of literature exists on the subject of estimating nutritional intake and points out the shortcomings of each approach. There is no effort here to defend the efficacy of the 24-hour recall method which clearly suffers from problems of memory lapses and the desire of the respondent to impress according to what he suspects are ulterior motives of the study by underestimating (when he suspects potential welfare) or overestimating (when he believes status is important). Nonetheless, finding it unfeasible on the one hand to carry out lengthy (and not always unbiased) food weighings in the home, and inadequate on the other to rely purely on rough food groupings (such as that used by national sample surveys) or Guttmann scaling, the 24-hour recall emerged as the most sensible approach.

One serious problem encountered in 24-hour recall measurement is that of seasonality. Unless the survey covers several seasons, changes in consumption over the year may lead to major biases. Although this is believed to be a less serious problem among very young children, an effort was made to carry the survey over two parts of the year. Roughly the first half of the 523 children were reached during the monsoon season, considered to be the latter part of the "lean" period as categorized by the Narangwal RHRC (36). The second half was reached during the winter, found to be the "fat" period.

In addition to the 24-hour recall data, information was collected on the age any supplementary milk or solid food feeding was initiated and the age of terminating breast feeding in the case of entirely weaned children.

The food intake of each child was translated into calories, protein, vitamin A and iron. These four food constituents are related to what

repeatedly have been cited as India's primary nutritional deficiencies by the Indian Council of Medical Research, the (Indian) National Nutrition Advisory Committee and the (Indian) Food and Nutrition Board. Actual intakes were then related, according to the child's age, to the "Daily Allowances of Nutrients for Indians," adopted by the Indian Council of Medical Research.

It should be noted that these standards are allowances rather than requirements. Allowances, which are set higher than requirements, serve as goals for planning and include a margin above and beyond physiological requirements to allow for variation among individuals, to permit the achievement of full growth potential, and to provide a buffer against common stress. Thus, individuals whose diets do not meet all nutrient allowances are not necessarily suffering from malnutrition.

In order to provide a single measure of nutritional intake for use in the analysis, the percentages of recommended allowance figures for calories, protein, vitamin A and iron were combined into the following two nutrient intake indices. Although somewhat arbitrary, these indices would seem to be rough approximations of the relative importance accorded these food constituents with respect to their effect on the nutritional status of young children.

Nut. Int. 1:	Calories = 40
	Protein = 30
	Vitamin A = 15
	Iron = 15
Nut. Int. 2:	Calories = 45
	Protein = 25
	Vitamin A = 5
	Iron = 25

These two indices and the percentage of recommended allowance figures for calories alternatively were used as proxies for the nutritional intake variable in the analysis.

Infection and Disease

Three measures of infection and disease--disease history, diarrheal infection, and parasitic infection--were examined independently and then looked at a composite weighted infection index. The three independent measures are discussed below.

1. Disease history - A disease history score was derived from information collected on the incidence of those major diseases capable of affecting a child's nutritional status, i.e. smallpox, measles, skin eruptions (impetigo, rubella, chicken pox), dysentery and pneumonia. A score of 0 indicated no major illnesses while a score of 5 indicated five or more major illnesses.

2. Diarrheal infection - Similarly an index measuring the frequency and severity of diarrhea was constructed using a series of interview questions. The index ran from 0 (low frequency and severity) to 7. A child with almost no history of diarrhea was given a rating of 0. A child who had suffered from diarrhea 90 percent of its life or more was given a rating of 5. Two points were added if the child at any point in its life suffered from severe diarrheal infection as evidenced by blood or mucous in the stool.

3. Parasitic infection - The stool samples, collected from 96 percent of the original sample of 523 children, were used to test for evidence of parasitic infection. This laboratory analysis also permitted an estimation of the extent of parasite load where parasites were found.

Economic Status

Income and wealth were calculated as separate variables to permit both a stock and flow dimension of economic status. Of these the wealth variable was the more satisfactory with respect to precision of calculation, but the income one proved a better explanatory variable in the multiple regression analysis.

The income calculation was made on a per month basis for the nuclear family of each child in the study. In the case of salaried service persons this was a relatively easy procedure. For landless agricultural laborers an effort was made to calculate the total monetary value of wages and payment in kind (usually calculated on a per day basis) for an estimated number of days worked in an average month. Problems in this calculation included (1) the fact that wages differ significantly during harvest and non-harvest seasons, and (2) the less easily quantified components of reimbursement, e.g. landless laborers often are permitted to glean the fields after harvest. For the landed agriculturalists estimates were made of the monetary value of production minus the agriculture-related costs. One problem here is the necessary adjustment for that portion of production consumed by the family, an amount which otherwise would represent an expenditure from net income. Given these problems, the income calculation necessarily was less precise than might have been desired.[6/]

The wealth measure, on the other hand, was calculated in a fashion which, if not exact, probably is quite effective in giving a wealth

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6/ An attempt was made by Dr. Robert Parker of the Johns Hopkins group to assess income more exactly for a small part of the Narangwal sample through precise quantification of each factor affecting it. The interview time on this question alone often exceeded three hours.

ranking of the families in the sample. The calculation was made using a slight modification of an economic index developed by the Narangwal RHRC. Since final weightings for the index were not established by the RHRC at the time of this analysis, the weights used were those suggested by Mr. George Immerwahr, an RHRC consultant, again with minor modifications. The index assigned weights to such factors as size and construction of dwelling, number of animals, mechanical possessions, land and non-land related income. The index used is presented in Appendix II.

Mothers' Beliefs and Education

A beliefs index was developed on the basis of a series of pretested questions on mothers' beliefs pertaining to the nutritional and health status of their children. These questions asked mothers to state their beliefs on the ideal age to introduce supplementary milk and solid food and the adjustments that should be made to the child's diet in the event of diarrhea or fever, and to explain the cause of nutritional marasmus (a known disease with an equivalent word in the Punjabi language). These questions are included under section D on the data collection form in Appendix I.

The beliefs index was constructed using a scale of 1 (beliefs detrimental to the child's health) to 4 (beneficial beliefs). Information also was collected on the literacy and education of the mothers.

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In addition to the above variables basic demographic information was collected on age, sex, family size, the number of liveborn children who have died in the family, and caste. Difficulties always are encountered in collecting accurate age information on persons living in rural areas of low-income countries. These problems, of course, are less serious

for a young child whose entire lifetime is within the easily accessible memory of his parents. Nonetheless, it is necessary even in assessing the ages of young children to be quite persistent in placing the birth in relation to known seasons and festivals. Gross errors usually could be caught by visual inspection of the child (including the number of his teeth). Sometimes birth dates thus ascertained were compared with birth records kept in each village by the "chowkidar" or watchman, but such records often proved unreliable.

CHAPTER 4

THE SAMPLE CHILDREN: A STATISTICAL PROFILE AND GENERAL DISCUSSION

This chapter, using the data from the micro study, presents a quantitative description of the sample children according to the variables introduced in the preceding chapter. It includes, where appropriate, a general discussion of the variables as they relate to this part of Punjab.

Although Punjabi villages have been well described elsewhere (46,66) a few brief comments may be appropriate here. As in other low income countries, these villages are largely self-contained, concentrated units surrounded by agricultural holdings and generally linked to the nearest main road by a dirt road. The village itself is a maze of narrow paths of dirt or burnt brick, which often are bordered by mud walls, and which wind around houses, a few wells (each serving a particular portion of the village), numerous mud storage structures, a temple, a school (education of boys and girls usually is conducted separately), a small wheat grinding unit, and a few one-room shops. These paths, which become virtual streams during the monsoon, might at any given daylight moment be occupied by a bullock cart filled with agricultural produce, farm implements or bags of fertilizer, a hand-pushed vegetable cart, a half dozen water buffalo being herded to the nearby pond by a nine year old boy with a longer stick, a few goats ambling aimlessly or tethered in a grassy patch, a group of noisy school children with their wooden writing slates, and a few girls of seven or eight carrying younger siblings on their hips.

Residential dwellings usually are grouped according to caste with a clear-cut differentiation at least of Jat and Ramdasia households. The former generally are constructed of a combination of brick and mud, contain

one or two rooms sometimes with electrical outlets, a roofed section for animals, and an inner courtyard where fodder and fuel are stored, where the cooking is done and where most of the woman's day is spent. The Jat family is likely to have it's own private water pump.

Ramdasia dwellings almost always are smaller mud huts with dirt or dung floors and thatched roofs. Often these dwellings stand in a row with common side walls and roofs. Unlike her Jat counterpart, the Ramdasia woman spends a considerable portion of the day away from the home, often gathering fodder for the animals or, during harvest seasons working in the fields. During her absence from the home her younger children generally are entrusted to older daughters, or in some cases, a paternal grandmother.

Social-Demographic Information

The discussion of the sample children begins with basic social-demographic information, and then proceeds to the major variables. As seen in the previous chapter, Jats (42 percent) and Ramdasias (39 percent) constitute the bulk of the sample children. The heterogeneous grouping of "Other" children make up the remainder. As would be expected by the geometry of population growth, there are slightly more persons, proportionately, in the younger age group. Of the sample children, 52.8 percent are male, a figure almost identical with that found at Narangwal (53.0 percent among children aged 0-4) (36).

As seen in Table 2 the average child has over two live siblings, slightly but not statistically significantly higher among Ramdasias than Jats. The average number of liveborn children who died in the Ramdasia families, however, was over 70 percent higher than in Jat families. This would be consistent with the Narangwal RHRC data which found the infant

(0-12 months) mortality rate to be 128 per 1000 live births for Jats and 179 per 1000 for Ramdasias (36).

Table 2. Number of Live and Dead Siblings Per Sample Child

Group	Average number of live siblings	Average number of liveborn dead siblings
Jats	2.16[a]	0.49**
Ramdasias	2.36	0.85
Others	2.08	0.53
Total	2.22	0.64

a/ Not significantly different from the Ramdasia figure at the .95 level of statistical significance.
** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

Family income ranged from Rs. 50 ($7) to Rs. 1450 ($193) per month with a mean of Rs. 241 ($32). Mean family income figures by caste are presented in Table 3. The mean per capita income was Rs. 46 ($6) per month. The wealth index ranged from 40 to 1400 with a mean of 243. In spite of the largely coincidental similarity in range and mean values of the income and wealth variables, the correlation between them was only .738 (Perfect correlation is + or - 1.0).

Table 3. Average Monthly Income of the Nuclear Families of Sample Children

Group	Average monthly family income	
Jats	Rs. 336	($45)**
Ramdasias	Rs. 150	($20)
Others	Rs. 218	($29)
Total	Rs. 241	($32)

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

Nutritional Status

As discussed in the previous chapter, weights and heights of the children were compared with the Harvard Standards by three parameters: weight for age, height for age, and weight for height. The means of each of these are presented by caste grouping in Table 4.

Table 4. Mean Anthropometric Measures of Sample Children[a/] by Caste Grouping

Group	Weight as percentage of reference weight for age	Height as percentage of reference height for age	Weight as percentage of reference weight for height
Jats	79.2**	93.8**	87.8**
Ramdasias	73.5	91.7	85.5
Others	77.5	92.9	87.3
Total	76.6	92.8	86.8

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.
a/ Measurements as percentages of Harvard Standards.

In Table 5 this information for the sample children is presented by age group. As would be expected, children in the youngest group, 6-11 months, come closest to the reference measures for their age and height. Presumably the 0-5 month group would be highest of all. Then with the onset of the weaning period, the inadequacy of breast feeding alone and the syndrome of weanling diarrhea, the child's growth deviates sharply from the reference. The table would appear to suggest that during the second year the child's weight once again moves parallel with the reference weight parameters (although at a much lower level) while his height continues to fall relative to the height for age reference.

Table 5. Mean Anthropometric Measures[a/] of Sample Children by Age Group

Age group	Weight as percentage of reference weight for age	Height as percentage of reference height for age	Weight as percentage of reference weight for height
6-11 months	82.3**	95.4**	90.6**
12-17 months	73.9	92.3	84.8
18-24 months	73.8	90.7	85.1
Total	76.6	92.8	86.8

** Significantly different from the 18-24 month age group at the .95 level of statistical significance.
{ Indicates figures significantly different at the .95 level of statistical significance.
a/ Measurements as percentages of Harvard Standards.

The weight for age measure is the basis for the frequently used "Gomez Classification" of nutritional status (27) which groups children as follows:

Normal	: over 90 percent of reference weight for age
1st degree malnutrition:	76 to 90 percent of reference weight for age
2nd degree malnutrition:	60 to 75 percent of reference weight for age
3rd degree malnutrition:	below 60 percent of reference weight for age

Traditionally for 1st degree cases normal extension or outpatient care is considered adequate, while 2nd degree cases require more intensive care, e.g. a nutrition rehabilitation center, and 3rd degree cases require hospitalization (6).

The division of children according to the Gomez Classification in Table 6 indicates highly significant differentials in weight for age

between the landowning, economically advantaged Jats and the landless Ramdasias. It is in fact these differentials that the regression analysis, discussed in Chapter 5, attempts to explain. The table further reveals the extent of serious malnutrition existing in this area. Bengoa's review of community survey literature in low income countries (7) found the point prevalence of 3rd degree malnutrition within a range of 0.5 to 4.6 percent. The figure here is 8.3 percent with the Ramdasia average 12.3 percent. Similarly, Bengoa found on the average 25 percent of the children in these studies suffering from 2nd degree malnutrition, while the figure here is 39.5 percent.[1/]

Table 6. Breakdown of Caste Groupings by Gomez Classification[a/]

Group	Normal (91-100% of reference weight for age)	1st degree malnutrition (76-90%)	2nd degree malnutrition (60-75%)	3rd degree malnutrition (Below 60%)
	percent	percent	percent	percent
Jats	19.6	41.6	35.2	3.6
Ramdasias	6.9	35.8	45.1	12.3
Others	20.8	31.3	37.5	10.4
Total	14.8	37.3	39.5	8.3

a/ Percentage of reference weight for age using the Harvard Standards.

The figures also suggest considerably lower nutritional status than do those collected by the Narangwal RHRC in a cross section survey of four Ludhiana District villages in 1967 (36). That study found 5 percent

1/ The Jat figures roughly would resemble Gomez breakdowns elsewhere if there were about 15 percent more Jats in the 1st degree category and 15 percent fewer in the 2nd degree one.

suffering from 3rd degree, 10 percent with 2nd degree, and 35 percent with 1st degree malnutrition. These 1967 figures presumably reflect economic disparities between Ludhiana and Ropar Districts which have existed for many years, rather than "Green Revolution" effects (relating largely to the introduction of new seed varieties) which would not have been measurable that early.

An interesting article by Seoane and Latham (60) presents a means of utilizing height for age and weight for height measures in cross section data to assess the time frame of malnutrition among children with low weight for age. This technique divides these children into the following three groups, each calling for somewhat different interventions.

A. Current acute short duration malnutrition indicated by low weight for age and weight for height but normal height for age. The normal height (a better measure of protein-calorie malnutrition than weight for extended time periods) suggests recent, short duration deficiencies.

B. Past chronic malnutrition indicated by low weight for age and height for age but normal weight for height. Jelliffe (35) refers to this group as suffering from nutritional dwarfism.

C. Current long duration malnutrition indicated by low percentages on all three indices.

To permit a grouping into these categories, those children below 80 percent weight for age (62.7 percent of the sample) were classified using adequacy dividing points of 95 percent for the height for age measure and 90 percent for the weight for height measure. The resulting breakdown was:

Group A - 11.7 percent of the sample

Group B - 14.1 percent

Group C - 74.2 percent

indicating that relatively few presently malnourished children were adequately nourished in the past, and conversely that most children with previous malnutrition are still malnourished.

Food and Nutrient Intake

On the basis of the 24-hour recall information, several generalizations can be made about feeding practices in this area, all of which appear consistent with those found in the Narangwal and Khanna studies.

Food intake - As in most low income areas which have escaped excessive contact with the industrialized world, prolonged breast feeding remains the norm in rural Punjab. Except for the rare case of maternal death or severe illness, all children up to the age of 6 months are breast fed. Of infants between 6 and 12 months, 91.6 percent were breast fed. The percentage then dropped to 82.1 percent for those between 13 and 18 months, and to 63.7 percent between 19 months and 2 years. Breast feeding often continued to the age of 3 years and in some cases beyond.[2/]

Feeding of diluted buffalo, cow or goat milk usually is introduced during the first 6 months after birth. Often this milk is fed in a mixture with tea and processed or unrefined sugar in varying proportions. In fact for these children as a whole, the quantity of tea consumed is second only to milk as a component of the diet. Of the infants aged 6 to 12 months, 77.8 percent received some supplementary milk. Of the 13 to 18 month age group, 93.1 percent received supplementary milk, and 95.1 percent between 19 and 24 months.

2/ The median duration of breast feeding reported by Wyon and Gordon (66) was 26 months.

Delay in the introduction of solid food, a phenomenon discussed in Chapter 2, was the norm regardless of economic or social class. Almost no children received solid food before the age of 6 months. Between 6 and 12 months, 49.3 percent received some supplementary food. This is roughly consistent with the finding in Khanna (66) that 53 percent of all children at 11 months were receiving solid food. Of the children aged 13 to 18 months in this study, 87.5 percent were receiving solid food as were virtually all of the children (98.1%) between 19 months and 2 years. Of course, the quantity and quality of this food varied enormously as will be seen below.

Of the children who did consume some solid food (76 percent of the total sample) the average age of initiating this feeding was 10.5 months. This is an underestimate for the 6-24 month age group as a whole, but not a major one since most of those in the sample who were not consuming solid food were between 6 and 10 months of age. As indicated in Table 7 the average ages of initiating solid food among "Other" and Jat children respectively were 9.8 and 10.5 months, as opposed to 10.8 months for Ramdasias. This would argue against the hypothesis sometimes voiced that poorer mothers (in this case the Ramdasias), who spend much of the day in the fields or collecting fodder for animals, tend to provide solid food earlier as a matter of convenience.

Solid food fed to these children almost always is adult food. Rarely are foods prepared specifically for children. The solid food usually fed first to the child and that consumed most regularly is the wheat chapatti[3/] dipped in one of a wide variety of pulses or vegetables. Following the

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3/ A flat unleavened bread baked on a hot griddle and somewhat resembling a tortilla.

Fall harvest there is also considerable consumption of corn by these children. Rice is less often consumed. A wide range of fruits are fed depending on the season, but to only about a third of the children.

Table 7. Consumption of Solid Food mong Sample Children by Caste

Group	Percent receiving solid food	Average age of initiating solid food (months)
Jats	76.6[a]	10.5[a]
Ramdasias	73.7	10.8
Others	80.6	9.8
Total	76.2	10.5

a/ Not significantly different from the Ramdasia figure at the .95 level of statistical significance.

Average daily food consumption figures for these children are presented in Table 8. The figures clearly indicate the quantitative inadequacy of the diets of these children, and will be examined further in the discussion of caloric deficiencies. Jat-Ramdasia differences are

Table 8. Average Daily Food Consumption of Sample Children by Food Group and Caste

Group	Supplementary milk (gms.)	Cereals (gms.)	Pulses (gms.)	Fruits (gms.)	Vegetables (gms.)	Sugar (gms.)
Jats	210**	26	9	15	9	17
Ramdasias	155	26	8	13	7	18
Others	192	24	6	15	12	16
Total	185	26	8	14	9	17

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

statistically insignificant with the striking exception of supplementary milk intake. This significant difference also is reflected in Table 9 showing the sources of calories, by percentage, for the children by caste groups. Given the status connotation of milk in Punjab as elsewhere and its high relative price, these caste differences in milk consumption would seem to suggest an income relationship. The lower income Ramdasia mother who cannot afford as much supplementary milk for her child makes it up by breast feeding the child somewhat longer and providing a larger proportion of the child's calories with cereals. Because of the caloric density of the cereals, she may in fact be allocating her resources more effectively than her Jat counterpart with respect to the child's nutrient intake. Some Jat mothers may believe they are meeting their feeding responsibilities to the child by providing this high-status, expensive milk, when in reality, given the quantitative inadequacy of the diet, they better could use their resources for cereal preparations.

Table 9. Sources of Calories Among Sample Children by Caste

	Percentage of calories from:							
Group	Breast milk	Supplementary milk	Cereals	Pulses	Fruits	Vegetables	Sugar[a/]	Total
Jats	43.8**	29.7**	11.4	3.5	1.5	0.8	7.8**	98.5%
Ramdasias	50.0	22.6	12.3	3.7	1.2	0.7	8.9	99.4%
Others	45.6	28.2	12.0	2.7	1.3	0.9	8.0	98.7%
Total	46.5	26.6	11.9	3.4	1.3	0.8	8.2	98.7%

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.
a/ Refined and unrefined.

In Table 10 the sources of calories for the children are presented by age group. Here, as would be expected, one finds a highly significant decrease in the percentage of calories coming from breast milk as age increases. Over two-thirds of the calories in the 6-11 month age group come from breast milk, while it accounts for only slightly over one-fourth in the 18-24 month group. In the older groups, as can be seen, the calories are made up for with the other foods, most notably by supplementary milk and cereals. In the case of supplementary milk, these children appear to level off their consumption (as a percentage of total calories) during the second year, while cereal and pulse consumption continue to increase.

Interestingly, pulses, which have received considerable attention by nutritionists, constitute only 3.4 percent of the calories consumed by children in this age group. Given the particularly low income elasticity of consumption for pulses among this age group (discussed in Chapter 5) it is unlikely that increased pulse production, lower pulse prices, or income increments per se will have a major effect on their pulse consumption.

Table 10. Sources of Calories Among Sample Children by Age Group

	Percentage of calories from:						
Age group	Breast milk	Supplementary milk	Cereals	Pulses	Fruits	Vegetables	Sugar[a]
6-11 months	69.5**	19.5**	3.9**	0.8**	0.4**	0.2**	5.6**
12-17 months	45.4	28.1	11.6	3.0	1.2	0.9	8.7
18-24 months	26.3	31.9	19.5	6.2	2.3	1.3	10.3
Total	46.5	26.6	11.9	3.4	1.3	0.8	8.2

** Significantly different from the 18-24 month age group at the .95 level of statistical significance.

{ Indicates figures significantly different at the .95 level of statistical significance.

a/ Refined and unrefined.

Nutrient intake - As discussed in the previous chapter, this food information was converted into calories, protein, vitamin A and iron, which in turn were compared with the official Indian daily allowances. Table 11 presents the average percentages of nutrient allowances by caste.[4/] Table 12 presents the percentage of each caste group falling into four percentile of allowance classifications.

Table 11. Average Percentages of Nutrient Allowances[a/] by Caste Grouping for Sample Children

Group	Calories	Protein	Vitamin A	Iron
Jats	63.6**	87.0	86.1	38.0
Ramdasias	59.2	83.3	83.2	35.1
Others	60.7	85.5	85.6	36.8
Total	61.3	85.3	84.9	36.7

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

a/ Nutrient intake compared with "Daily Allowances of Nutrients for Indians" prepared by the Indian Council of Medical Research, 1968.

As indicated in these tables, the most serious nutrient deficiencies among this age group are those of iron (average intake 36.7 percent of the allowance with just over 4 percent having adequate intake)[5/] and calories (average intake 61.3 percent of the allowance with 7.5 percent having adequate intake). The average vitamin A intake was 84.9 percent

4/ Given the lack of an obesity concern in this study, intakes exceeding 100 percent of allowance were recorded as 100 percent of allowance.

5/ The exceedingly low iron intakes are consistent with the Narangwal RHRC finding that 80 percent of the hemoglobins of children examined were below 10 gm. % (36).

Table 12. Breakdown of Caste Groupings by Percentage of Nutrient Intake Allowances[a]

	Calories				Protein			
	100% of allowance	76-99%	51-75%	50% + below	100%	76-99%	51-75%	50% + below
Jats	10.9%	16.1%	45.5%	27.5%	57.8%	16.1%	19.9%	6.2%
Ramdasias	5.2	14.4	43.8	36.6	45.1	19.2	28.5	7.3
Others	4.5	18.0	42.7	34.8	45.7	25.0	22.8	6.5
Total	7.5	15.8	44.3	32.4	50.6	19.0	23.8	6.7

	Vitamin A				Iron			
	100%	76-99%	51-75%	50% + below	100%	76-99%	51-75%	50% + below
Jats	43.2%	31.4%	19.1%	6.4%	4.8%	7.6%	17.1%	70.5%
Ramdasias	38.5	34.1	18.5	8.8	4.7	3.7	15.1	76.6
Others	35.1	43.3	17.5	4.1	2.2	5.6	18.9	73.3
Total	39.8	34.7	18.6	6.9	4.3	5.7	16.7	73.4

a/ Nutrient intake compared with "Daily Allowances of Nutrients for Indians" prepared by the Indian Council of Medical Research, 1968.

of allowance[6/] (39.8 percent had adequate intake), and the average protein intake was 85.3 percent of allowance (50.6 percent having adequate intake).

With respect to the caloric deficiency there is some possibility that the ICMR caloric allowance used as a reference may in fact be too generous. This is suggested by Table 22 in Chapter 5 indicating that "normal" children in terms of the Gomez classification (over 90 percent of reference weight for age) meet only 65 percent of the ICMR caloric allowance. Even allowing for higher references to provide necessary buffers against stress and infection, the ICMR allowance may err on the high side. Alternatively there is the possibility that caloric intake was generally underestimated for this group. This is somewhat less likely unless the breast milk intake estimates used in the study seriously underestimate the actual breast milk intake of these children.

Unless the caloric allowance is grossly overestimated, however, (and even if food intake is overestimated which would increase protein as well as caloric intake) the findings would tend to substantiate the hypothesis frequently voiced to the effect that protein deficiencies in this part of the world are a subset of a broader protein-calorie malnutrition. Where protein deficiency exists it appears to be largely the result of caloric deficiency and the burning up of otherwise utilizable protein for energy. Using the ICMR allowances, there was no case of a child ingesting adequate calories (i.e. enough food) but inadequate protein. The "enough calories means adequate protein" argument sometimes is made for the population as

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6/ This vitamin A figure is almost four times higher than that (22.1% of allowance) found by the (Indian) National Institute of Nutrition (28) among preschool age children in the Hyderabad area of South India where vitamin A deficiency is particularly serious and debilitating. The average percentage of the recommended iron allowance found among the Hyderabad group (33.7%) was similar to that found in this study (36.7%).

a whole, but rarely for this critical age group, given their much higher proportionate requirements for protein. The findings here would suggest, again assuming the validity of the caloric allowance, that at least in this part of India, even this age group would not be excluded from the generalization.7/

Among certain population groups in low income countries, such a conclusion might be questionable. It has been suggested, for example, that where the quality of protein consumed is particularly low, a higher intake of protein will be required. Similarly, it has been argued that the presence of major infection increases physiological requirements for protein. Both of these factors have been taken into account by the Indian Council of Medical Research in setting its allowances. Beyond this, however, neither the protein quality nor the infection factor present particular problems for this population group. As indicated in Tables 9 and 10, so large a proportion of food intake comes from breast and supplementary milk that the quality of the protein consumed would be quite high. Similarly, as will be seen below, the absence of major parasitic infestation eliminates the need to adjust protein allowances on this count.

Interestingly, the nutrient intake findings in this study are similar to those found in a recent study of preschool age children (0 to 5 years old) conducted under the auspices of the Indian Council of Medical Research (ICMR) in five parts of India (Hyderabad, Vellore, Poona, Bombay, Delhi, and Calcutta) (28). Using the same ICMR standards as employed here, that study found 92 percent of the children deficient in calories (92.5

7/ While true in Punjab and perhaps in India as a whole, this relationship is unlikely to exist in those parts of the world dependent on low protein food staples, notably sub-Sahara Africa.

percent in this study) and 35 percent deficient in protein (49.4 percent in this study -- the differential presumably explained in part by the younger age group studied here). These results have important implications for intervention as will be seen in Chapter 6.

As suggested earlier, the lack of major Jat-Ramdasia differences with respect to nutrient intake would be explained partially by the Jats' heavy reliance on supplementary milk as opposed to other foods with higher caloric density relied upon by Ramdasias.

The most important effect of age on food intake relates to iron intake. Because of the much larger quantities of cereal they consume, iron intakes of children in the 18-24 month age group are roughly twice that of children between 6 and 11 months of age.

Infection and Disease

As discussed earlier, three indices were used to measure infection and disease. The findings with respect to each are discussed separately below.

1. Disease history - Table 13 presents the average number of major diseases for each caste group. As seen, the average for the sample children as a whole is below 1. The Ramdasia figure is significantly higher than the Jat average.

2. Diarrheal infection - Table 14 presents information on diarrheal infection using the index of frequency and severity described in Chapter 3. The mean rating for the children as a whole of just below 2 suggests that the average child has suffered from diarrhea about 25 percent of his life but has not suffered from severe dysentery. Again the Ramdasia figure is significantly higher than that of the Jats.

Table 13. Disease History Rating of Sample Children

(0 = no major illness; 5 = five or more major illnesses)

Group	Medical experience rating
Jats	0.84**
Ramdasias	0.99
Others	0.82
Total	0.89

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

Table 14. Diarrheal Infection Index for Sample Children

(7 = high frequency and severity; 0 = low frequency and severity)

Group	Diarrheal infection rating
Jats	1.74**
Ramdasias	2.29
Others	1.95
Total	1.99

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

In Table 15 this information is presented by age group. The figures indicate that diarrheal infection increases significantly during the first half of the second year, and continues to increase during the 18-24 month period though at a lower rate of increase.

3. Parasitic infection - One of the more surprising results of the study, although consistent with the findings of the Narangwal RHRC, was the virtual absence of hookworm, roundworm or other important parasites. Analysis of stool samples revealed only one case of roundworm and

Table 15. Diarrheal Infection Index by Age Group for Sample Children

(7 = high frequency and severity; 0 = low frequency and severity)

Age group	Diarrheal infection rating
6-11 months	1.48**
12-17 months	2.17
18-24 months	2.32
Total	1.99

** Significantly different from the 18-24 month age group at the .95 level of statistical significance.
{ Indicates figures significantly different at the .95 level of statistical significance.

no hookworm. At the same time 32.1 percent of the samples contained giardia.[8/] Interestingly as shown in Table 16 the point prevalence of giardia was higher among Jats (32.2 percent) than among Ramdasias (29.6 percent) and highest of all among the "Others" (37.2 percent). This presumably is explained by the ingestion (by Jats and "Others") of larger quantities of food, the primary carriers of this cyst. Ramdasias were also lower in the point prevalence of severe giardia which afflicted 5.5 percent of the entire sample.

The point prevalence of giardia found in this sample was almost twice that found for a comparable age group by the Narangwal RHRC (18 percent). The Narangwal data further indicates that giardia prevalence tends to increase with age in the early years of childhood (36).

8/ A unicellular flagellate which lodges in the intestinal tract and, like an intestinal parasite, adversely affects absorption. The extent of malabsorption resulting from giardia is unclear.

Table 16. Prevalence of Giardia Among Sample Children

Group	Percent with giardia	Percent with severe giardia (2+ or higher)
Jats	32.2[a]	7.5[a]
Ramdasias	29.6	5.1
Others	37.2	9.6
Total	32.1	5.5

a/ Jat and Ramdasia figures not significantly different from one another at the .95 level of statistical significance.

Mothers' Beliefs and Education

As stated earlier, mothers of the sample children were asked a series of questions designed to determine their beliefs relating to the nutritional and health status of their children. Questions sought the mothers' conception of the ideal age to initiate supplementary feeding, the appropriate dietary response to infection, and the cause of nutritional marasmus.

On the average, mothers believed solid food should be introduced near the age of one year, although the range of answers varied from six months to two years. Virtually all mothers responded that solid food should be removed during bouts of diarrhea or fever. Suggested cures ranged from breast milk or tea alone to locally procured homeopathic medicines and visits to religious figures known as sianas. Fifty-six percent of the mothers attributed marasmus (a known disease with an

equivalent word in the Punjabi language)[9] in whole or in part to the casting of an evil shadow by a person or spirit. This concept does not appear inconsistent with larger belief patterns in these villages or with the remedies selected.

Parents bringing their marasmic child to a siana might be given one of the following prescriptions:

(a) The green stick ritual - A green twig full of sap is waved over the child's head with an appropriate Sanskrit incantation. The twig is then thrown some distance away. When the twig dries, the child will be cured. If the magic doesn't work, the twig will grow and the child will die.[10] To minimize the likelihood of a reverse transfer of this life force, the parents and child must avoid for three months the spot where the twig lies.

(b) The seven wells ritual - This longer duration prescription calls for the mother to take her child to seven particular wells in seven different villages on seven consecutive full moon nights (one a month). She waits at the well until the moon is at its zenith, then repeats an incantation to the spirit of the well to the effect of "bring water into my child and make it live". After this the mother bathes the child in the water of that well.

(c) Purification by excrement - Cow dung periodically is rubbed on the back of the child. After sufficient rubbing the mother removes what she believes are worms and which in fact probably is a thin outer layer of skin.

9/ The word "soka", literally translates "dried up".
10/ This "transfer effect" is common in anthropological literature from many parts of the world.

A more medically-oriented siana and some practitioners of ayurvedic medicine[11] might prescribe dried goat liver, actually an excellent source of needed vitamins, iron, and some essential amino acids, but usually prescribed in inadequate quantities. One ayurvedic practitioner was found whose entire business is the treatment of marasmic children.[12]

As indicated in Table 17, belief in the shadow concept was highest among the "Others" group (61.3 percent) which contains a large number of Hindus with considerably more ritualism and superstition than normally associated with Sikhism. Fifty-nine percent of the Ramdasias believe in the shadow concept as opposed to 50.2 percent of the Jats.

Table 17. Mothers' Beliefs in Casting of Shadow Cause of Marasmus

Group	Percentage attributing shadow as cause of marasmus
Jats	50.2**
Ramdasias	59.3
Others	61.3
Total	55.8

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

With this information a beliefs index was constructed using a scale of 1 (beliefs detrimental to the child's health) to 4 (beneficial beliefs).

11/ An indigenously developed Indian practice of medical treatment based in part on herbal cures.

12/ These and other interesting anthropological findings are included in presently unpublished papers by D. N. Kakar of the Narangwal Rural Health Research Center.

As shown in Table 18 the average for the entire sample was 2.42, with Jats slightly higher (2.41) than Ramdasias and "Others" (2.37).

Table 18. Nutrition and Health Beliefs Index for Mothers

(4 = beliefs beneficial to child's health;
1 = beliefs detrimental to child's health)

Group	Beliefs index
Jats	2.46[a]
Ramdasias	2.41
Others	2.37
Total	2.42

a/ Not significantly different from the Ramdasia figure at the .95 level of statistical significance.

The Jat-Ramdasia differential here and with respect to belief in the shadow concept, probably is explained in part by significant differences in literacy. As indicated in Table 19, 31 percent of the Jat mothers were literate as opposed to only 7.7 percent of the Ramdasia mothers. The 22.6 percent literacy figure for the sample as a whole is less than half that (48 percent) found by the Narangwal RHRC among a comparable age group of mothers.

Table 19. Literacy of Mothers of Sample Children

Group	Percentage literate[a/]
Jats	31.1**
Ramdasias	7.7
Others	34.4
Total	22.6

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

a/ In any language.

CHAPTER 5

ANALYSIS AND RESULTS

In the previous chapter, a statistical profile of the sample population was presented using measures of nutritional status and a wide range of explanatory variables. We now can examine the relationships among these factors in terms of the analytical framework introduced in Chapter 3. The analysis basically is a two step process: first, weighing the effects of food intake and infection, the direct determinants of nutritional status[1/]; second, identifying the relative importance of a range of indirect determinants on food intake and infection respectively. The two steps are accomplished using ordinary least squares (OLS) multiple regression analysis[2/] supplemented by tabular presentations of the pertinent relationships.

Estimating Determinants of Nutritional Status

The first step in the analysis is the estimation of the effects of food or nutritional intake and infection on nutritional status. The nutritional status (NUT STAT) measures, defined in Chapter 3, were used as the dependent variable. As independent variables the two nutritional intake (NUT INT) indices and calories (CALOR) alternatively were used to represent intake. Infection was represented by diarrheal infection (DIAR), giardia (GIAR) and disease history (DISEASE) and by the infection index (INFEC) of these three.

1/ As will be seen below, other variables were found to have an independent effect on nutritional status and therefore also are included in this first step.

2/ An attempt to bring these equations into a simultaneous model using the technique of two stage least squares failed to yield meaningful results because of instability caused by particularly low R^2's in two of the equations.

The nutritional status variable which proved best explained by nutritional intake and infection was NUT STAT #1, the straight average of the weight for age, height for age and weight for height percentages. NUT STAT #3 and NUT STAT #4, multiplication of the square roots and cube by cube squared roots respectively of height for age and weight for age, were the next best nutritional status variables. The fact that NUT STAT #1 resulted in higher R^2's than the indices of weight and height for age combinations and higher than any single anthropometric measure indicates that each of the anthropometric measures adds something important to that NUT STAT #1 index.

After NUT STAT #1,[3/] 3 and 4, the nutritional status variables emerged as follows in order of their R^2's: NUT STAT #2 (the average of weight and height for age), weight for age, weight for height, and height for age.

Between the two nutritional intake indices, NUT INT #1 (calories = 40, protein = 30, iron and vitamin A = 15) proved to be a more successful explanatory variable than NUT INT #2 (calories = 45, protein and iron = 25, vitamin A = 5). However, the insertion of calories alone as the nutritional intake variable was better than either. This would be explained both by the great variation in caloric intake and by the general shortage in calories which adversely affects the utilization of other nutrients, and which at this level apparently overwhelms in both a physiological and a statistical sense the other deficiencies.

Among the three infection measures, when used together, diarrheal infection proved to be the most significant by a wide margin. Neither

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3/ Hereafter simply referred to as nutritional status, or NUT STAT in the equations.

Table 20. Estimation of Equations for All Sample Children Using Ordinary Least Squares With Coefficients Expressed as Elasticities

1. NUT STAT = 89.704 + .054 CALOR** - .033 DIAR** - .004 GIAR + .004 DISEASE - .072 AGE** (R^2 = .240)
(4.651) (-6.788) (-1.574) (1.039) (-7.117)

2. NUT STAT = 89.047 + .050 CALOR** - .032 DIAR** - .004 GIAR + .004 DISEASE - .072 AGE** + .011 INCOME** (R^2 = .248)
(4.275) (-6.559) (-1.548) (1.004) (-7.211) (2.236)

3. NUT STAT = 92.092 + .041 CALOR** - .027 DIAR** - .002 GIAR - .001 DISEASE - .068 AGE** + .010 INCOME** - .031 SEX** (R^2 = .369)
(3.865) (-5.965) (-0.962) (-0.276) (-7.404) (2.027) (-9.692)

4. CALOR = 46.815 + .065 INCOME** + .179 BELIEF** + .022 FAM SZ + .002 CASTE 1 - .005 CASTE 2 - .023 SEX* - .003 INFEC (R^2 = .067)
(2.635) (4.160) (0.813) (0.108) (-0.298) (-1.731) (-0.157)

5. CALOR = 50.854 + .033 WEALTH + .184 BELIEF** - .010 FAM SZ - .00[illegible] CASTE 1 - .009 CASTE 2 - .024 SEX* - .004 INFEC (R^2 = .057)
(1.359) (4.246) (-0.423) (-0.010) (-0.553) (-1.786) (-0.193)

6. DIAR = 1.947 + .010 INCOME - .047 BELIEF + .152 FAM SZ** - .053 CASTE 1 + .056 CASTE 2 + .049 SEX - .144 CALOR (R^2 = .037)
(0.146) (-0.378) (2.010) (-1.100) (1.261) (1.299) (-1.112)

7. INFEC = 21.870 - .017 INCOME + .038 BELIEF + .073 FAM SZ - .040 CASTE 1 + .026 CASTE 2 + .032 SEX - .017 CALOR (R^2 = .019)
(-0.281) (0.363) (1.149) (-0.983) (0.696) (1.011) (-0.157)

t values in parentheses
* statistically significant at the .90 level
** statistically significant at the .95 level

giardia nor disease history were found to be statistically significant determinants. Nor did giardia appear as a significant determinant of diarrheal infection. Disease history failed to emerge as significant, presumably because the incidence of major disease among surviving children in this age group is relatively low. When the infection index was used in place of the three components, the result was a more highly significant coefficient than any individual component but a lower R^2 than when the three components were used together in an equation.

In addition to food intake and infection, the differences in the anthropometric measures found for different age groups within the sample (Table 5) suggested that age itself explained a portion of the variation in nutritional status and therefore should be included as an independent variable in the equation.

Using the best index for each variable this first set of relationships for the population as a whole is stated in equation 1 of Table 20. The coefficients for each of the independent variables are presented as elasticities to facilitate their usage. The first equation would be interpreted as follows: Holding diarrheal infection, giardia, disease history and age constant, a one percent increase in caloric intake would improve nutritional status by .054 percent.[4/] Then holding calories, giardia, disease history and age constant, a one percent increase in diarrheal infection would result in a .033 percent decrease (because of the minus sign) in nutritional status. Similarly, the effects of a one percent change in giardia, disease history or age on nutritional status, holding the others constant, are indicated by the magnitude and signs of

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4/ Similarly, a decrease of one percent in caloric intake would result in a decrease in nutritional status by .054 percent.

their coefficients. The t values are noted parenthetically below the coefficients, and asterisks mark the levels of statistical significance. In the first equation, caloric intake, diarrheal infection and age are significant at the .95 level of statistical significance.

The R^2 of .240 indicates that the independent variables (on the right side of the equal sign) in this equation explain 24 percent of the variation found in nutritional status among the sample children. Although cross section analysis, inherently, seems to be characterized by low R^2's, an attempt was made to incorporate other possible explanatory variables into the equation. In equation 2, the addition of per capita income raised the R^2 to .248. This means that above and beyond the effects of income on caloric intake and infection (which will be examined later in this chapter) and hence indirectly on nutritional status, there is a statistically significant independent effect of income on nutritional status. Reasons for such a relationship will be discussed below.

In equation 3 the sex variable was added to those in the previous equation, boosting the R^2 to .369. The increase in the R^2 and the high statistical significance of the variable suggest the major importance of the sex variable in the analysis. Each of the significant variables in this third equation will be examined separately below.

Equation 3 is estimated separately for Jats and Ramdasias as equations 1 in Table 21. Although the same variables prove statistically significant, there are three important differences. First, the coefficients for the calorie variable indicate that caloric intake is a far more important determinant of nutritional status among Ramdasias than among Jats. Hence, increases in food consumption are likely to result in greater improvement in the nutritional status of Ramdasia children who

Table 21. Estimation of Equations for Jat and Ramdasia Children Using Ordinary Least Squares With Coefficients Expressed as Elasticities

JATS

1. NUT STAT = 94.378 + .029 CALOR* - .027 DIAR** - .002 GIAR - .003 DISEASE - .057 AGE** + .003 INCOME - .029 SEX** (R^2 = .376)
(1.839) (-4.472) (-0.712) (-0.615) (-4.168) (0.377) (-6.168)

RAMDASIAS

1. NUT STAT = 88.367 + .063 CALOR** - .029 DIAR** + .001 GIAR + .008 DISEASE - .078 AGE** + .006 INCOME - .028 SEX** (R^2 = .345)
(3.533) (-3.412) (0.234) (1.270) (-5.028) (0.652) (-5.032)

JATS

2. CALOR = 49.838 + .053 INCOME + .173 BELIEF** - .075 FAM SZ - .011 SEX + .006 INFEC (R^2 = .051)
(1.349) (2.695) (-0.116) (-0.545) (0.225)

RAMDASIAS

2. CALOR = 46.786 + .089 INCOME* + .129 BELIEF* + .039 FAM SZ - .052 SEX** + .005 INFEC (R^2 = .069)
(1.799) (1.727) (0.786) (-2.342) (0.171)

JATS

3. DIAR = .802 + .203 INCOME + .153 BELIEF + .196 FAM SZ + .136 SEX** - .070 CALOR (R^2 = .041)
(1.498) (0.346) (1.559) (2.085) (-0.308)

RAMDASIAS

3. DIAR = 3.885 - .418 INCOME** - .238 BELIEF + .006 FAM SZ - .045 SEX + .001 CALOR (R^2 = .063)
(3.097) (-1.249) (0.058) (-0.780) (.004)

t values in parentheses
* statistically significant at the .90 level
** statistically significant at the .95 level

consume less food to begin with, and for whom inadequate food intake is a more limiting factor. Second, age is somewhat more important among Ramdasias than Jats, suggesting that Ramdasia children depart more sharply from the anthropometric standards during the latter half of the first year and during the second year than do the Jat children. Finally, although statistically significant for neither group, the independent effects of income on nutritional status are greater among Ramdasias than among Jats.

Another way of looking at the relationships between these explanatory variables and nutritional status for the population as a whole is presented in Table 22 which breaks down the sample population by Gomez classification groupings. Although such a tabular breakdown does not address the matter of causality implied by multiple regression analysis, it does illustrate dramatically the differences in the explanatory variables associated with differences in nutritional status (in this case using the weight for age proxy). The table indicates that "normal" children consume 25 percent more calories than those with 3rd degree malnutrition, have less than a third of the diarrheal infection, and have had about a third as much major disease. In addition, the "normal" children average 5½ months younger than those with 3rd degree malnutrition and their incomes are roughly 50 percent higher. Even more striking are the sex differences. While females constitute 19 percent of the normal children, they account for over 87 percent of those with 3rd degree malnutrition. Similarly Ramdasias constitute less than 20 percent of the normal cases, but almost 60 percent of the 3rd degree cases.

Returning now to Table 20 we will examine in more detail the primary direct determinants of nutritional status for the population as a whole (those with statistically significant coefficients in equation 3), namely caloric intake, diarrheal infection, age, income and sex.

Table 22. Tabular Profile of Sample Children by Gomez Classification Grouping

Gomez grouping	Number of cases	Average age (months)	Percentage female	Percentage Jat	Percentage Ramdasia	Average number of live siblings	Average number of dead siblings
Normal (over 90% of "Harvard" reference weight for age)	73	10.5**	19.2**	54.8	19.2**	2.4	0.5**
1st degree malnutrition (76-90%)	181	14.8	34.8	46.4	37.6	2.2	0.6
2nd degree malnutrition (60-75%)	202	16.1	60.4	37.7	44.1	2.2	0.6
3rd degree malnutrition (below 60%)	40	16.1	87.5	20.0	57.5	2.6	1.1
Total	496	14.8	47.2	42.1	39.1	2.2	0.6

Gomez grouping	Average percentage of caloric allowance	Average number of major diseases	Average diarrheal infection rating a/	Average mother's belief's index rating b/	Average percentage literacy of mothers	Average monthly income of child's family	Average monthly per capita income
Normal (over 90% of "Harvard" reference weight for age)	65.0**	0.5**	1.1**	2.4	36**	Rs. 285 ($38)**	Rs. 53 ($7.06)
1st degree malnutrition (76-90%)	63.1	0.8	1.7	2.5	22	Rs. 245 ($33)	Rs. 47 ($6.27)
2nd degree malnutrition (60-75%)	60.4	1.0	2.2	2.4	21	Rs. 231 ($31)	Rs. 44 ($5.87)
3rd degree malnutrition (below 60%)	51.8	1.4	3.5	2.2	13	Rs. 192 ($26)	Rs. 34 ($4.53)
Total	61.3	0.9	2.0	2.4	23	Rs. 241 ($32)	Rs. 46 ($6.13)

** Significantly different from the 3rd degree malnutrition figure at the .95 level of statistical significance.
{ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.
b/ 4 = beliefs beneficial to child's health; 1 = beliefs detrimental to child's health.

Determinants of Caloric Intake

Having determined the significance of caloric intake as a determinant of nutritional status, particularly among the Ramdasias, we can proceed to identify the determinants of caloric intake, as we will do subsequently with diarrheal infection. In equations 4 and 5 of Table 20, caloric intake is expressed as a function of per capita income (equation 4) or wealth (equation 5) plus beliefs, family size (FAM SZ), caste (two dummy variables to express three castes, with CASTE 1 being Jats and CASTE 2 Ramdasias), sex (again a dummy variable where 0 = males and 1 = females), and the infection index. In spite of particularly low R^2's for these, and for the infection equations which follow, several determinants prove statistically significant. The most significant determinant for the population as a whole is beliefs, followed by income. The wealth index used as an explanatory variable in equation 5, failed to prove statistically significant, in spite of the fact that it appeared more satisfactory with respect to precision of calculation than income. This would seem to suggest that food consumption, at least that given to young children, is more significantly affe ed by short-run income flows than by non-liquid, accumulated assets. Sex emerges as a significant determinant of caloric intake, but only at the .90 level of statistical significance.

More revealing is the estimation of equation 4 separately for Jats and Ramdasias as presented in equations 2 of Table 21. For the Jats, beliefs is clearly the most important determinant suggesting that interventions solely designed to affect their belief patterns probably would have significant effects on their food intake. Among the Ramdasias, beliefs is a less important determinant while income is a more important one than among the Jats. This would seem to suggest that unlike the Jats, the

Ramdasia family probably requires income supplementation before it can take full advantage of information dissemination programs.

While sex is not a significant determinant of caloric intake among Jats, it is a highly significant one among Ramdasias where major differentials in caloric intake exist between male and female children. As will be discussed later in a discussion of the sex variable, such a differential is closely related to the income constraint affecting this group.

The relationship between food intake and income, introduced above, is a critical one with major policy implications. As noted in Chapter 2, there probably is no more important determinant of food intake for the population as a whole than income. Among the 6-24 month age sample population, however, the effects of income are somewhat less clear. Though a statistically significant determinant of caloric intake for the sample population as a whole, and presumably a prerequisite at the low end of the income spectrum, the coefficients estimated for the income variable are far lower than would be expected for the population as a whole. The relationship is clarified somewhat by looking at income elasticities of demand (or more accurately, of consumption) for food items and nutrients among the sample children broken down into 6 month subgroups in Table 23. For purposes of rough comparison these elasticities are accompanied by total expenditure elasticities of demand for all age groups in rural India.[5/] Among the young children the amounts of pulses, fruits and vegetables are

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5/ The differences in meaning of these two sets of figures should be noted, however. For the sample children the elasticities are derived from quantities of food consumed among different per capita income groups, while the other elasticities are derived from expenditures on food purchased among different per capita total expenditure groups. In addition, somewhat different statistical functions are used in estimating the two sets of elasticities. Nonetheless, the essential meaning is similar and rough comparisons are not unwarranted.

Table 23. Income Elasticities of Consumption[a] and Total Expenditure Elasticities of Demand Among Sample Children by Age Group and for All India (Rural) Respectively

Item	Income elasticities of consumption among sample children aged: 6-11 months	12-17 months	18-24 months	Total sample children	Total expenditure elasticities of demand for all age groups[b] in rural India
Supplementary milk	.159	.176	.282	.242	1.66
Cereals	-.160	-.099	.011	.010	0.50
Pulses	-.107	.178	-.073	.026	0.71
Fruits	-.049	-.077	.009	.036	1.43
Vegetables	.470	.232	.115	.218	0.69
Calories	.070	.041	.082	.071	
Protein	.045	.033	.034	.042	
Vitamin A	.013	.036	.065	.035	
Iron	-.055	-.057	.020	.012	

a/ Using the double-log function: $\log C_i = a + b \log Y$

where:

C_i = per capita daily consumption of a particular item

Y = per capita income

b/ Calculated by Sinha (61) using the log-log inverse function:

$$\log E_i = a - \frac{b}{X} + C \log e X$$

where:

E_i = per capita expenditure on a particular item

X = total per capita expenditure (as a proxy for income)

using 1957-58 data from the 13th Round of the (Indian) National Sample Survey.

so small and their consumption so erratic among these children that the elasticities are less meaningful than those for supplementary milk and cereals. The figures are given, nonetheless, to permit comparison with the all-age group figures.

The figures[6/] indicate clearly that the effects of income per se on the food consumption of the young children are far less pronounced than for the population as a whole. The income elasticities of consumption for calories, even among the 18-24 month age group with a lesser dependence on breast milk, is only .082 meaning that if a family somehow succeeded in doubling its income (assuming everything else, including prices remained constant) their child's caloric intake would increase by only 8 percent. (The increase in an adult's caloric intake might be 10 times that great.) The young child's protein, vitamin A and iron intake would increase by even less. This would suggest that, for the sample population as a whole, a simple income supplement program unaccompanied by other interventions is unlikely to have a major effect on their food intake.

At the same time the elasticities indicate that income becomes an increasingly important determinant of supplementary milk and cereal intake (representing 75 percent of non-breast milk calories) as the children get older. In the case of cereals, their use among lower income groups as a partial substitute for larger quantities of higher status, more expensive supplementary milk account for the negative cereal elasticities among the youngest age groups. This also would explain the negative elasticities for iron, largely a function of cereal intake.

6/ The milk elasticity of .242 would be interpreted as follows: "A 10 percent increase in income would result in a 2.42 percent increase in milk consumption."

Finally the income-food intake relationship can be examined in the per capita income group breakdowns and frequency distributions presented as a group in Appendix III. Tables III-1, 2, 3, 5, 7 and 9 give data for each of five per capita income groups, while Tables III-4, 6, 8 and 10 present the same information pooling the two top income groups and the two bottom ones respectively.[7/] Tables III-3 and 4 indicate the positive although irregular effects of income on calories, protein and vitamin A intakes. Iron intake, again because of its largely cereal source, is not significantly affected by income. The frequency distributions presented in Tables III-7 and 8 indicate, nonetheless, the extent of the calorie and hence nutritional intake problem even among the highest income groups. Table III-8 using the pooled income groups indicates that in the high income group only 35 percent attain over 76 percent of their caloric allowance, while 20 percent meet 45 percent of the allowance or less. Thus, there is little question of the need for nutritional improvement even among children of economically advantaged families in this area.

The important male-female differentials in these tables will be examined in the discussion of the sex variable below.

Determinants of Diarrheal Infection

As indicated in equations 1-3 in Table 20, the one infection variable to emerge as a significant determinant of nutritional status was diarrheal

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7/ It should be noted that, ideally, grouping by total expenditure would be preferable to income grouping in such tables, since total consumption expenditure, and hence expenditure on children, could be financed not only from current income, but also from past savings and borrowings. In fact, the considerable amount of dissaving among the lowest income group may result in their spending as much as the next group up. Nonetheless, the income groupings, particularly the pooled figures, probably represent a reasonable proxy for total expenditure.

infection.[8] The variable proved highly significant, even more so than caloric intake. Estimating, in turn, the determinants of diarrheal infection resulted in the same low R^2's encountered in the caloric intake equations, probably suggesting the need for more sensitive measures of environmental conditions, water supply and food preparation procedures, preferably using time series data. Nonetheless, the equations reveal several interesting findings.

Equation 6 in Table 20 examines the determinants of diarrheal infection for the population as a whole. The primary determinant to emerge in this equation is family size. The high positive correlation with diarrheal infection would indicate either that the spread of diarrheal infection is facilitated by the crowding found in densely populated households, or that parents tend to provide less good care to later born children. Either conclusion would add still another dimension to the set of population-nutrition relationships presently being explored in many countries. Interestingly, as seen in equations 3 of Table 21 the family size determinant is far more important among Jats than Ramdasias. This would be consistent with either explanation of the family size-diarrheal infection relationship. If the spread of infection hypothesis is valid, the differentials are likely to be greater among the Jats whose households and level of environmental sanitation, while hardly ideal, are far more infection-free than those of Ramdasia families. It would be reasonable to assume that environmental conditions among Ramdasias are so poor to begin with, and the frequency and severity of diarrheal infection already so high,

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8/ Nonetheless, the infection index of diarrhea, giardia and disease history was used as a dependent variable in equation 7 of Table 20. Because of the lack of any statistical significance in the equation, discussion in the text is limited to equation 6 using diarrheal infection alone as the dependent variable.

that the addition of more children would have an umimportant additive effect. If the less-good-care-to-later-born-children hypothesis is valid, one could assume that Jats have the resources which permit such differentials. As will be suggested in the following sections, the low income Ramdasia woman at present may not be in a position to provide adequate care t a young child, even if these are only a small number of children to care f

The other important finding in equations 3 of Table 21 is the far greater effect of income on diarrheal infection among Ramdasias than among Jats. To deal with this relationship and the ensuing analysis, it probably would be useful to think of income among Ramdasias as both a resource and a time factor. As discussed earlier, the Ramdasia woman, although usually living amidst abject poverty, is, unlike most of her Jat counterparts, a fully employed person. During sowing and harvest seasons she works in the fields. Throughout the year she collects fuel and fodder and cares for the animals above and beyond her household duties. When the income of a Ramdasia family increases, the increment will not only increase the woman's purchasing power but will at a certain level permit her to dispense with many of her responsibilities outside of the home and increase the time she has for herself and her children. This has major implications for child health. Child illness is even under the best circumstances a difficult process. Recurring diarrheal infection is among the most problematic. For the harried Ramdasia mother it is well-nigh an impossible one. In such a situation, income alone is unlikely to be a panacea. Responses to questions on the treatment of diarrheal infection indicate that a general lack of knowledge on this subject is pervasive.[9/]

9/ This lack of a major differential in beliefs and knowledge pertaining to diarrheal infection would explain the absence of a significant beliefs coefficient in these equations.

The existence of considerable diarrheal infection among upper income groups as indicated by the frequency distributions in Tables III-9 and 10, would further support the contention that more than income is necessary to deal effectively with the problem. Nonetheless the upper income Ramdasia woman with more time to devote to the problem apparently is able to deal more effectively with it even lacking adequate knowledge.

The Age Variable

The importance of the age variable, as discussed earlier, simply indicates the increasing severity of malnutrition problems as children progress beyond the age of six months. As noted earlier, these children are plagued by the combination of increased nutritional intake requirements which cannot be met with breast milk alone, and the debilitating syndrome of weanling diarrhea, so well described by Gordon, Chitkara and Wyon (29). The significance of this age variable reinforces the contention made in Chapter 1 of the need to focus the thrust of intervention programs on children of this age. The closer to the six month age group the program can come, the greater effect it is likely to have.

Income as a Proxy

The significance of per capita income as a determinant of nutritional status independent of its effects on food intake and infection (and hence on nutritional status) would seem to suggest that the income variable here represents other variables not explicitly measured in the study but highly related to income. Three such variables would seem to be most plausible:

a. Pre-natal environment - The height and weight of the child's mother (primarily a function of environmental factors during her lifetime) and her food intake during pregnancy (particularly when her height and weight are substandard) are likely to affect the birthweight of the child.

Here, as in industrialized nations, one finds significantly lower birthweights among lower income groups.

b. Demand breast feeding - Ramdasia mothers who spend a large part of each day out of the home are less available for breast feeding than are their Jat counterparts. Even if the Ramdasia mothers fed an equal quantum of breast milk during a 24 hour period, the fact that this is accomplished through fewer feedings[10/] probably makes it somewhat less efficient. In actuality, however, the Ramdasia mother probably feeds a smaller quantum of breast milk, particularly during the sowing and harvest seasons, leading to what Jelliffe refers to as "breast starvation" (35).

c. Psychological effects of a mother's presence - Although least easy of all to quantify, the psychological effect of a mother's presence may explain some of the variation in growth (54, 64).[11/]

The Sex Variable

In terms of equation 3 in Table 20, the most statistically significant determinant of nutritional status is sex. In other words, a child's sex per se would more consistently account for variations in nutritional status than any of the other variables. Similarly, sex has emerged as a determinant, although less statistically significant of caloric intake for the population as a whole, and of diarrheal infection among Jats. Thus, the sex variable clearly represents a critical determinant in the analysis and requires careful examination.

10/ Bailey (5) refers to this phenomenon of breast feeding when the mother gets a chance as "opportunity feeding" as opposed to "demand feeding".

11/ An excellent discussion of the relationship of these factors to anthropometric measures should be published shortly by Dr. DeSweemer of the Johns Hopkins Department of International Health.

To aid in this examination the major variables are broken down by caste and sex in Table 24. As seen in this table the most significant sex differences are in the anthropometric measures used as proxies for nutritional status. The magnitude of these differentials reinforces the highly significant coefficient of the sex variable in equation 3 of Table 20, indicating an important effect of sex on nutritional status independent of its effects on caloric intake and infection. There may be two explanations for such an effect. First, it is likely that the establishment of India-specific or Punjab-specific reference growth curves, like those in other low income parts of the world, would provide somewhat greater differentials in the reference growth curves of males and females even for this age group than do the Harvard standards. At the same time the greater premium placed on sons than on daughters clearly results in major differentials in their care and upbringing[12/]. Some of these differences discussed below are picked up by the data. Others relating to such factors as extra time, attention and affection devoted to male children are not accounted for statistically, yet might have major effects on child growth.

These differences reflect an economic as well as a cultural premium placed on living sons, with roots deep in Indian tradition, yet reinforced by present-day realities. Sons represent an economic asset to their parents as a bread winner and a source of social security. Daughters are considered unproductive and an expensive economic drain, particularly the cost of the dowry when they marry[13/].

12/ Our own experience in Punjab paralleled that of the Narangwal RHRC which spent "an inordinate proportion of time saving baby girls."

13/ Conversations recorded by Dr. Helen Gideon while collecting information on family size as part of the Khanna Study (66) are particularly revealing. After realizing that she was receiving information only on male children, she confronted the next woman with the dilemma and was told, "Of course, we have girls; you only asked about children and said nothing about girls."

Table 24. Tabular Profile of Jat and Ramdasia Sample Children by Sex-Caste Groupings

	Sex-caste group			
	Jat male	Jat female	Ramdasia male	Ramdasia female
Number of cases	111	98	98	96
Average percent reference weight for age	84.2	73.5	77.8	69.0
Average percent reference height for age	95.5	91.8	93.4	89.9
Average percent reference weight for height	90.1	85.3	87.0	84.0
Average percent of caloric allowance	64.4	62.7	62.6	55.7
Average percent of protein allowance	86.1	88.0	84.9	81.7
Average percent of vitamin A allowance	89.7	81.9	86.0	80.4
Average percent of iron allowance	35.1	41.3	37.5	32.7
Percent breast fed	84	70	87	82
Percent receiving supplementary milk	88	93	91	80
Percent receiving solid food	72.1	81.6	79.6	67.7
Average age of initiating solid food (months)	10.5	10.3	10.5	11.1
Average supplementary milk consumption (gms.)	204	217	164	146
Average cereal consumption (gms.)	22	31	27	25
Average pulse consumption (gms.)	8.5	8.7	6.2	9.3
Average vegetable consumption (gms.)	10.8	7.1	9.2	4.4
Average fruit consumption (gms.)	15.7	14.5	15.7	10.0
Average number of major diseases	0.91	0.75	1.08	0.89
Average diarrheal infection rating	1.52	1.98	2.38	2.21

⌣ Indicates figures significantly different at the .95 level of statistical significance.

The most serious male-female differentials in the explanatory variables occur at the lower end of the income spectrum, among the Ramdasias. This indicates the severe resource and time constraint at that income level resulting in serious consequences for the young female child who often is not particularly wanted in the first place. Only with increases in income and time, adequate for the woman to meet what are, to her, highe priority responsibilities, is she likely to turn her attention to the female child. When resources and time are no longer serious constraints, as in the case of many Jat families, the young girl can be cared for adequately, although there still will be male-female differences in the quality of that care, and, interestingly, in the length of breast feeding. Apparently both Ramdasia and Jat mothers feel obliged to breast feed male children somewhat longer, believing it will increase the likelihood of their survival and well-being.

The sex-caste differential is most dramatically illustrated in the case of food intake. Table 24 indicates that except for vitamin A and vegetable intake, the feeding of Jat females largely compensates for the shorter breast feeding noted above. The Jat female child consumes almost as many calories, more protein, more iron, more supplementary milk and more cereal than the Jat male. The Ramdasia female child not only is breast fed for a shorter time period than the Ramdasia male, but consumes less supplementary milk and less solid food, begins consuming solid food later, and receives less of each of the nutrients. The relationship similarly is seen in Tables III-1 to 4 in Appendix III. Although more erratic, they indicate that while roughly equalling the males with respect to food intake among upper income groups, female children are far less well off at the low end of the income spectrum.

The sex differences in diarrheal infection and disease among Ramdasias might appear to contradict the conclusion that male-female differences are greatest among lower income groups. According to Table 25, Ramdasia females actually have slightly less major disease and diarrheal infection that Ramdasia males. In fact, it is likely that the malnourished Ramdasia female stricken with a major disease or with severe diarrheal infection simply does not survive. This contention would be supported by the much higher infant mortality rates for females (196 per 1000) than for males (125 per 1000) found by the Narangwal RHRC (36). Among low income families these differences would be even more pronounced. Thus, a Ramdasia female child who remains in the sample would likely have somewhat less frequent and severe diarrheal infection, although more than her Jat counterpart, and probably would not have had more than one major disease.

Discussion

The above analysis demonstrates rather strikingly the difficulties in dealing uniformly with different socioeconomic groups, even within a narrow age group. The health of a young Jat child probably approximates the norm for children of his age in low income countries as a whole, although male-female health differentials may be somewhat greater in Punjab. His caloric intake is low, and this, coupled with diarrheal infection, limits his physical growth. His family is, on the average, economically better off than similarly placed families in other low income countries. Yet, though his mother has both the resources and the time, she lacks the facilities in her rural surroundings to translate this income and time into major health improvement for the child. Evidence from Calcutta (30) suggests that were she living there or in other urban centers her family income would be a far more significant determinant of her child's well-being.

This would seem to suggest that only where facilities exist which permit easy translation of improved income into such advantages as better health care and advice, improved environmental sanitation and perhaps better education, are income increments likely to make much of a difference in a child's food intake and his health.

Were such facilities, in the form of clinics or education programs, available to the Jat mother living in the Morinda area, she probably would be in a position to benefit significantly from them. Coming from a landed family she is somewhat more worldly than her Ramdasia counterpart, she may have studied in a school for a few years, she may be literate or at least have a literate husband, and she has both the resources and the time to put into practice the messages of a feeding demonstration program or health clinic. Perhaps most important, she is not living on the edge of poverty and therefore, like her husband faced with new seed varieties or fertilizer, is somewhat more willing to innovate.

For the Ramdasias the situation is quite different. The child in a Ramdasia family is considerably more malnourished, often reaching the point where survival depends on escaping a bout of measles or severe diarrhea. If the child is a girl, the situation is that much worse. The child spends much of the day in the care of an older sibling while its mother is working outside of the house. In some extreme cases the family simply lacks the resources to provide even minimal care for the child. More often its mother lacks the time to deal explicitly with the need. From her own experience and that of her neighbors, she knows that giving her child supplementary food probably will result in a severe attack of diarrhea which she would just as soon avoid. If her child is a girl, there are that many more priorities which must be met first.

Providing education alone to women in such circumstances is virtually doomed from the start. The annals of well-meaning educators are filled with episodes of neatly arranged demonstrations attended only by the well-to-do. The educators track down the lower income mother and deliver their message to a nodding, acquiescent woman who then totally ignores it. The educator throws up her hands in horror and stomps away to write another report about the ignorant villager.

In fact, the Ramdasia woman and her counterparts in other societies rarely can afford the leisure of visits to a demonstration program or health clinic. Furthermore, being more reticent and fatalistic and less worldly than the Jat mother, she is far less willing to take the initiative often required for such participation. Should she actually attend the clinic or demonstration she is unlikely to fully understand the message. And if she does understand the message, she is unlikely to have the resources, time or security to translate this information into practice. Finally, even if the mother can get past the child's first few years without income supplements by reallocating existing resources with the aid of newly acquired education, how is she to deal with the increasing expenses of feeding and caring for a child as it grows older and until it becomes a productive unit? Should the child be a girl, in this society a less productive unit, with the major expense of a dowry in her mid-teens, the question becomes that much more ominous.

In sum, one probably could conclude that any intervention would have a far greater positive effect on the Jat child than on the Ramdasia, and have the ultimate effect of further widening existing differentials.

CHAPTER 6

CONCLUSIONS AND INTERVENTIONS

On the basis of the analysis presented in the preceding two chapters the following conclusions might be drawn about this population of young children in rural Ropar District near Morinda:

1. The extent of malnutrition in this population, in spite of its location on the outskirts of the "Green Revolution," is more serious than that found in most other parts of the low-income world. It also is more severe than that found in the heart of the Indian "Green Revolution" (Ludhiana District) although nutritional status of the comparable age population in that area is seriously substandard. While all groups are affected, the two most severely malnourished subgroups of young children in both areas are the Ramdasias and the females.

2. When anthropometric measures are used to measure nutritional status in cross section analysis, nutritional intake (at a point in time) and infection are both highly significant determinants. Among Ramdasia children whose nutritional intake is lower and a more severely limiting factor, this intake variable is a more important determinant of nutritional status than among Jats.

3. Another important explanatory variable of differences in nutritional status is age which is inversely related. Beyond the age of about six months the children become increasingly vulnerable to protein-calorie malnutrition and weanling diarrhea, and begin to depart sharply from the reference anthropometric standards.

4. Beyond these, income has a significant effect on nutritional status independent of its effects through food intake and infection.

This effect probably reflects such income-related, growth affecting factors as pre-natal environment (largely a function of the weight, height and nutritional intake of the child's mother), demand as opposed to opportunity breast feeding throughout the child's lifetime, and perhaps the psychological advantage to the child of the mother's presence.

5. Finally, sex has a significant effect on nutritional status, independent of its effect on food intake and infection. This might be partly attributable to insufficient sex differentials in the reference standards used. It also would be explained by the premium placed on living sons in this society, and the resulting difference in the quality of care and in the affection given to male and female children, factors not fully accounted for in the other explanatory variables.

6. Caloric intake is, by a wide margin, the most important component of nutritional intake. It emerges, in fact, as a better explanatory variable than weighted indices of calories, protein, vitamin A and iron. In terms of the deficiencies per se, the most serious are calories (average 61.3 percent of allowance) and iron (36.7 percent of allowance) although there would seem to be some question about the validity of at least the caloric allowance. Protein deficiency appears less serious and not a significant problem independent of the calorie one. Similarly, vitamin A deficiencies do not appear as serious as in other parts of India.

7. Among both Jats and Ramdasias, caloric intake is a function both of beliefs and income, although the variables as a whole explain little of the variation in caloric intake. Among Jats, beliefs clearly is most important suggesting that interventions solely designed to affect these belief patterns would have significant effects on food intake. Among Ramdasias, beliefs is less important than among Jats but income more

important suggesting that the income problem in these families probably has to be addressed before education programs can have the desired effects At the same time, as indicated by particularly low income elasticities of consumption, income supplementation alone will have a limited effect on the overall problem of inadequate food intake for the children as a whole in this age group.

While sex is not a significant determinant of caloric intake among Jats, it is important among Ramdasias where major differentials in caloric intake exist between male and female children. Given particularly tight income constraints, plus major demands on the time of a Ramdasia woman, coupled with the much higher premium placed on male children, even near-adequate feeding of a young female child is the exception rather than the norm.

8. The beliefs measured and found to be a significant determinant of caloric intake particularly among Jats, related to mothers' views on the optimal age of food supplementation, her dietary response to infection, and her beliefs on the cause of a Punjabi language equivalent of nutritional marasmus. The practice of delayed solid food supplementation emanates from the association of such supplementation with diarrheal infection and gastrointestinal disorders in general, and the association of these, in turn, with child mortality.

9. Diarrheal infection is, again by a wide margin, the most important component of infection. Neither disease history nor giardia proved significant. As in the case of caloric intake little of the variation in diarrheal infection is explained by variables in this study, and probably requires more sensitive measures of environmental sanitation, water supply, and food preparation practices. While income has an insignificant

effect on diarrheal infection among Jats, it is highly significant among Ramdasias. For the sample population as a whole, family size is the most important determinant of diarrheal infection, suggesting either that the spread of diarrheal infection is facilitated by the crowding found in more densely populated households, or that parents tend to provide less good care to later born children. Diarrheal infection and disease is higher among Ramdasia males than females, probably suggesting that the malnourished female, stricken with severe diarrhea or disease, is less likely to survive.

10. In general, because of a greater availability of time and resources coupled with somewhat less fatalism and a more basic sense of security, the Jat mother and hence the Jat child (who also suffers from malnutrition) are likely to derive higher benefits from any intervention program than will their Ramdasia counterparts. For the Jat woman, most of the preconditions would seem to be met for the effective translation of her income and time into improved health for her children once the facilities to permit such translation (education programs, health clinic or other interventions) are established. For the Ramdasia, largely bypassed by the development process, these preconditions generally have not been met.

Intervention Strategies

To the extent possible the discussion of interventions will be carried out in the context of a nutrition planning model developed by Levinson and Call (37) for the U. N. Protein Advisory Group in 1970. The relevant portion of that model, for our purposes, permits the comparison of alternative nutrition intervention programs or program proposals by rough estimation of their benefits or their effectiveness and of their costs according

to a particular objective. Generally such an objective is cast in terms of economic efficiency. As discussed in Chapter 1, however, there is virtually no empiricism on which to support an economic efficiency base. Alternatively one could employ an equity objective either with respect to economic class, or perhaps as in this case, with respect to sex. Even here, however, one encounters major difficulties in quantifying benefits for a particular economic class or sex. Given these difficulties it probably makes sense to select a somewhat narrower objective such as decreasing malnutrition-related mortality or meeting a specific nutritional deficiency (e.g. low iron intake) or a particular nutritional disease (e.g. prevalence of nutritional marasmus in a population).

Direct benefits of a proposed program then would be measured in terms of its projected effectiveness in meeting that specific objective. Beyond the direct benefits with respect to the nutrition objective, the indirect multiplier effects of a proposed program on other development sectors or goals must be considered. A school feeding program even with negligible direct nutrition effects might be justified on the basis of increased school registration and performance. A labor-intensive dairy or fruit and vegetable program may not be the best means of meeting, say, vitamin deficiencies, but might be justified on the basis of their positive effects on income-generating employment (with, perhaps, increased nutritional benefits in the long run). Similarly, nutrition intervention programs might have multiplier effects on agricultural or industrial productivity or on family planning motivation.

On the cost side one first would examine direct production, distribution and administrative costs of a proposed program. It might also be necessary to isolate and examine the foreign exchange component of the

costs. Beyond these, one would examine the expected consumer acceptability of a program, its expected speed of implementation (with calculations using a discount rate), and its viability, each of which could substantially affect the real cost of a program. Finally one would project the program's political effects which could be a benefit or a cost.

On the basis of projected or actual data, a proposed program would be measured by each of these benefit (or effectiveness) and cost criteria. It then would be necessary to assign appropriate weights to each of the criteria based on their perceived political and socioeconomic importance (weights which in actuality usually are assigned by political leadership). Having assigned such weights, the benefits or effectiveness and costs of the alternative program proposals can be compared.

Although no such quantitative cost-benefit or cost-effectiveness analysis is undertaken in this study, it nonetheless is possible to examine the relevance of certain types of interventions in the context of the criteria outlined above. This discussion constitutes the remainder of the chapter.

The fact that the food intake problem among this group relates more to calories and beliefs than say to protein and availability would eliminate at the outset a number of interventions which have been considered or attempted in other areas. For example, although any of these conceivably might be justified on other grounds or for other groups, the primary needs of this group would not suggest the development of protein supplements or the production of oilseed or fish protein concentrates or of single cell protein from petroleum or algae. In terms of the above-discussed cost-benefit model, the direct benefits to the target group of such interventions would be too small to warrant their consideration.

Similarly, neither the production of synthetic amino acids nor the development of cereal strains with higher protein or better amino acid profiles would seem to be a priority here.

Since the availability of particular food commodities does not appear to constitute an important constraint to improved nutritional status among this group, the utilization of price policy as an intervention to aid this group would similarly seem out of place. Neither would commonly employed positive price policies[1/] have a beneficial longer run effect on the objective of improving the economic status of low income groups. In general, these positive price policies have an income transfer effect from the consumer to the producer. The result is a welfare improvement in the agricultural sector at the expense of a decline in urban welfare. Within the urban sector, increases in food prices will most seriously affect low income groups, who spend a larger percentage of their incomes on food. Within the agricultural sector, since benefits of a positive price policy are in proportion to sales, they will accrue to the large producer who markets the bulk of his goods rather than to the small subsistence farmer who markets little or nothing (49). Thus, while a positive price policy may increase production of desirable commodities and hence be a sensible course of action under certain conditions, it will not often, in and of itself, improve the nutritional well-being of urban and rural low income groups in greatest need of assistance. On the contrary, it may well adversely affect their welfare. In the context of the model, commonly employed price policy would have low direct benefits and potentially very high costs including the need for scarce administrative resources with particularly

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1/ A policy maintaining support or incentive prices for food producers.

high opportunity costs. In addition, it has a negative multiplier effect on the process of economic transformation or the transfer of resources from the agricultural to the industrialized sector, a general requisite for economic growth (48).

As noted earlier, virtually any nutrition intervention program initiated in this area is likely to have a significantly greater beneficial effect on Jat children than on Ramdasias. At the same time, the malnutrition problem among Jat children is a serious one and probably deserving of attention even if the interventions employed have a less significant effect on the Ramdasias. The interventions discussed in the following sections are likely to fall into this category. They are followed by some comments on the Ramdasia problem per se and the prerequisites needed to bring about viable change for that group.

Information Dissemination

In terms of intervention the problems of inadequate food intake, delayed food supplementation, diarrheal infection and beliefs, each of which exists at all points on the economic spectrum, might best be addressed as a group. If so, this might suggest some combination of information dissemination, geared initially at the Jats, and the provision of a specially prepared easily digested weaning food. Both are exceedingly difficult. In fact to date there have been few if any successes in either on anything beyond a demonstration scale in terms of significantly affecting the nutritional status of those in need among this age group.

Ideally what is called for is the effective dissemination of a rather simple message, perhaps as simple as "If you want to increase the likelihood of your child's survival and improve his health, you must begin giving him solid food at the age of 4 to 6 months, even if this results initially

in some diarrheal upset. To decrease the chances of severe diarrhea, feed him a well cooked easily digestible food such as 'dahlia' (porridge) or 'halwa' made from sooji (samolina) and 'ghee' (unrefined butter)."[2] Secondary messages, equally simple, might stress hygiene and in some cases inoculations.[3] They also could emphasize the need for increased food consumption by women in their last trimester of pregnancy. Again, to the extent any of these messages are directed at the Ramdasias, they should take into account the severe resource and time limitations of that group.

There is evidence from Narangwal, Khanna, and our own study that on a small scale this message can be effectively disseminated with rather dramatic results in the case of malnourished children. The question is how best to disseminate it on the massive scale required. Traditionally, two basic approaches have been available for such a purpose, the person to person extension approach and the mass media one. The former has been undertaken as part of U. N.-assisted Applied Nutrition Programs and by government extension agents, health clinics, and voluntary agencies. In some cases it is incorporated into the formal education curriculum. Ideally it permits firsthand demonstrations, firsthand responses to expressions of scepticism, and the necessary followup.

The critical questions to be answered in the case of "person to person" information dissemination are two. First, what is the cost and

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2/ The fat content of the diets of these children probably has to be increased. Given the bulk constraint on diets of young children, such a source of concentrated calories would clearly be desirable.

3/ Information collected in this study on inoculations indicated that virtually all children were vaccinated against smallpox and about half received BCG inoculations against tuberculosis (the latter depending almost solely on whether or not the local inoculation unit reached the child's village). No other inoculations were given. A child's inoculation history was not significantly related to belief patterns or disease history.

time period necessary to reach the bulk of the population in a medium or large sized low income country? While nutrition rehabilitation centers have had considerable success in Haiti, the cost of similarly reaching the pre-school age population of India, for example, would exceed 1.5 billion dollars.

The second question is the effectiveness of such intervention as measured by the ultimate criterion of improved nutritional status. Equally important are the carryover effects over time and space. Does the mother who has received such education continue to observe the recommended practices a year later? Does she observe them with her subsequent children? Does she effectively pass the knowledge to her neighbor or must the neighbor also be reached directly? Unfortunately few nutrition education programs gather such information, which would be of considerable value in refining existing programs and designing new ones.

Mass media efforts are carried out through newspapers and magazines, cinema, billboards, radio, television, and through messages on everything from buses and rickshaws to calendars and yo-yos. Operating on a "mass" basis they circumvent the basic problems of cost and time cited above in relation to person to person efforts. While many mass media initiatives may lack the human, personal approach of more traditional nutrition education, others may provide it more effectively through the broadcast speech of a prime minister or important religious figure. Furthermore, mass media efforts are usually undertaken by groups better capable of communicating than traditional nutrition educators. They must of course be provided with the right messages -- as they sometimes haven't been -- if this communication is to have the desired effect.

The primary questions to be answered by advocates of increased investment in the mass media approach would be the following:

1. How much does the approach depend on the skills or sophistication of the lowest income groups in need of the assistance? Where literacy is required these groups automatically would be largely eliminated in rural Punjab. Similarly, Westernized techniques of selling a product or concept which might have considerable appeal to the communicators and to the well educated segments of the population might well bypass most of the lower income group in rural Punjab for whom the communication was intended (24, 35).

2. What is the cost of introducing large scale but decentralized broadcasting or television capable of reaching the bulk of the populace but still keeping the messages relevant and in the right language or dialect?

3. While presumably capable of successful motivation if handled intelligently, how effective are the media (television aside) in disseminating the techniques of new practices to an illiterate populace?

4. Can low income groups translate the messages into improved practice and well-being without income increments, or will they merely widen their expectations gap with possible social and political consequences (25.

With respect to the cost-benefit model, person-to-person extension efforts would have potentially high benefits assuming adequately skilled extension personnel plus sufficient income among the recipients. On the other hand, such programs imply high costs (particularly the opportunity costs of trained extension personnel) and lengthy implementation periods. Mass media efforts might have somewhat lower direct benefits but involve lower costs and more rapid implementation. In terms of actual programs,

person-to-person and mass media efforts actually constitute two ends of a spectrum with many possible points in-between. Among them are such entities as under-five clinics serving one or several villages and requiring minimal staffing. Equipped to provide uncomplicated health care and utilizing simple height-weight charts, such units can claim many of the advantages of the extension effort at lower cost.

In the context of rural Punjab, the level of overall economic growth coupled with the existence of a rather impressive network of extension services would suggest the possibility that a well planned, well financed and highly focussed information dissemination program largely utilizing existing facilities could be successful in reaching the Jat mother and her child. With respect to health extension there presently exists a cadre of public health nurses, lady health visitors and village attendants who already provide basic health and family planning services to a portion of the population. By significantly increasing the number of such persons (probably accomplished without major difficulty if their status and salaries were made commensurate with their responsibilities) and providing training in the effective dissemination of the message, this group could begin to have an effect on the problem. Similarly, the network of maternal child health centers and family welfare planning centers currently being geared up to provide improved family planning services could also be an instrument for the dissemination of this message.

With respect to mass media, the major instrument presently available is the radio. Of the families whose children were included in this study 47 percent own radios, almost all of them Jats. Although only slightly over a third (36 percent) of the mothers in these radio owning families listen to the existing "women's programs" which include information on

child care and family planning, the time spent listening to such programs proved a significant determinant of beliefs which, in turn, was found to be the primary factor affecting the nutritional intake of children. One wonders what kind of impact might be possible if these programs were improved and made more attractive while, at the same time, means were found to increase the availability and decrease the cost of transistor radios in these areas.[4/] Beyond radios there is room for considerable imagination in reaching the target audience through mobile film shows, and many of the same techniques effectively used in selling everything from soap and cooking oil to cigarettes and batteries in rural India.

Weaning Foods

It is possible that efforts to disseminate the child care message would be facilitated if accompanied by the distribution of food. If the food were a precooked, easily digestible weaning food, it also might aid directly in alleviating the nutritional intake problem. Finally, if family planning centers were among its distribution outlets, the availability of food might considerably strengthen the effectiveness and drawing power of these centers. Success in population control in turn, aside from its obvious importance to overall development, would, according to these findings have a positive effect in decreasing infection among children of this age group. There already is a sizeable body of evidence that children from smaller families eat better. Though that relationship failed to emerge in this study, it probably would be found among slightly older children whose food consumption is less affected by family belief patterns.

4/ In addition to their utility for information dissemination (and in spite of their noise) it is generally accepted that the existence in rural areas of such mechanized items, representing a tangible means of translating earnings into satisfaction, serve as a necessary component of the earnings incentive (48).

There have been numerous efforts in low income countries to commercialize such food products supposedly geared to nutrition, and more specifically protein, problems. During the past two decades, and beginning with dried skimmed milk, numerous such products have been developed and marketed with such an orientation: Vitascy in Hong Kong, Pro-Nutro in South Africa, Incaparina in Central America, Fafa in Ethiopia, Laubina in Lebanon, Saci in Brazil, and many others. Other processed foods, particularly baby foods, have been promoted in these countries on nutritional grounds but make no pretext of aiming for other than the middle and upper income markets.

A wide range of problems has faced producers of such products but one basic one has faced them all. This in simplest terms is the conflict between nutritional impact and profits. The fact that the two have been mutually exclusive in virtually all such efforts represents the basic dilemma facing this type of intervention. In Punjab as elsewhere the disposable incomes of economically disadvantaged groups in these countries are often inadequate to afford even the regional food staple. In the production of a processed food, even with negligible margins, the cost of the raw materials represents no more than a third to a half, and usually much less, of the total product cost, which is dictated by costs of processing and packaging in these countries and by the normal marketing costs involved in any commercialization. This leaves the product well beyond the reach of most of those who need it.

It would seem apparent, therefore, that if such a product, in this case a processed weaning food, is considered desirable the market mechanism alone is unlikely to suffice. If it is desirable to commercialize such a product at all, and it may well be, this would have to be done

through government subsidy and control. In terms of its non-commercial production and distribution the government's role seems reasonably clear. The basic need is to institutionalize the feeding into the domestic food distribution system where this has not yet been done. Where this is not done, low income countries will remain dangerously dependent on existing international assistance in child feeding, which in and of itself is problematic and which, if withdrawn, might leave little if any structure remaining. Mechanisms to accomplish this usually needn't be developed from scratch. Where governments are actively engaged in the buying and selling of food commodities, particularly as the supply of these commodities begins to exceed effective demand, portions of government stocks might automatically be earmarked for child feeding. Beyond this, an agricultural planning body projecting supply requirements to meet domestic demand, buffer stock and export needs, could without major complication add a fourth category, namely, child feeding requirements. Within this larger framework there may be a role for the local food processing industry.

Looking at weaning foods per se in the context of the cost-benefit model, the extent of their direct benefits would seem to be dependent on their cost, the effectiveness of their distribution, and the efforts made to overcome initial consumer resistance. Given the belief patterns noted in this part of Punjab it is unlikely that the introduction of such a weaning food would meet with much receptivity unless coupled with an effective motivational effort. If such production permitted reasonable profits it could become a relatively viable program. More likely, however, a weaning food production and distribution program resulting in significant nutritional benefits to this age group not only would preclude

profit margins but would entail major, recurring government expense. On the other hand, an effective distribution, aside from its direct benefits, could as noted above have the important multiplier effect of strengthening the institutions used to distribute it.

Iron Supplementation

Even though the specific effects of low iron intake on the morbidity, mortality and general health of these children may be difficult to isolate with precision, the extent of severe iron intake deficiency found in Chapter 4 suggests the need for explicit intervention. The problem might be addressed by an enlarged network of extension personnel and health centers through the distribution of iron and folic acid supplements to women and children. This already has been undertaken in parts of India with some success. Given the dimensions of the problem and its existence in severe form well beyond the target group, however, it may be useful to consider the iron fortification of a food item such as salt (44) consumed by the entire population. Such fortification, in terms of the cost-benefit model would have potentially high benefits for those in the target populace who regularly consume solid food. It would have no effect on exclusively breast-fed or supplementary milk fed infants. Given the major iron deficiencies existing in other population groups, such mandatory fortification could have direct health benefits well beyond the target group. Production, distribution and administrative costs would be relatively low, and assuming no adverse effects on the appearance or taste of the salt, acceptability should be high permitting relatively rapid implementation.

The Ramdasia Problem

As indicated earlier, most of the interventions discussed above are likely to have a more significant effect on the Jat child than on the

Ramdasia[5/]. Such programs can be justified on the basis of the significant malnutrition found among Jat children and the expectation that reasonably efficient programs will bring about major improvement in their well-being. But what about the Ramdasia child and his even more severe malnutrition problem?

To assume that slightly more resources or more governmental commitment behind such programs will, in and of themselves, meet the needs of these children, is, as discussed in the previous chapter, probably unrealistic. Even if the services were available the Ramdasia woman is unlikely to have the resources, time, or basic sense of security to take advantage of them. And even if she should express receptivity there is little assurance she will be able to fully avail of existing programs. In the usual case where demand for scarce services exceeds supply, they usually end up going to the more economically advantaged. In addition, where such programs are controlled by existing rural elites there may be little effort to extend these services to the poor. An evaluation of the Indian Applied Nutrition Program, currently underway, has found considerable evidence of the difficulties involved in reaching the intended poor when programs at the local level were controlled by these rural elites.

As seen in the Chapter 5 analysis, the most basic and limiting constraint facing the Ramdasia child is income. Both with respect to food intake and infection, income increases are necessary both to provide resources and to permit the child's mother more time at home. The potency of any other intervention directed at this group is likely to be minimal until this basic limiting factor is addressed.

5/ Free weaning food distribution and salt fortification might be exceptions.

The major developmental thrust in rural Punjab, namely technological change in agriculture, probably has had little if any positive effect on this problem. While new seed varieties and multiple cropping have increased the demand for agricultural labor, the consolidation of holdings by landowners (meaning less intensive cultivation) and the increase in mechanization probably have had a somewhat offsetting effect. Meanwhile, there has been major economic advantage to the landowning Jats, thus widening previous economic differentials.

To some extent the problem could be addressed through an increase in labor intensive income generating employment. This would include not only rural works schemes and small scale industrial developments (e.g., brick kilns or agricultural implement manufacturing) but also labor intensive milk production and fruit and vegetable cultivation (50)[6/]. While such efforts might well have the important effect of reducing the number of non-participants in the growth process, it would still leave largely unaffected the major population group at the bottom of the economic spectrum.

Stated simply, neither the range of alternative nutrition intervention programs nor the available means of generating income through employment is likely to have the desired effect on the most economically disadvantaged. Programs attempting to reach the Ramdasias through these means are not only

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6/ If the Ramdasia child's nutritional status suffers significantly during harvest and sowing seasons because the mother, needed in the fields, is absent for much of the day, it may be worse if additional employment opportunities for which she is eligible are created. It is likely, however, that even the Ramdasia woman's income elasticity of demand for leisure is sufficiently high that once her family income level has reached a tolerable point she would opt to follow the ways of her Jat counterpart and spend increasingly more time at home. In addition, increasing technological change in agriculture will have the longer run effect of evening out seasonal labor requirements, and by leveling off the peak sowing and harvest seasons, reduce the need for woman labor.

likely to be unsuccessful, but might have the negative effect of permitting complacency in regard to the basic plight of these highly disadvantaged, and largely ignored enclaves. One can only conclude that the plight of the poorest poor will continue unless and until they themselves become substantially involved in the income growth and development process. Until they are permitted active political participation in the processes of change and development which surround them, there is little likelihood these persons will be able to take advantage of such change or restructure it in ways necessary to ameliorate their own condition and that of their children in some viable fashion.

In conclusion, the study would seem to suggest two rather different approaches to the malnutrition problem. For the landed Jats (and probably for most of the heterogeneous "others" group and even a small portion of higher income Ramdasias) a program of information dissemination related to child care and feeding probably would be the single most important intervention. Such information dissemination might be facilitated by a weaning food distribution which, in turn, could strengthen the outlets selected for such distribution, among them family planning institutions. For the Ramdasia, a substantial improvement in his economic position appears to be a prerequisite for viable improvement in the nutritional status of his children. Only when this basic income constraint is overcome, are his children likely to be able to derive significant benefits from the kinds of nutrition intervention programs discussed in this chapter. Such economic betterment, in turn, probably requires rather basic changes in social and political organization through which the poor can restructure and more fully avail themselves of the opportunities inherent in the development process.

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APPENDIX I

DATA COLLECTION SHEET

Number _____

A. General Information

Name of village _____ Patti or Vehra _____

Name of child _____

Name of child's father _____

Age of child (months) _____ Date of birth _____

Sex: M / F (circle) Caste: Jat / Ramdasis (or Harijan)/ Other _____ (specify) (circle)

Weight _____ Height _____

B. Demographic

List living children by age and sex

	Sex	Age
1.		
2.		
3.		
4.		
5.		

No. of liveborn children who died _____

To be filled in later:

Nutritional intake per 24 hours: Calories _____ _____
Protein _____ _____
Vitamin A _____ _____
Iron _____ _____

Parasite measure _____

Medical experience rating _____

Family wealth index _____ Family income _____

Beliefs index _____ Inoculations index _____

C. Medical

		Circle	At what age (months)
Has child had:	Smallpox (Bara mata)	Yes No	_____
	Measles (Khasra)	Yes No	_____
	Other matas (Impetigo, Rubella, Chicken pox)	Yes No	_____
	Severe diarrhea (dysentery, or stools with blood or mucous)	Yes No	_____
	Pneumonia	Yes No	_____
Does child have a smallpox scar?		Yes No	
Does child have a BCG scar:		Yes No	
Does child have diarrhea now?		Yes No	

On how many days during past 7 days has child had diarrhea? _____

How much diarrhea has the child had during its life?

Circle: almost none 10% of time 25% 50% 75% 90%

D. Mother's Beliefs and Education

In your opinion, at what age should child be given supplementary milk?_____ solid food?_____

What would you do to the child's diet if child had

diarrhea? _____

fever? _____

mata or typhoid? _____

What is the cause of marasmus (soka)? _____

Does explanation involve evil spirits or shadows? Yes No (circle)

What should be done if child has soka? _____

Years of schooling of mother_____ Literacy (any language) Yes No (circle)

No. of days during past 7 days that mother listened to a women's program on the radio (12:30 afternoon, 7:30 evening, 11:30 Sunday)_____

2. Child Feeding

Is child breast fed? Yes No (circle) If no, at what age was breast feeding stopped? _____

Is the amount of breast milk normal? Yes No (circle) If no, explain _____

Does the child receive supplementary milk? Yes No (circle)

If yes, at what age was it started? _____

Does the child receive solid food? Yes No (circle)

If yes, at what age was it started? _____

If yes, why is it that some other mothers don't give solid food? _____

If no, why is it that some other mothers give solid food? _____

Was food given in the past 24 hours normal for the child? Yes No (circle)

If no, explain _____

Are any vitamin pills consumed by the child? Yes No (circle) If yes, which _____

Food consumed by child yesterday

Item	Volume	Weight	Calories	Protein	Vitamin A	Iron

F. Family Wealth Index

Father's occupation _____

1. Housing (circle)

Walls: All brick / Mixed / All mud

Floor: Paved / Dung / Other _____ (specify)

Roof: Brick / Thatched / Other _____ (specify)

Total number of rooms _____ Electricity in house Yes / No

2. Animals

Oxen _____ (number) Cows _____ Buffalo _____

Camels _____ Other, specify _____

3. Sanitation

Water source	Drinking	Other uses	Ownership	Jt. ownership
Open well				
Hand pump				

Distance of drinking water source from kitchen (in yards) _____

4. Mechanical possessions (Yes or No) (Put fraction if joint ownership)

Bicycle _____ Radio _____ Sewing machine _____

Cart _____ Persian wheel _____ Borewell _____

Thrasher _____ Mechanical fodder cutter _____

Sugar cane crusher _____ Other (specify) _____

5. Economic Status

House owned: Yes / No

Land owned: Cultivatable

	kub / pub / ki / a
Rented in	
Rented out	
Sharecropped in	
Sharecropped out	

Income from other than one's own land

Source	Cash	Kind	
			D / M / Y
			D / M / Y
			D / M / Y

Total income _____ D / M / Y

APPENDIX II

FAMILY WEALTH INDEX

House walls: Brick = 20 Mixed = 15 Mud = 10

House floor: Paved = 10 Mixed = 6 Dung = 2

House roof: Brick = 20 Mixed = 17 Thatched = 15

Rooms: 20 per room

Electricity: Yes = 12 No = 0

multiply by $\frac{1}{2}$ if house is not owned

Animals: Ox = 5 Cow = 3 Buffalo = 5

Camel = 5 Other = 1

Source of drinking water: Open well = 2 Hand pump = 10

Source of water for other uses: Open well = 2 Hand pump = 10

multiply by: ownership = 1 part ownership = 2/ not owned = 1/3

Possessions: Bicycle = 2 Radio = 1 Sewing machine = 2

Cart = 5 Persian wheel = 10 Bore well = 50

Thrasher = 20 Mechanical fodder cutter = 10

Fodder cutter = 2 Sugar cane crusher = 5

Land owned: Acre = 40 Kucha Bigha = 8 Pucca Bigha = 4 Kila = 32

Income from other than family-owned land: Divide annual income in rupees by 140

APPENDIX III

PER CAPITA INCOME GROUP BREAKDOWNS AND FREQUENCY DISTRIBUTIONS

Table III-1 Tabular Profile of Male Children by Per Capita Income Groups

	Monthly per capita income				
	Rs. 24 and below (Jats=6.3% Ramdasias=81.3%)	Rs. 25-39 (Jats=22.0% Ramdasias=47.5%)	Rs. 40-50 (Jats=55.6% Ramdasias=27.8%)	Rs. 51-75 (Jats=52.1% Ramdasias=25%)	Rs. 76 and above (Jats=75.5% Ramdasias=7.5%)
Number of cases	48	59	54	48	53
Average percent reference weight for age	77.7**	79.6	83.2	83.3	84.4
Average percent reference height for age	93.7**	93.4	94.9	95.2	95.9
Average percent reference weight for height	86.5**	88.7	90.0	89.5	89.8
Average percent of caloric allowance	62.3	55.0	63.6	68.3	66.8
Average percent of protein allowance	84.0	79.3	87.0	89.3	88.7
Average percent of vitamin A allowance	85.3	83.1	89.2	87.6	91.1
Average percent of iron allowance	36.3	32.3	34.6	38.8	37.2
Percent breast fed	85.4	89.8	81.5	79.2	81.1
Average daily supplementary milk consumption (gms)	191	124	182	234	223
Average daily cereal consumption (gms)	25	21	24	26	24
Average number of major diseases	1.17	1.00	0.89	0.65	1.09
Average diarrheal infection rating[a]	2.65**	2.17	1.85	1.46	1.28

** Significantly different from the "Rs. 76 and above" figure at the .95 level of statistical significance.
⌣ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.

Table III-2 Tabular Profile of Female Children by Per Capita Income Groups

	Monthly per capita income				
	Rs. 24 and below (Jats=7.5% Ramdasias=77.4%)	Rs. 25-39 (Jats=25.5% Ramdasias=52.7%)	Rs. 40-50 (Jats=45.0% Ramdasias=27.5%)	Rs. 51-75 (Jats=60.0% Ramdasias=24.4%)	Rs. 76 and above (Jats=82.9% Ramdasias=9.8%)
Number of cases	53	55	40	45	41
Average percent reference weight for age	69.5	69.2	71.2	74.2	71.8
Average percent reference height for age	90.1	90.1	90.9	91.5	91.3
Average percent reference weight for height	84.3	83.2	83.7	86.7	84.7
Average percent of caloric allowance	53.2**	60.4	55.3	63.6	66.4
Average percent of protein allowance	77.4**	86.9	85.8	85.6	91.2
Average percent of vitamin A allowance	82.5	79.0	77.6	87.9	84.8
Average percent of iron allowance	34.1	39.7	42.3	35.1	38.6
Percent breast fed	88.7	69.1	65.0	82.2	75.6
Average daily supplementary milk consumption (gms)	116**	188	156	216	247
Average daily cereal consumption (gms)	25	28	33	28	27
Average number of major diseases	0.91	0.98	0.78	0.64	0.68
Average diarrheal infection rating[a]	2.36	2.44	1.70	1.49	2.49

**Significantly different from the "Rs. 76 and above" figure at the .95 level of statistical significance.
⌣ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.

Table III-3 Tabular Profile of All Sample Children by Per Capita Income Groups

	Monthly per capita income				
	Rs. 24 and below (Jats=6.9% Ramdasias=79.2%)	Rs. 25-39 (Jats=23.7% Ramdasias=50%)	Rs. 40-50 (Jats=51% Ramdasias=27.7%)	Rs. 51-75 (Jats=55.9% Ramdasias=24.7%)	Rs. 76 and above (Jats=78.7% Ramdasias=8.5%)
Number of cases	101	114	94	93	94
Average percent reference weight for age	73.4**	74.6	78.1	78.9	78.9
Average percent reference height for age	91.8**	91.8	93.3	93.4	93.9
Average percent reference weight for height	85.3	86.0	87.3	88.2	87.6
Average percent of caloric allowance	57.6**	57.6	60.0	66.0	66.6
Average percent of protein allowance	80.5**	83.0	86.5	87.5	89.8
Average percent of vitamin A allowance	83.8	81.1	84.2	87.7	88.3
Average percent of iron allowance	35.1	35.9	37.9	37.0	37.8
Percent breast fed	87.1	79.8	74.5	80.6	78.7
Average daily supplementary milk consumption (gms)	151**	155	171	225	233
Average daily cereal consumption (gms)	25	24	27	27	26
Average number of major diseases	1.03	0.99	0.84	0.65	0.92
Average diarrheal infection rating[a]	2.50**	2.30	1.79	1.47	1.81
Average mother's beliefs index rating[b]	2.27	2.41	2.43	2.46	2.55

** Significantly different from the "Rs. 76 and above" figure at the .95 level of statistical significance.
⌣ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.
b/ 4 = beliefs beneficial to child's health; 1 = beliefs detrimental to child's health.

Table III-4 Tabular Profile of Lower and Upper Per Capita Income Groups by Sex

	Monthly per capita income					
	Males		Females		All Children	
	Rs. 39 and below (Jats=15.0% Ramdasias=62.6%)	Rs. 51 and above (Jats=64.4% Ramdasias=15.8%)	Rs. 39 and below (Jats=16.7% Ramdasias=64.8%)	Rs. 51 and above (Jats=70.9% Ramdasias=17.4%)	Rs. 39 and below (Jats=15.8% Ramdasias=63.7%)	Rs. 51 and above (Jats=67.4% Ramdasias=16.6%)
Number of cases	107	101	108	86	215	187
Average percent reference weight for age	78.7	83.9	69.4	73.1	74.0	78.9
Average percent reference height for age	93.5	95.6	90.1	91.4	91.8	93.7
Average percent reference weight for height	87.7	89.7	83.7	85.7	85.7	87.9
Average percent of caloric allowance	58.3	67.5	56.9	64.9	57.6	66.3
Average percent of protein allowance	81.4	89.0	82.2	88.3	81.8	88.6
Average percent of vitamin A allowance	84.1	89.4	80.7	86.4	82.4	88.0
Average percent of iron allowance	34.1	38.0	36.9	36.8	35.5	37.4
Percent breast fed	87.9	80.2	78.7	79.1	83.3	79.7
Average daily supplementary milk consumption (gms)	154	228	153	231	153	229
Average daily cereal consumption (gms)	23	25	27	28	25	26
Average number of major diseases	1.08	0.88	0.94	0.66	1.01	0.78
Average diarrheal infection rating[a]	2.38	1.40	2.40	1.97	2.39	1.64
Average mother's beliefs index rating[b]	-	-	-	-	2.34	2.50

~ Indicates figures significantly different at the .95 level of statistical significance.

a/ 7 = high frequency and severity; 0 = low frequency and severity.

b/ 4 = beliefs beneficial to child's health; 1 = beliefs detrimental to child's health.

Table III-5 Frequency Distribution of Gomez Classification Groupings by Per Capita Income and Sex

Per capita monthly income	Percent normal (over 90% of "Harvard" reference weight for age)	Percent with 1st degree malnutrition (76-90%)	Percent with 2nd degree malnutrition (60-75%)	Percent with 3rd degree malnutrition (below 60%)
		ALL CHILDREN		
Rs. 24 and below	9.7	29.1	51.5	9.7
Rs. 25 - 39	11.6	33.0	41.1	14.3
Rs. 40 - 50	18.1	38.3	35.1	8.5
Rs. 51 - 75	16.1	44.1	35.5	4.3
Rs. 76 and above	19.1	35.1	43.6	2.1
		MALES		
Rs. 24 and below	14.0	40.0	42.0	4.0
Rs. 25 - 39	14.0	47.4	36.8	1.8
Rs. 40 - 50	30.2	41.5	24.5	3.8
Rs. 51 - 75	25.0	50.0	25.0	0
Rs. 76 and above	30.2	43.4	26.4	0
		FEMALES		
Rs. 24 and below	5.7	18.9	60.4	15.1
Rs. 25 - 39	9.1	18.2	45.5	27.3
Rs. 40 - 50	2.4	34.1	48.8	14.6
Rs. 51 - 75	6.7	37.8	46.7	8.9
Rs. 76 and above	4.9	24.4	65.9	4.9

Table III-6 Frequency Distribution of Gomez Classification Groupings for Lower and Upper Per Capita Income Groups by Sex

Per capita monthly income	Percent normal (over 90% of "Harvard" reference weight for age)	Percent with 1st degree malnutrition (76-90%)	Percent with 2nd degree malnutrition (60-75%)	Percent with 3rd degree malnutrition (below 60%)
		ALL CHILDREN		
Rs. 39 and below	10.7	31.2	46.0	12.1
Rs. 51 and above	16.6	39.6	39.6	3.2
		MALES		
Rs. 39 and below	14.0	43.9	39.3	2.8
Rs. 51 and above	27.7	46.5	25.7	0
		FEMALES		
Rs. 39 and below	7.4	18.5	52.8	21.3
Rs. 51 and above	5.8	31.4	55.8	7.0

Table III-7 Frequency Distribution of Percentage Caloric Intake Allowance by Per Capita Income and Sex

Per capita monthly income	Percentage ingesting 76 - 100% of allowance	Percentage ingesting 59 - 75% of allowance	Percentage ingesting 46 - 58% of allowance	Percentage ingesting 45% of allowance and below
		ALL CHILDREN		
Rs. 24 and below	17.5	23.3	32.0	27.2
Rs. 25 - 39	14.9	27.2	30.7	27.2
Rs. 40 - 50	15.2	35.9	28.3	20.7
Rs. 51 - 75	37.9	18.9	18.9	24.2
Rs. 76 and above	32.3	32.3	19.4	16.1
		MALES		
Rs. 24 and below	25.0	25.0	29.2	20.8
Rs. 25 - 39	13.6	20.3	32.2	33.9
Rs. 40 - 50	19.2	44.2	21.2	15.4
Rs. 51 - 75	41.7	22.9	14.6	20.8
Rs. 76 and above	30.2	35.8	22.6	11.3
		FEMALES		
Rs. 24 and below	10.9	21.8	34.6	32.7
Rs. 25 - 39	16.4	34.5	29.1	20.0
Rs. 40 - 50	10.0	25.0	37.5	27.5
Rs. 51 - 75	34.0	14.9	21.3	29.8
Rs. 76 and above	35.0	27.5	15.0	22.5

Table III-8 Frequency Distribution of Percentage Caloric Intake Allowance for Lower and Upper Per Capita Income Groups by Sex

Per capita monthly income	Percentage ingesting 76 - 100% of allowance	Percentage ingesting 59 - 75% of allowance	Percentage ingesting 46 - 58% of allowance	Percentage ingesting 45% of allowance and below
		ALL CHILDREN		
Rs. 39 and below	16.1	25.3	31.3	27.2
Rs. 51 and above	35.1	25.5	19.1	20.2
		MALES		
Rs. 39 and below	18.7	22.4	30.8	28.0
Rs. 51 and above	35.6	29.7	18.8	15.8
		FEMALES		
Rs. 39 and below	13.6	28.2	31.8	26.4
Rs. 51 and above	34.5	20.7	18.4	26.4

Table III-9 Frequency Distribution of Diarrheal Infection Groupings by Per Capita Income and Sex

Per capita monthly income	Percentage with low frequency and severity	Percentage with low-moderate frequency and severity	Percentage with high-moderate frequency and severity	Percentage with high frequency and severity
		ALL CHILDREN		
Rs. 24 and below	20.8	15.8	32.7	30.7
Rs. 25 - 39	22.8	21.1	24.6	31.6
Rs. 40 - 50	26.6	22.3	34.0	17.0
Rs. 51 - 75	40.9	19.4	25.8	14.0
Rs. 76 and above	28.7	23.4	28.7	19.2
		MALES		
Rs. 24 and below	16.7	14.6	37.5	31.3
Rs. 25 - 39	22.0	22.0	30.5	25.4
Rs. 40 - 50	27.8	18.5	33.3	20.4
Rs. 51 - 75	39.6	20.8	25.0	14.6
Rs. 76 and above	37.7	32.1	18.9	11.3
		FEMALES		
Rs. 24 and below	24.5	17.0	28.3	30.2
Rs. 25 - 39	23.6	20.0	18.2	38.2
Rs. 40 - 50	25.0	27.5	35.0	12.5
Rs. 51 - 75	42.2	17.8	26.7	13.3
Rs. 76 and above	17.1	12.2	41.5	29.3

Table III-10 Frequency Distribution of Diarrheal Infection Groupings for Lower and Upper Per Capita Income Groups by Sex

Per capita monthly income	Percentage with low frequency and severity	Percentage with low-moderate frequency and severity	Percentage with high-moderate frequency and severity	Percentage with high frequency and severity
		ALL CHILDREN		
Rs. 39 and below	21.9	18.6	28.4	31.2
Rs. 51 and above	34.8	21.4	27.3	16.6
		MALES		
Rs. 39 and below	19.6	18.7	33.6	28.0
Rs. 51 and above	38.6	26.7	21.8	12.9
		FEMALES		
Rs. 39 and below	24.1	18.5	23.2	34.3
Rs. 51 and above	30.2	15.1	33.7	20.9

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THE MORINDA EXPERIENCE

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Probably the primary factor contributing to the rapid and effective conduct of the field work was our good fortune in being able to work with Mrs. Gurdial Kaur, a highly skilled, remarkably dedicated medical paraprofessional holding the barely descriptive title of Lady Health Visitor in the Morinda area of Ropar District, Punjab. Clearly the future of Punjab's health depends far more on these women than on those much higher paid but largely irrelevant officials who, in the words of Solzhenitzen "preside over the inauguration of undertakings...and then reappear to officiate over their deaths or to crown their achievements."

With the help of Gurdial Kaur we were able not only to collect the information presented here, but also to provide certain health services

to the children in this critical age group. Although accurate accounting is difficult in the absence of an explicit evaluation we were able to get rid of, at least for a few months (but probably an important few months at that age), most of the giardia infection and also, surprisingly, bring about significant improvement in all but one case of frank marasmus.

If this study contributes anything to our knowledge of the malnutrition problem among young children, it is in large part because of the solid base of Punjab health and nutrition information painstakingly collected over the years by Johns Hopkins and Harvard Universities. Results of the Harvard work, to which I refer frequently in the text, have been published in The Khanna Study by Drs. John Wyon and John Gordon. I was fortunate in having Dr. Wyon's counsel both at the beginning and conclusion of the field work.

The Johns Hopkins work directed by Dr. Carl Taylor and the Department of International Health is being done at the Narangwal Rural Health Research Center in Ludhiana District of Punjab. It was the existence of their work which largely prompted my selection of Punjab and specifically Ropar District for the field work. The Johns Hopkins work at Narangwal has included the collection of large bodies of data, much of it longitudinal, as well as controlled studies on the effects of particular combinations of health, nutrition, and family planning interventions. Accordingly, rather than starting from scratch, I was able to begin the field work with as much accumulated knowledge and experience as the Johns Hopkins group could fill me with during my pre-field work visits. Similarly, they were extremely helpful in the analysis. Clearly the future of this kind of work depends on such cooperation within the academic community rather than the rivalries which often have characterized it in the past.

Among the Johns Hopkins group I worked most closely with Dr. Cecile DeSweemer who provided invaluable advice at every stage of the project. Dr. DeSweemer is a dedicated wealth of information whose knowledge of the Punjab is surpassed only by her love for it.

A number of other individuals provided important counsel at various stages of the project, among them Dr. C. Gopalan, Director of the (Indian) National Institute of Nutrition; Dr. V. Ramalingaswami, Director of the All India Institute of Medical Sciences; Dr. Kalyan Bagchi, presently WHO Representative in Khartoum; Dr. R. Kalra of the Punjab Directorate of Health Services; Dr. Saroja of Lady Irwin College in New Delhi (whose students most kindly standardized my vessels for the 24-hour recall work); Dr. B. N. S. Walia, Director of the Pediatrics Department of the P.G.I.; and Dr. O. N. Bhakoo of that department. Counsel on the parasitology work was provided by Dr. Nevin Scrimshaw, Head of the Department of Nutrition and Food Science at M.I.T.

Helpful ideas along the way came from Mr. Alan Berg, Senior Fellow at the Brookings Institution. Some of the concepts discussed here emerged from our work together in India in the late 1960's.

A great deal of highly appreciated logistical support was extended to us by Mr. Charles Puttkammer and Messrs. Gurbax and Onkar Singh of the USAID Mission in New Delhi. That plus lots of care and encouragement were provided by my in-laws in Chandigarh and parents in Pittsburgh. I'm also grateful to Mrs. Doreen Doty who typed the dissertation and the drafts which preceded it.

I've saved Satinder Levinson for last because her contributions have been so special. She was up before sunrise for our trips to the villages, did much of the interviewing, and spent endless hours with me in data

compilation and card sorting. One of my lasting memories will be of the two of us checking columns of figures (in the true spirit of research) by flashlight during the blackout imposed by the Indo-Pakistan war. These are her people, and it is to her that this study is dedicated.

to Sati

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SUMMARY

Widespread recognition of the importance of combating malnutrition among young children in low income countries has increased the need for systematic planning to permit the development of effective strategies to deal with the problem. Such country or regional planning might be thought of as a three step process. The first assesses the dimensions and magnitude of the problem. Step two seeks to identify the relative importance of the determinants of malnutrition. Where malnutrition exists, how much of the problem is due to income levels or relative prices of important commodities, to what extent is parasitic infection a limiting factor, how important are belief patterns relating to health and nutrition? The final step then attempts, through some form of cost-benefit or cost-effectiveness analysis, to find the optimum means of affecting those determinants which prove most limiting.

This study addresses primarily the second step of the process through an analysis of 496 children in the critical 6-24 month age group, the period of highest malnutrition-related mortality and the time of origin for any mental debilitation which occurs among the survivors. The study was carried out in 17 villages in Ropar District of Punjab in Northern India surrounding the small market town of Morinda, an area on the periphery of, or in an early stage of the so-called "Green Revolution".

Using multiple regression analysis on cross section data the study attempts to identify the primary direct determinants of nutritional status and then, in turn, to examine these determinants in terms of a series of socioeconomic explanatory variables. Nutritional status was measured using anthropometric measures. Food intake was assessed using the 24-hour recall method, after which the foods consumed were translated into calories,

protein, vitamin A, and iron. Infection was measured by the child's disease history, the frequency and severity of his diarrheal infection, and by the extent of parasitic infection assessed through the laboratory analysis of stool samples. Belief patterns were measured on the basis of answers to a series of questions relating to optimum age of food supplementation, dietary response to infection, and the cause of a Punjabi language equivalent of nutritional marasmus. In addition to the above, basic social-demographic data was collected, and a stock (wealth) and flow (income) measure of economic status was estimated for the family of each child.*

The study found the extent of malnutrition among these children, in spite of their location on the outskirts of the Green Revolution, particularly serious--more serious than in most other parts of the low-income world. Almost half were suffering from 2nd or 3rd degree malnutrition using the Gomez classification.

With respect to food intake, the most serious deficiencies were of calories (average 61.3 percent of allowance) and iron (36.7 percent of allowance) although there may be some question regarding the validity of the caloric allowance. Protein deficiency is less serious and not a significant problem independent of the calorie one. Similarly vitamin A deficiencies do not appear as serious as in other parts of India. In terms of infection, diarrhea proved considerably more important for children of this age than either their disease history or giardia (the only parasite-like infection found in this population).

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* A more detailed summary of the analytical results of the study is found at the beginning of Chapter 6.

Variation in nutritional status among the young children was explained both by differences in their caloric intake and the extent of their diarrheal infection. Variation also was explained by three other variables:

a. Age - From about the age of 6 months, as breast feeding alone becomes inadequate and with the onset of the syndrome of weanling diarrhea, children begin to depart sharply from the standards.

b. Sex - The much higher premium placed on living sons in this society is reflected in the better care and attention devoted to them, particularly at the low end of the economic spectrum.

c. Such non-quantified factors as pre-natal environment, demand vs. opportunity breast feeding, and the psychological effect of a mother's presence, all of which would be closely related to economic status.

The determinants of caloric intake and diarrheal infection, and hence the means of addressing them differ significantly between children of Jat (landowning) and Ramdasia (landless agricultural laborer) families. While malnutrition exists in both groups the most critically affected are the Ramdasias. For the Jats, the most important determinant of food intake is belief patterns suggesting that an information dissemination program addressing these beliefs could well prove an effective intervention. Among the Ramdasias, estimation of the determinants of both caloric intake and diarrheal infection suggests that the factor most critically inhibiting improvement in their nutritional status is income. The income problem relates both to the availability of resources and to the mother's time. For the Ramdasia woman, required by economic necessity to spend a major portion of the day working outside of her home, the adequate care of a young child is seriously problematic. If the child is a girl, the case is that much more serious.

In terms of interventions, it is likely that the Jat child will derive higher benefits from virtually any intervention program than will the Ramdasia. For the Jat woman, most of the preconditions would seem to be met for the effective translation of her income and time into improved health for her children once the facilities to permit such translation (education, programs, health clinics, or other interventions) are established. For the Ramdasia, largely bypassed by the development process, these preconditions generally have not been met.

To positively affect the nutritional status of Jat children a program of information dissemination related to child care and feeding probably would be the single most important intervention. Such information dissemination might be facilitated by a weaning food distribution which, in turn, could strengthen the outlets selected for such distribution, among them family planning institutions. For the Ramdasias, a substantial improvement in their economic position appears to be a prerequisite for viable improvement in the nutritional status of their children. Only when this basic income constraint is overcome, are these children likely to be able to derive significant benefits from specifically nutrition intervention programs. Such economic betterment, in turn, probably requires rather basic changes in social and political organization through which the poor can restructure and more fully avail themselves of the opportunities inherent in the development process.

CHAPTER 1

INTRODUCTION AND PERSPECTIVE

The planning and implementation of programs to combat malnutrition in low income countries is, at best, a complex undertaking. Perhaps nowhere else in the development process does an area of undertaking cut across so many disciplines, so much subject matter. Further, given the relative infancy of international concern with the subject, we lack precision in identifying and quantifying the developmental benefits of better nutrition and hence effectively bidding for scarce resources. Finally, while there are widely differing schools of thought on the segment of the population to address, the best means of reaching it and the cost, there is remarkably little empiricism on any of this. These problems coupled with what often seem to be the unmanageable dimensions of the problem, not only have complicated the nutrition planning process but also, undoubtedly, have served as a deterrent to major investment in this area.

Nonetheless, malnutrition is becoming a matter of increasing concern in low income countries both as a major source of mortality and sickness, and as a serious drain on developmental efforts to achieve human resource potential. The mortality rate among children aged one to four in low income countries ranges from roughly 20 to 80 times higher than in industrialized ones (11,57). Probably over half of the deaths in this age group could be considered malnutrition-related. FAO contends that "malnutrition is the biggest single contributor to child mortality in the developing countries" (22). Berg has compiled Latin American data indicating that malnutrition is an underlying or associated cause of between 52 and 70 percent of all deaths between the ages of one and four (11).

Further, those malnourished children who survive may be physically and mentally debilitated, perhaps irreparably.

On purely humanitarian grounds the case would appear sufficiently convincing. Yet, in the context of scarce budgetary resources, and in competition even with advocates of solutions to other human needs (insufficient food on a macro level, communicable diseases, and inadequate shelter), the humanitarian case for combatting malnutrition has not fared particularly well. As a result, the nutrition advocate during the past decade has begun to examine the developmental implications of malnutrition. He has begun to examine the hypothesis that malnutrition-caused mental and physical debilitation may limit the utilization of a country's existing educational capacity and adversely affect productivity. He also has advanced an argument suggesting that high child mortality rates, in large part a function of malnutrition, provide a disincentive for social security-conscious parents to practice family planning.

More recently, advocates of these positions have been joined by critics of the overall patterns of development which have emerged in low income countries during the past few decades. These critics note that investment-oriented development programs in many of these countries essentially have excluded major segments of their populations and that concerns with income distribution and employment, though frequently voiced, seldom have been addressed explicitly. Consequences have been both economic (un- and underemployment probably representing the first limiting factor in the development process in many countries) and political (disruptive violence being a natural outgrowth of major income differentials and large scale unemployment). The equity problems inherent in these patterns of development often are reflected in widespread malnutrition. Conversely, nutrition

intervention emerges as a meaningful, attractive and visible component of broader strategies designed to reorient these development processes.

Thus, not withstanding the difficulties, the development of strategies to combat malnutrition is likely to become an increasingly important pursuit of planning commissions in low income countries.

It has been suggested elsewhere (15) that the nutrition planning process basically involves a threefold investigation. The first level involves identification in a particular geographic area of the nutrition problem in terms of food availability and intake, and in terms of physical, clinical and biochemical measurements. This first step in the analysis also should provide at least a general idea of the population target group to be addressed.

All too often the process of investigation ends with this first step after which program decisions are made according to the interests of existing administrative and technical entities. Further levels of analysis are clearly necessary, however, to provide some basis for rational investment decisions. A second level of the investigation would identify the determinants or causal factors of malnutrition among a target group, while a third level would attempt, through cost-effectiveness analysis, to find the optimum means of positively affecting these determinants.

This study is concerned primarily with the second level of the investigation: identification of the determinants of nutritional status or health and their relative importance. The phrasing of the sentence poses the thorny conceptual problem arising here; namely the question of whether we are dealing with nutritional status or with health. At first glance it may appear that the types of measurements used to quantify so-called "nutritional status" (i.e., clinical, biochemical or, as in this

study, anthropometric measurements) are actually measures not only of nutrition but also of diarrheal and parasitic infection and the individual's disease history. This would seem to suggest that, at least for the young child, such measures are in reality a measure of overall health.

Looked at another way, however, it could be argued that the health of an individual is a complex set of highly interrelated constituent elements including mental health, disease and nutritional status. In such a context nutritional status would not be defined simply as a measure of food intake, but rather as the extent to which food constituents are physiologically absorbed or utilized. The extent of this absorption will depend significantly on the presence or absence of infection and disease as well as on the food consumed. Clinical, biochemical and anthropometric measures serve to quantify this nutritional status variable as thus defined (although, in some cases, such measures for a young child might also serve as a reasonable proxy for his overall health). Using such a conceptualization, infection and disease, aside from their effects on the nutritional status component of health, are independent components of health in their own right along with numerous other health components which have little or no effect on nutritional status. A child contracting diarrheal infection today could not be considered in good health even though the infection has not yet affected his nutritional status as defined here.

The case for isolating this nutritional status component of overall health for analysis is twofold. First, there is reason to believe, at least in low income countries, that the nutritional status component of health among young children is the most important component of overall health status, often more important than the others combined, and a major

determinant of the severity of virtually all the others. Second, there is the more practical consideration that while ideally the nutritional status component might best be addressed as part of an overall health approach (in the same way that inadequate food, housing and education might best be jointly addressed as manifestations of poverty in industrialized nations), there is little evidence this is happening or that it will happen on the scale required.[1/] To date the vast majority of health directed efforts in these countries have been medical, usually curative, in nature. In part it was the success of these measures which pointed up the vital, but relatively untouched matter of nutritional status. The medical groups quantified the magnitude of the problem but seldom addressed it, in large part because the interventions called for usually were non-medical. It soon became evident that if this problem were to be addressed -- and its dimensions and implications demanded it -- the problem would have to be addressed by a group other than the traditional medically-oriented one and with a very different set of tools. Thus, the analysis in this study is designed not so much for the medical or public health professions per se (although there is major overlap into the public health field) as for this new group attempting to address nutritional status specifically.

Nutritional status will be examined through a micro study designed to estimate the primary determinants and where possible their interaction for a particular population group. The study rests on the assumptions that, (1) malnutrition has negative effects on economic growth and social

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1/ Interestingly, one of the few places where this is being done is at Narangwal by the Rural Health Research Center (RHRC) whose work is discussed throughout this study.

well-being, and (2) combatting this problem has some valid claim on the budgetary resources of the area. The seriousness of the malnutrition will speak for itself.

Not actually part of the second level of investigation, but necessary for its undertaking is a determination of the target group to be addressed. Cases can and have been made for different groups depending on the circumstances. The target group in a highly labor intensive economy that is not labor surplus could be the adult working populace, particularly with respect to its caloric deficiency. Alternatively, in situations of food scarcity coupled with high fertility rates, the primary problem might be maternal malnutrition, perhaps reflected in a high proportion of low birthweight infants. In most low income countries, however, the primary nutritional target should be the preschool age child. Both the mental debilitation and family planning motivation arguments noted earlier suggest the preschool age child as the target. Similarly the equity argument would have sympathy with a concentration on this group as a highly meaningful and visible object of concern.[2/] More specifically, these arguments probably point to the child between 6 and 24 months of age. Studies of mental growth indicate that malnutrition-caused debilitation, where it occurs, traces back to this critical 18 month period. Similarly, Wyon and Gordon's findings in India (66) add further empirical evidence that the major bulk of preschool age, malnutrition-related mortality occurs within this age period. Their study, conducted in Ludhiana District of Punjab, found a

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2/ One must assure, however, that these visible kinds of intervention accompany and not substitute for change in existing patterns of development. Otherwise they will represent nothing but a palliative, and probably have the effect of delaying the day of reckoning on the larger issue.

particularly high mortality rate during the first month of age (averaging between 70 and 80 deaths of liveborn children per 1000 live births) resulting largely from birth-associated difficulties or diseases such as tetanus. During the next four months, the mortality rate decreased to about 30 deaths per 1000 live births. Between 6 and 11 months, with the onset of more severe malnutrition and weanling diarrhea, the mortality rate increased sharply to 50 for males and close to 70 for females per 1000. The rate remained almost as high for the 12-17 month age group, then began to drop regularly with age. The 24-29 month age group had a mortality rate of only about 10 per 1000. In terms at least of the hypothesized developmental returns on nutrition investment then, this 6-24 month age group would appear to constitute the primary target. On this basis it has been selected as the age group addressed in the micro study.

The following chapter presents a general discussion of the determinants usually believed to affect the nutritional status of the target group. Chapter 3 presents the methodology utilized in examining these determinants in the micro study, and Chapters 4 and 5 examine the results found. Chapter 6 presents conclusions and a discussion of appropriate interventions.

CHAPTER 2

THE DETERMINANTS OF NUTRITIONAL STATUS

This chapter provides a brief, general examination of those determinants usually believed to affect the nutritional status of young children. The following chapters will examine the extent to which these factors are in fact important determinants for children in the micro study. The discussion here is limited to those factors which, unlike religion or genetic traits, lend themselves to intervention.

Conceptually, these determinants might be classified into direct and indirect factors. Basically, the nutritional status of a child is determined by (1) his food intake, and (2) the presence or absence of disease and infection, the direct determinants. These two, in turn, are functions of such factors as family purchasing power (involving income, commodity prices and the cost of other demands on a family budget), the nutrition and health beliefs of the child's mother, the nutritional content of the foods consumed, the presence or absence of health care and non-family feeding programs, plus numerous environmental and social phenomena. These determinants presented diagramatically in Figure 1 are considered separately below.

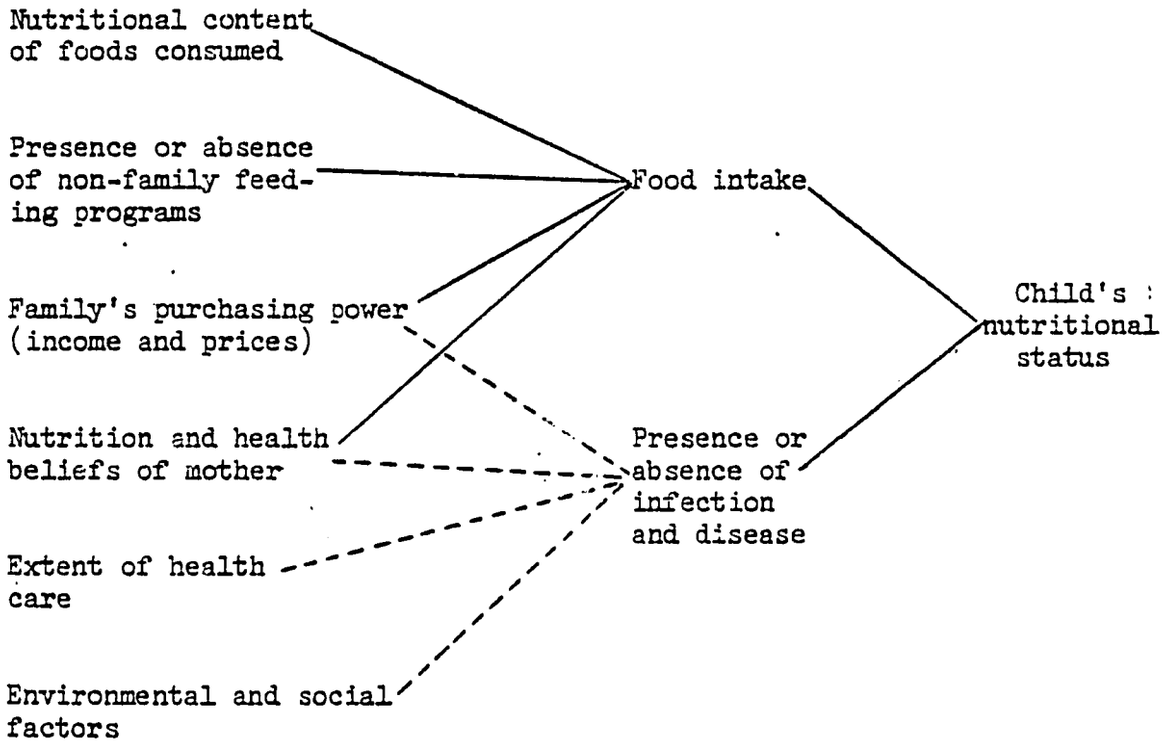
Family Purchasing Power

A family's purchasing power depends basically on (1) its wealth and income position, (2) the relative prices of food commodities it buys, and (3) the cost of other demands on its budget, particularly necessities that require cash. Thus, at least conceptually, increasing a family's purchasing power or real income for nutritional purposes can be accomplished by augmenting income flows to the family, by reducing the prices

of food it consumes, or by subsidizing its other budgetary necessities, i.e. housing, schooling, health, or clothing, thereby releasing additional funds for food purchase. The third approach suggests that existing government financing of education, health centers, and low-cost housing provides a secondary benefit to food consumption and hence nutrition.

Income and prices, the primary components of purchasing power, are discussed separately below and in the ensuing discussion.

Figure 1. DETERMINANTS OF A CHILD'S NUTRITIONAL STATUS



Income: Probably no other single factor has so major an effect on the components of nutritional status for the population as a whole in low income countries as income. Examination of cross section food consumption data in these countries (21) reveals highly significant differences in food consumption patterns along the income spectrum. Three

trends appear to be almost universal, none of which is particularly surprising. The first, commonly referred to as Engel's law, finds that as income rises the percentage of that income allocated to food declines but that absolute expenditures rise.[1/] A second trend is that the proportion of total calories supplied by carbohydrate staples (cereals and tubers) decreases and is replaced by more expensive animal or vegetable commodities as income increases (8). A third trend is that within food groups there is a shift toward processed, more expensive items and varieties.

In nutritional terms the third trend, usually involving payment for various marketing services, may have a negative effect. The literature abounds with examples of shifts from brown rice to polished rice, high extraction to low extraction flour, and cane to refined sugar as income increases (9). On balance, processed foods in general probably represent a nutritional minus where lost nutrients are not restored.

In terms of overall nutritional effect, however, these negative effects of income are entirely outweighed by the positive effects of the first and second trends. While part of the increase in absolute expenditure suggested by the first trend results in the purchase of more expensive items, the increase will almost invariably result in the ingestion of more food, hence more calories, thereby overcoming a major, often limiting, nutritional obstacle (23). In surveys that have examined caloric intake explicitly, a clearly positive linear relationship of calories with income emerges (53).

1/ The exception lies with the lowest income groups in most countries. Though the percentage of their incomes spent on food is quite high (60 to 80 percent) the absolute expenditures are still so low that the first income increments usually result in a still higher percentage spent on food.

While the amount of food consumed increases with income, so does the variety as suggested by the second trend. Diets based on cereals, plantains, roots or tubers gradually become more diversified, and legumes, fruits and vegetables, milk, and other sources of animal protein become more important in terms of total calories. With reference to some foods, notably legumes, consumption increases with the first income increments and then levels off. More often, however, consumption of nutritious foods increases more or less linearly along the income spectrum. Monthly family expenditures on milk, for example, increase 50-fold from the lowest to the highest income groups in India (as compared with an 8-fold increase in cereal expenditures) (31). These differences are best reflected in income elasticities of demand[2/] for the commodities. In general, the more nutritious items are those with the highest elasticities (although there is no evidence whatever that the relationship is causal). In Asia and the Far East (excluding Japan) the elasticities of vegetables, meat and eggs are estimated at 0.9, 1.5, and 2.0 respectively, while the elasticity of cereals is 0.5. In the Near East, Africa, and Latin America the elasticities are somewhat lower but in almost the same proportions[3/] (20).

While for the population as a whole increases in income almost automatically are translated into larger quantities and a higher quality of food and hence improved nutritional status, the relationship for the target

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2/ The percentage increase in consumption of a food as income increases by 1 percent. Thus consumption of a food with an income elasticity of demand of .6 will increase by 0.6 percent as income increases by 1 percent.

3/ As a rule, these elasticities decrease as income increases and tend to be higher in rural than in urban areas (48).

6 to 24 month old population is less clear. Although prior studies focusing exclusively on this target group have been few and those rarely income specific, it has been suggested (66) that even in cases where available food is adequate to meet the young child's requirements, his difficulty in digesting and absorbing solid adult foods (preparation of specific foods for children among lower income groups in these countries is a rarity) often results in solid foods being withheld.

Commodity prices: Income is, of course, a relative concept, which takes on a specific meaning only in the context of its inherent purchasing power. This depends on food prices which, together with income, clearly affect the consumer's purchases and hence the child's diet. While some might argue that availability should be included here along with price, availability is actually built into the price concept since any existing item becomes available at some price. In the case of "on the farm" consumption of goods that never reach the market, the "price" of the item becomes its imputed value or opportunity cost; in other words the amount of money the family "sacrifices" by not selling the item. Basically price is a function of the supply of and the demand for particular commodities and of their transfer costs.

Nutritional Content of Food Commodities

A family's income and the prices of food commodities, to a significant extent, will dictate the amount of particular commodities purchased. The child's nutritional status then will depend in large part on the nutritional content of these commodities. Frequently the commodity itself implies a certain nutritional value although differences within commodity groups or even among varieties of a given commodity can be significant. The food's nutritional content might also be affected by ecological

factors or by processing between points of production and consumption.

Traditions and Beliefs

Almost regardless of the aforementioned factors, food consumption always has been based to an extent on preconceived beliefs relating to foods and their functions and on traditional preparation and consumption practices. In some cases these beliefs and processes have obvious validity relating to the health value of the item. In others the practice may support a basic cultural tenet of the population group and thus be equally valid (16,47). In still other cases, in both non-industrialized and industrialized countries, where such validity cannot be ascertained, these practices have been, rightly or wrongly, attributed to ignorance.

Practices relating to the feeding of young children have been under particular surveillance in recent years. Two such practices emerge as being notably significant. The first involves the critical period of weaning where problems are numerous. In some cases breast feeding continues well beyond six months but without supplementation. Elsewhere the milk is supplemented but with foods low in essential nutrients. Where more nutritious items are explicitly withheld, they sometimes reflect underlying association of these items with intestinal parasites or diarrhea. When weanling diarrhea does occur, any protein rich foods that were consumed are often withheld or solid foods are withheld altogether, a practice that further exacerbates the problem.

To some these practices simply reflect ignorance. Probably more accurate is Wyon and Gordon's contention that behavior is based on empirical experience. In many cases a mother recognizing the increased incidence of diarrheal infection when supplemental foods are given and recognizing the incidence of mortality from the infection, makes a

conscious, seemingly sensible decision to withhold such foods. What she will fail to recognize, largely because it is so undramatic, is the much higher mortality rate resulting from protein-calorie malnutrition and the child's inability to resist infection when supplemental foods are withheld (66).

The preceding set of practices or malpractices are usually attributed to tradition. Yet tradition is not always the culprit. Frequently problems arise as a direct result of abandoning traditions, often as a result of direct exposure to more industrialized regions. The prime example is the cessation of breast feeding in several parts of the low income world. Substituted is higher priced commercially bottled milk or powdered concentrate. All too often the higher price results in the use of inadequate quantities. Just as often the concentrate is reconstituted with unclean water. In either case the nutritional and health consequences are serious (35).

Infection and Disease

Even if the right foods are available to the child, they may not have their full effect upon his nutritional status if he suffers from other health problems, particularly gastrointestinal infection. Such infection can lower nutritional status or precipitate malnutrition in several ways. It can reduce food intake through loss of appetite. It results in loss of nitrogen, hence requiring increased protein consumption thereafter. Where the infection is the result of intestinal parasites, such as hookworm, the blood loss from the intestinal tract frequently leads to anemia. Finally, where the infection causes diarrhea, absorption of nutrients in the intestine will be reduced. Where protein levels already are low, diarrheal disease can precipitate kwashiorkor

(40,58). In addition, it has been well established that common childhood diseases like measles can have a drastic effect, either precipitating severe malnutrition or having a much higher degree of severity in the chronically underfed child.

The child also may be affected by the nutritional status of his mother during pregnancy and lactation, although findings here are less clear. In general, the quality of breast milk, with the exception of its thiamine content, does not appear to be affected significantly by the mother's nutritional status. However, in times of severe food shortage the quantity of milk secreted might be reduced.

Non-Family Feeding

In much of the world the preceding five factors are the primary determinants of a target group's nutritional status. For increasing numbers of children in many countries, however, there is a sixth determinant in the form of food received outside the home. In most cases such feeding represents a government initiative, at times supported with international assistance. Such feeding may appear to be more an intervention than a determinant, but its widespread prevalence at present probably qualifies it for the latter category as well.

The micro study presented in the following chapters looks at food intake, infection and disease, income and wealth, and beliefs as the primary categories of determinants. Given the cross sectional, geographically concentrated nature of the study, there was no variation in commodity prices or in the nutritional content of foods, hence these variables could not be examined. Non-family feeding also was eliminated as a variable since no program aimed at this group presently exists in

this area. Of course, the inability to quantify the effects of these variables by no means eliminates them as appropriate for intervention, and we accordingly shall return to them in the final chapter.

Although less easily affected the study also looks at family size, caste and sex to ascertain their importance relative to the other determinants.

CHAPTER 3

METHODOLOGY

The Study Objective and Research Design

The micro study was designed to identify the actual importance of the variables discussed in the preceding chapter as determinants of nutritional status among a group of children aged 6 to 24 months in rural North India. To carry out such an analysis it was proposed to collect, from a rather large sample of children of this age, information on various measures of nutritional status and on a wide range of potentially direct and indirect determinants of such status, to quantify these variables, and to examine their relationship through so-called ordinary least squares multiple regression analysis.

The general model originally envisaged for this analysis closely resembles the diagram in Figure 1 and will be elucidated further in Chapter 5. In the first equation, nutritional intake and infection are expressed as determinants of nutritional status. In the second and third equations, nutritional intake and infection become dependent variables explained by a series of socioeconomic variables plus each other. This would give us the following three equation model:

Nutritional Status = f (Nutritional intake, Infection)

Nutritional Intake = f (Economic status, Family size, Sex, Caste, Mother's beliefs, Infection)

Infection = f (Economic status, Family size, Sex, Caste, Mother's beliefs, Nutritional intake)

The use of cross sectional data such as that used in this study presents problems which should be noted at the outset. First, there is the

implicit assumption that Group A with less income or intake (or anything else) will behave like Group B with more income or intake when, sometime in the future, Group A achieves the same income or intake levels that Group B enjoys today. In a context of rapid technological change, increasing options on expenditures, improved marketing facilities increasing the amount and variety of available foods, and significant changes in relative prices, all of which exist in Punjab, this may be a questionable assumption. More basic are the problems of using point in time measures (of say intake or parasitic infection) to explain variations which have emerged over a life time (i.e. size of the child). In addition, variation among children is simply a less accurate indicator of any variable than variations in the individual child over time. Thus, attempts to use cross sectional data in such analysis, results in the explanation of considerably less of the variation in the dependent variable, or in statistical terms, lower R^2's.

Nonetheless the alternative to cross section information is the collection of time series data, assuming it doesn't presently exist, through longitudinal studies. As valuable as such studies are, they by definition take years to carry out; time which may not be available to the planner with a strict time constraint. This would suggest that although time series studies are vital for precision in estimating the effects of these variables, there may be value in sharpening the tools of cross section analysis to permit a more rapid approximation of these effects for use in the planning process.

Having identified the primary determinants of nutritional status, it was proposed to project the relevance of alternative interventions

utilizing to the extent possible a previously developed nutrition planning model. This discussion is contained in Chapter 6.

The Locale and Sample

The study was conducted in the Indian state of Punjab, long the breadbasket of Northern India and today a leading grain surplus area in South Asia. With a recent reorganization of North Indian states, Punjab today numbers roughly 15 million persons and is largely dominated by persons of the Sikh religion.[1/] The population of rural Punjab is divided into three main groups: the Jats, traditionally the land-owning class or caste and clearly the predominant group in terms of resources and power; the Ramdasias or landless agricultural laborers, most of them Hindu "outcastes" or as Gandhi called them, "Harijans" in recent generations; and a third, smaller group designated "Others" representing a broad array of "service occupations": shopkeepers, barbers and teachers, some of whom are Hindu. Economically this more heterogeneous group falls between the Jats and Ramdasias.

Although clearly leading the rest of India agriculturally, Punjab itself is geographically heterogeneous with resulting economic disparities. Ludhiana District in the central part of the State represents one end of the Punjab economic spectrum with highly concentrated technological change in agriculture and major investment in irrigation. On the other end of the spectrum lies Ropar District in Eastern Punjab, an area

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1/ A reformist offshoot of Hinduism in the 16th century, Sikhism evolved from a pacifist sect to a highly militant one under pressure from Moghul rulers. Largely devoid of complex Hindu ritual and mythology, Sikhism follows the teachings of ten Gurus or prophets and a holy book called the Guru Granth Sahib. Followers of Sikhism are clearly distinguished by their unshorn hair, turbans and steel bracelets.

demographically similar to Ludhiana but considerably behind in all agricultural production indices. These differences are clearly indicated in Table 1 which compares the two districts, Punjab State and India by several indices of agricultural development (wheat and corn yields) and innovation (irrigation and area under new seed varieties). In each case the Ludhiana figure lies well above the Punjab State average, while Ropar lies below it, and all three lie well above the All-India figures.

Table 1. Indices of Agricultural Output and Innovation for Ludhiana and Ropar Districts, Punjab State, and India[a]

Index	Ludhiana District	Ropar District	Punjab State	India
Wheat yield per acre (pounds)	2,712	1,717	1,998	1,076
Corn yield per acre (pounds)	1,892	1,103	1,294	862
Percentage of cultivated acreage irrigated	83.0	27.8	74.0	22.0
Number of tractors (1966)	1,625	140		
Percentage wheat cultivation area under high yielding varieties	86.1	43.6	68.6	18.0
Percentage corn cultivation area under high yielding varieties	12.3	3.2	9.7	3.0

a/Data compiled from Government of Punjab, Statistical Abstract of Punjab, 1970.

In order to permit eventual comparative analysis of these two ends of the spectrum, or of what might be called initial and advanced stages of the "Green Revolution", it was decided to carry out the study in Ropar District and subsequently to compare these findings with those of the

ongoing research of Johns Hopkins University at the Narangwal Rural Health Research Center (RHRC) in Ludhiana District.[2] The area chosen is a contiguous rural one surrounding and within a five mile radius of the small (population 9,000) market town of Morinda. The area includes 17 villages and a total population of roughly 13,000 persons.[3]

Rather than selecting a sample of children along some predetermined lines, it was decided to collect information on every available child in these villages from the age of 6 through 24 months. In total, information was collected on 523 children. With respect to coverage, the effort was between 90 and 95 percent effective. In each village there were a few cases of families out visiting maternal in-laws or mothers unwilling to participate in the study. For purposes of consistency the analysis was limited to 496 children for whom all information was available. The numerical breakdown of these children by caste and age group is as follows:

Caste:	Jats	209
	Ramdasias	194
	Others	93
	Total	496
Age:	6-11 months (6 month period)	163
	12-17 months (6 month period)	157
	18-24 months (7 month period)	176
	Total	496

2/ Some comparative analysis is contained in this study. More will be possible upon completion of the extensive data collection and analysis at Narangwal.

3/ Two villages, Bhateri and Himatpur, fall just over the border into neighboring Patiala District. Those in Ropar District are Badwali, Chaklan, Chitamla, Chitamli, Datarpur, Dhangrali, Doomsheri, Khant, Mankheri, Manpur, Marauli , Ramgarh Mandan, Rangian, Rattangarh-Kalheri, and Saheri. The average population per village was roughly 750 persons.

Much of the data was collected through an interview with the child's mother using the data collection form which is reproduced as Appendix I. These interviews conducted in Punjabi by the author, his wife, and Mrs. Gurdial Kaur, a locally posted paramedical extension agent, lasted approximately 30 minutes each. In addition, each child was weighed and measured, and a subsequent visit was made to collect a stool sample for laboratory analysis. This analysis was carried out by the Post Graduate Institute of Medical Research and Training in Chandigarh, the capital city of Punjab.

In the sections below, the variables examined in this study are presented, and the means of collecting and quantifying them are discussed. The actual findings are presented in the following chapter.

Nutritional Status

Nutritional status as defined and discussed in Chapter 1 is estimated using anthropometric measures. Although, ideally, one might desire clinical and biochemical measures as well, neither were feasible given the nature and time frame of the research. Nonetheless, the anthropometric measures probably provide the best single means of assessing the extent and, more important, gradations of protein-calorie malnutrition. There seems to be general agreement on the reliability and importance of growth, the variable actually measured over time by anthropometry, as an index of nutritional status (33). Growth also has been considered "the severest test of nutritional sufficiency" (26).

Nutritional status was assessed through the weight and height information collected for each child. These individual weights and heights then were compared with the so-called "Harvard Standards" (62). Although on the surface U. S. references might appear inapplicable for children

in low income countries, there is in fact considerable validity in their use. Comparative analysis seems to indicate clearly that the growth of healthy children in low income countries, at least in the early years, closely approximates these U. S. standards, thus ruling out the likelihood of significant genetic differentials biasing the use of such standards. Jelliffe (34) reports evidence from many parts of the world to the effect that well nourished infants and preschool age children attain at least weight levels closely approximating these standards. Jackson (33) found these same similarities by superimposing on U. S. growth curves the growth patterns of normal children from different countries. On the basis of surveys in seventeen low income countries conducted by the U. S. Interdepartmental Committee on Nutrition for National Defense (ICNND), Woodruff states that "infants and preschool children in most areas of the world have growth characteristics that are nearly the same under optimal environmental conditions. Racial and genetic factors probably play only a small part in the relative growth failure in many of the populations studied" (65).[4/]

Weights and heights were compared with the Harvard Standards[5/] by three parameters:

4/ None of this, however, negates the value of preparing reference growth curves for specific ethnic groups. Such caste and sex-specific standards for the Punjab currently are being prepared by Dr. DeSweemer of the Johns Hopkins Department of International Health and will be a valuable aid in all future endeavors of this kind.

5/ Like most studies of this kind, including that of Johns Hopkins at Narangwal, this study uses the Harvard Standards as presented in the WHO monograph on the Assessment of Nutritional Status of the Community (34) which, for young children, pools the sexes. The validity of such a procedure lies in the absence of significant male-female differences in the Harvard Standards for this age group. At no point do sex-specific weight references differ from the uniform standard by more than four-tenths of a pound or one-fifth of an inch.

weight for age: the weight of the child as a percentage of the reference weight for children of his age

height for age: the height of the child as a percentage of the reference height for children of his age

weight for height: the weight of the child as a percentage of the reference weight for children of his height.

In addition, recognizing the limitations of using any one of the above as a single measure of nutritional status, four other indices arbitrarily were constructed using combinations of these parameters. These indices are defined below:

Index	Definition
Nut. Stat. #1	An average of the three percentages
Nut. Stat. #2	An average of the weight for age and height for age percentages
Nut. Stat. #3	Multiplication of the square roots of the weight for age and height for age percentages
Nut. Stat. #4	Multiplication of the cube root of the height for age percentage by the cube root squared of the weight for age percentage

Each of these indices plus the three basic parameters are used alternatively as proxies for nutritional status in the analysis.

Nutrient Intake

Nutrient intake was estimated for each child through the use of the 24-hour recall method. Mothers were asked to indicate the amount of each food actually ingested by the child during the preceding 24 hour period, through the use of sample foods, the ingested portion of which the mother was asked to transfer into commonly used vessels. These vessels were

standardized in advance for each commodity by volume and weight. In the case of non-breast milk or milk-tea combinations, special care was taken to account for the universal practice of milk dilution. Similar care also was practiced in accounting for pulses which are served in a variety of consistencies. Translation of these food items into nutrients was then done using the tables of The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets, published by the Indian Council of Medical Research (4).

Breast milk quantities were calculated using quantities by age of the child as determined empirically in earlier research carried out by the Indian National Institute of Nutrition (56). That research estimated the breast milk intake of 184 infants and children in different stages of lactation and from different parts of India using the so-called test-feeding technique. Each child and its mother were admitted to a hospital for a 24-hour period. The child was weighed nude before and after every breast feeding, the total difference in weights representing the amount of milk ingested during the 24-hour period. A previously weighed diaper was tied on the baby permitting adjustments for any urine or stool voided during the feeding.

In spite of efforts made in the present study to ascertain whether or not the flow of breast milk was normal and to adjust accordingly, this estimate by definition lacks precision. It does not appear, however, to bias the figures for the sample as a whole in one direction or the other. Given the alternatives of (a) taking weight measurements after each breast feeding for each child over a 24 hour period or longer, or (b) leaving breast milk out of the nutrient estimates altogether, use of the existing estimates by age appeared to be the most sensible approach.

A large body of literature exists on the subject of estimating nutritional intake and points out the shortcomings of each approach. There is no effort here to defend the efficacy of the 24-hour recall method which clearly suffers from problems of memory lapses and the desire of the respondent to impress according to what he suspects are ulterior motives of the study by underestimating (when he suspects potential welfare) or overestimating (when he believes status is important). Nonetheless, finding it unfeasible on the one hand to carry out lengthy (and not always unbiased) food weighings in the home, and inadequate on the other to rely purely on rough food groupings (such as that used by national sample surveys) or Guttmann scaling, the 24-hour recall emerged as the most sensible approach.

One serious problem encountered in 24-hour recall measurement is that of seasonality. Unless the survey covers several seasons, changes in consumption over the year may lead to major biases. Although this is believed to be a less serious problem among very young children, an effort was made to carry the survey over two parts of the year. Roughly the first half of the 523 children were reached during the monsoon season, considered to be the latter part of the "lean" period as categorized by the Narangwal RHRC (36). The second half was reached during the winter, found to be the "fat" period.

In addition to the 24-hour recall data, information was collected on the age any supplementary milk or solid food feeding was initiated and the age of terminating breast feeding in the case of entirely weaned children.

The food intake of each child was translated into calories, protein, vitamin A and iron. These four food constituents are related to what

repeatedly have been cited as India's primary nutritional deficiencies by the Indian Council of Medical Research, the (Indian) National Nutrition Advisory Committee and the (Indian) Food and Nutrition Board. Actual intakes were then related, according to the child's age, to the "Daily Allowances of Nutrients for Indians," adopted by the Indian Council of Medical Research.

It should be noted that these standards are allowances rather than requirements. Allowances, which are set higher than requirements, serve as goals for planning and include a margin above and beyond physiological requirements to allow for variation among individuals, to permit the achievement of full growth potential, and to provide a buffer against common stress. Thus, individuals whose diets do not meet all nutrient allowances are not necessarily suffering from malnutrition.

In order to provide a single measure of nutritional intake for use in the analysis, the percentages of recommended allowance figures for calories, protein, vitamin A and iron were combined into the following two nutrient intake indices. Although somewhat arbitrary, these indices would seem to be rough approximations of the relative importance accorded these food constituents with respect to their effect on the nutritional status of young children.

Nut. Int. 1:	Calories = 40
	Protein = 30
	Vitamin A = 15
	Iron = 15
Nut. Int. 2:	Calories = 45
	Protein = 25
	Vitamin A = 5
	Iron = 25

These two indices and the percentage of recommended allowance figures for calories alternatively were used as proxies for the nutritional intake variable in the analysis.

Infection and Disease

Three measures of infection and disease--disease history, diarrheal infection, and parasitic infection--were examined independently and then looked at a composite weighted infection index. The three independent measures are discussed below.

1. Disease history - A disease history score was derived from information collected on the incidence of those major diseases capable of affecting a child's nutritional status, i.e. smallpox, measles, skin eruptions (impetigo, rubella, chicken pox), dysentery and pneumonia. A score of 0 indicated no major illnesses while a score of 5 indicated five or more major illnesses.

2. Diarrheal infection - Similarly an index measuring the frequency and severity of diarrhea was constructed using a series of interview questions. The index ran from 0 (low frequency and severity) to 7. A child with almost no history of diarrhea was given a rating of 0. A child who had suffered from diarrhea 90 percent of its life or more was given a rating of 5. Two points were added if the child at any point in its life suffered from severe diarrheal infection as evidenced by blood or mucous in the stool.

3. Parasitic infection - The stool samples, collected from 96 percent of the original sample of 523 children, were used to test for evidence of parasitic infection. This laboratory analysis also permitted an estimation of the extent of parasite load where parasites were found.

Economic Status

Income and wealth were calculated as separate variables to permit both a stock and flow dimension of economic status. Of these the wealth variable was the more satisfactory with respect to precision of calculation, but the income one proved a better explanatory variable in the multiple regression analysis.

The income calculation was made on a per month basis for the nuclear family of each child in the study. In the case of salaried service persons this was a relatively easy procedure. For landless agricultural laborers an effort was made to calculate the total monetary value of wages and payment in kind (usually calculated on a per day basis) for an estimated number of days worked in an average month. Problems in this calculation included (1) the fact that wages differ significantly during harvest and non-harvest seasons, and (2) the less easily quantified components of reimbursement, e.g. landless laborers often are permitted to glean the fields after harvest. For the landed agriculturalists estimates were made of the monetary value of production minus the agriculture-related costs. One problem here is the necessary adjustment for that portion of production consumed by the family, an amount which otherwise would represent an expenditure from net income. Given these problems, the income calculation necessarily was less precise than might have been desired.[6/]

The wealth measure, on the other hand, was calculated in a fashion which, if not exact, probably is quite effective in giving a wealth

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6/ An attempt was made by Dr. Robert Parker of the Johns Hopkins group to assess income more exactly for a small part of the Narangwal sample through precise quantification of each factor affecting it. The interview time on this question alone often exceeded three hours.

ranking of the families in the sample. The calculation was made using a slight modification of an economic index developed by the Narangwal RHRC. Since final weightings for the index were not established by the RHRC at the time of this analysis, the weights used were those suggested by Mr. George Immerwahr, an RHRC consultant, again with minor modifications. The index assigned weights to such factors as size and construction of dwelling, number of animals, mechanical possessions, land and non-land related income. The index used is presented in Appendix II.

Mothers' Beliefs and Education

A beliefs index was developed on the basis of a series of pretested questions on mothers' beliefs pertaining to the nutritional and health status of their children. These questions asked mothers to state their beliefs on the ideal age to introduce supplementary milk and solid food and the adjustments that should be made to the child's diet in the event of diarrhea or fever, and to explain the cause of nutritional marasmus (a known disease with an equivalent word in the Punjabi language). These questions are included under section D on the data collection form in Appendix I.

The beliefs index was constructed using a scale of 1 (beliefs detrimental to the child's health) to 4 (beneficial beliefs). Information also was collected on the literacy and education of the mothers.

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In addition to the above variables basic demographic information was collected on age, sex, family size, the number of liveborn children who have died in the family, and caste. Difficulties always are encountered in collecting accurate age information on persons living in rural areas of low-income countries. These problems, of course, are less serious

for a young child whose entire lifetime is within the easily accessible memory of his parents. Nonetheless, it is necessary even in assessing the ages of young children to be quite persistent in placing the birth in relation to known seasons and festivals. Gross errors usually could be caught by visual inspection of the child (including the number of his teeth). Sometimes birth dates thus ascertained were compared with birth records kept in each village by the "chowkidar" or watchman, but such records often proved unreliable.

CHAPTER 4

THE SAMPLE CHILDREN: A STATISTICAL PROFILE AND GENERAL DISCUSSION

This chapter, using the data from the micro study, presents a quantitative description of the sample children according to the variables introduced in the preceding chapter. It includes, where appropriate, a general discussion of the variables as they relate to this part of Punjab.

Although Punjabi villages have been well described elsewhere (46,66) a few brief comments may be appropriate here. As in other low income countries, these villages are largely self-contained, concentrated units surrounded by agricultural holdings and generally linked to the nearest main road by a dirt road. The village itself is a maze of narrow paths of dirt or burnt brick, which often are bordered by mud walls, and which wind around houses, a few wells (each serving a particular portion of the village), numerous mud storage structures, a temple, a school (education of boys and girls usually is conducted separately), a small wheat grinding unit, and a few one-room shops. These paths, which become virtual streams during the monsoon, might at any given daylight moment be occupied by a bullock cart filled with agricultural produce, farm implements or bags of fertilizer, a hand-pushed vegetable cart, a half dozen water buffalo being herded to the nearby pond by a nine year old boy with a longer stick, a few goats ambling aimlessly or tethered in a grassy patch, a group of noisy school children with their wooden writing slates, and a few girls of seven or eight carrying younger siblings on their hips.

Residential dwellings usually are grouped according to caste with a clear-cut differentiation at least of Jat and Ramdasia households. The former generally are constructed of a combination of brick and mud, contain

one or two rooms sometimes with electrical outlets, a roofed section for animals, and an inner courtyard where fodder and fuel are stored, where the cooking is done and where most of the woman's day is spent. The Jat family is likely to have it's own private water pump.

Ramdasia dwellings almost always are smaller mud huts with dirt or dung floors and thatched roofs. Often these dwellings stand in a row with common side walls and roofs. Unlike her Jat counterpart, the Ramdasia woman spends a considerable portion of the day away from the home, often gathering fodder for the animals or, during harvest seasons working in the fields. During her absence from the home her younger children generally are entrusted to older daughters, or in some cases, a paternal grandmother.

Social-Demographic Information

The discussion of the sample children begins with basic social-demographic information, and then proceeds to the major variables. As seen in the previous chapter, Jats (42 percent) and Ramdasias (39 percent) constitute the bulk of the sample children. The heterogeneous grouping of "Other" children make up the remainder. As would be expected by the geometry of population growth, there are slightly more persons, proportionately, in the younger age group. Of the sample children, 52.8 percent are male, a figure almost identical with that found at Narangwal (53.0 percent among children aged 0-4) (36).

As seen in Table 2 the average child has over two live siblings, slightly but not statistically significantly higher among Ramdasias than Jats. The average number of liveborn children who died in the Ramdasia families, however, was over 70 percent higher than in Jat families. This would be consistent with the Narangwal RHRC data which found the infant

(0-12 months) mortality rate to be 128 per 1000 live births for Jats and 179 per 1000 for Ramdasias (36).

Table 2. Number of Live and Dead Siblings Per Sample Child

Group	Average number of live sibilings	Average number of liveborn dead siblings
Jats	2.16[a]	0.49**
Ramdasias	2.36	0.85
Others	2.08	0.53
Total	2.22	0.64

a/ Not significantly different from the Ramdasia figure at the .95 level of statistical significance.
** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

Family income ranged from Rs. 50 ($7) to Rs. 1450 ($193) per month with a mean of Rs. 241 ($32). Mean family income figures by caste are presented in Table 3. The mean per capita income was Rs. 46 ($6) per month. The wealth index ranged from 40 to 1400 with a mean of 243. In spite of the largely coincidental similarity in range and mean values of the income and wealth variables, the correlation between them was only .738 (Perfect correlation is + or - 1.0).

Table 3. Average Monthly Income of the Nuclear Families of Sample Children

Group	Average monthly family income	
Jats	Rs. 336	($45)**
Ramdasias	Rs. 150	($20)
Others	Rs. 218	($29)
Total	Rs. 241	($32)

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

Nutritional Status

As discussed in the previous chapter, weights and heights of the children were compared with the Harvard Standards by three parameters: weight for age, height for age, and weight for height. The means of each of these are presented by caste grouping in Table 4.

Table 4. Mean Anthropometric Measures of Sample Children[a/] by Caste Grouping

Group	Weight as percentage of reference weight for age	Height as percentage of reference height for age	Weight as percentage of reference weight for height
Jats	79.2**	93.8**	87.8**
Ramdasias	73.5	91.7	85.5
Others	77.5	92.9	87.3
Total	76.6	92.8	86.8

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.
a/ Measurements as percentages of Harvard Standards.

In Table 5 this information for the sample children is presented by age group. As would be expected, children in the youngest group, 6-11 months, come closest to the reference measures for their age and height. Presumably the 0-5 month group would be highest of all. Then with the onset of the weaning period, the inadequacy of breast feeding alone and the syndrome of weanling diarrhea, the child's growth deviates sharply from the reference. The table would appear to suggest that during the second year the child's weight once again moves parallel with the reference weight parameters (although at a much lower level) while his height continues to fall relative to the height for age reference.

Table 5. Mean Anthropometric Measures[a] of Sample Children by Age Group

Age group	Weight as percentage of reference weight for age	Height as percentage of reference height for age	Weight as percentage of reference weight for height
6-11 months	82.3**	95.4**	90.6**
12-17 months	73.9	92.3	84.8
18-24 months	73.8	90.7	85.1
Total	76.6	92.8	86.8

** Significantly different from the 18-24 month age group at the .95 level of statistical significance.
{ Indicates figures significantly different at the .95 level of statistical significance.
a/ Measurements as percentages of Harvard Standards.

The weight for age measure is the basis for the frequently used "Gomez Classification" of nutritional status (27) which groups children as follows:

Normal	: over 90 percent of reference weight for age
1st degree malnutrition:	76 to 90 percent of reference weight for age
2nd degree malnutrition:	60 to 75 percent of reference weight for age
3rd degree malnutrition:	below 60 percent of reference weight for age

Traditionally for 1st degree cases normal extension or outpatient care is considered adequate, while 2nd degree cases require more intensive care, e.g. a nutrition rehabilitation center, and 3rd degree cases require hospitalization (6).

The division of children according to the Gomez Classification in Table 6 indicates highly significant differentials in weight for age

between the landowning, economically advantaged Jats and the landless Ramdasias. It is in fact these differentials that the regression analysis, discussed in Chapter 5, attempts to explain. The table further reveals the extent of serious malnutrition existing in this area. Bengoa's review of community survey literature in low income countries (7) found the point prevalence of 3rd degree malnutrition within a range of 0.5 to 4.6 percent. The figure here is 8.3 percent with the Ramdasia average 12.3 percent. Similarly, Bengoa found on the average 25 percent of the children in these studies suffering from 2nd degree malnutrition, while the figure here is 39.5 percent.[1/]

Table 6. Breakdown of Caste Groupings by Gomez Classification[a/]

Group	Normal (91-100% of reference weight for age)	1st degree malnutrition (76-90%)	2nd degree malnutrition (60-75%)	3rd degree malnutrition (Below 60%)
	percent	percent	percent	percent
Jats	19.6	41.6	35.2	3.6
Ramdasias	6.9	35.8	45.1	12.3
Others	20.8	31.3	37.5	10.4
Total	14.8	37.3	39.5	8.3

a/ Percentage of reference weight for age using the Harvard Standards.

The figures also suggest considerably lower nutritional status than do those collected by the Narangwal RHRC in a cross section survey of four Ludhiana District villages in 1967 (36). That study found 5 percent

1/ The Jat figures roughly would resemble Gomez breakdowns elsewhere if there were about 15 percent more Jats in the 1st degree category and 15 percent fewer in the 2nd degree one.

suffering from 3rd degree, 10 percent with 2nd degree, and 35 percent with 1st degree malnutrition. These 1967 figures presumably reflect economic disparities between Ludhiana and Ropar Districts which have existed for many years, rather than "Green Revolution" effects (relating largely to the introduction of new seed varieties) which would not have been measurable that early.

An interesting article by Seoane and Latham (60) presents a means of utilizing height for age and weight for height measures in cross section data to assess the time frame of malnutrition among children with low weight for age. This technique divides these children into the following three groups, each calling for somewhat different interventions.

A. Current acute short duration malnutrition indicated by low weight for age and weight for height but normal height for age. The normal height (a better measure of protein-calorie malnutrition than weight for extended time periods) suggests recent, short duration deficiencies.

B. Past chronic malnutrition indicated by low weight for age and height for age but normal weight for height. Jelliffe (35) refers to this group as suffering from nutritional dwarfism.

C. Current long duration malnutrition indicated by low percentages on all three indices.

To permit a grouping into these categories, those children below 80 percent weight for age (62.7 percent of the sample) were classified using adequacy dividing points of 95 percent for the height for age measure and 90 percent for the weight for height measure. The resulting breakdown was:

Group A - 11.7 percent of the sample

Group B - 14.1 percent

Group C - 74.2 percent

indicating that relatively few presently malnourished children were adequately nourished in the past, and conversely that most children with previous malnutrition are still malnourished.

Food and Nutrient Intake

On the basis of the 24-hour recall information, several generalizations can be made about feeding practices in this area, all of which appear consistent with those found in the Narangwal and Khanna studies.

Food intake - As in most low income areas which have escaped excessive contact with the industrialized world, prolonged breast feeding remains the norm in rural Punjab. Except for the rare case of maternal death or severe illness, all children up to the age of 6 months are breast fed. Of infants between 6 and 12 months, 91.6 percent were breast fed. The percentage then dropped to 82.1 percent for those between 13 and 18 months, and to 63.7 percent between 19 months and 2 years. Breast feeding often continued to the age of 3 years and in some cases beyond.[2/]

Feeding of diluted buffalo, cow or goat milk usually is introduced during the first 6 months after birth. Often this milk is fed in a mixture with tea and processed or unrefined sugar in varying proportions. In fact for these children as a whole, the quantity of tea consumed is second only to milk as a component of the diet. Of the infants aged 6 to 12 months, 77.8 percent received some supplementary milk. Of the 13 to 18 month age group, 93.1 percent received supplementary milk, and 95.1 percent between 19 and 24 months.

2/ The median duration of breast feeding reported by Wyon and Gordon (66) was 26 months.

Delay in the introduction of solid food, a phenomenon discussed in Chapter 2, was the norm regardless of economic or social class. Almost no children received solid food before the age of 6 months. Between 6 and 12 months, 49.3 percent received some supplementary food. This is roughly consistent with the finding in Khanna (66) that 53 percent of all children at 11 months were receiving solid food. Of the children aged 13 to 18 months in this study, 87.5 percent were receiving solid food as were virtually all of the children (98.1%) between 19 months and 2 years. Of course, the quantity and quality of this food varied enormously as will be seen below.

Of the children who did consume some solid food (76 percent of the total sample) the average age of initiating this feeding was 10.5 months. This is an underestimate for the 6-24 month age group as a whole, but not a major one since most of those in the sample who were not consuming solid food were between 6 and 10 months of age. As indicated in Table 7 the average ages of initiating solid food among "Other" and Jat children respectively were 9.8 and 10.5 months, as opposed to 10.8 months for Ramdasias. This would argue against the hypothesis sometimes voiced that poorer mothers (in this case the Ramdasias), who spend much of the day in the fields or collecting fodder for animals, tend to provide solid food earlier as a matter of convenience.

Solid food fed to these children almost always is adult food. Rarely are foods prepared specifically for children. The solid food usually fed first to the child and that consumed most regularly is the wheat chapatti[3/] dipped in one of a wide variety of pulses or vegetables. Following the

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3/ A flat unleavened bread baked on a hot griddle and somewhat resembling a tortilla.

Fall harvest there is also considerable consumption of corn by these children. Rice is less often consumed. A wide range of fruits are fed depending on the season, but to only about a third of the children.

Table 7. Consumption of Solid Food Among Sample Children by Caste

Group	Percent receiving solid food	Average age of initiating solid food (months)
Jats	76.6[a]	10.5[a]
Ramdasias	73.7	10.8
Others	80.6	9.8
Total	76.2	10.5

a/ Not significantly different from the Ramdasia figure at the .95 level of statistical significance.

Average daily food consumption figures for these children are presented in Table 8. The figures clearly indicate the quantitative inadequacy of the diets of these children, and will be examined further in the discussion of caloric deficiencies. Jat-Ramdasia differences are

Table 8. Average Daily Food Consumption of Sample Children by Food Group and Caste

Group	Supplementary milk (gms.)	Cereals (gms.)	Pulses (gms.)	Fruits (gms.)	Vegetables (gms.)	Sugar (gms.)
Jats	210**	26	9	15	9	17
Ramdasias	155	26	8	13	7	18
Others	192	24	6	15	12	16
Total	185	26	8	14	9	17

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

statistically insignificant with the striking exception of supplementary milk intake. This significant difference also is reflected in Table 9 showing the sources of calories, by percentage, for the children by caste groups. Given the status connotation of milk in Punjab as elsewhere and its high relative price, these caste differences in milk consumption would seem to suggest an income relationship. The lower income Ramdasia mother who cannot afford as much supplementary milk for her child makes it up by breast feeding the child somewhat longer and providing a larger proportion of the child's calories with cereals. Because of the caloric density of the cereals, she may in fact be allocating her resources more effectively than her Jat counterpart with respect to the child's nutrient intake. Some Jat mothers may believe they are meeting their feeding responsibilities to the child by providing this high-status, expensive milk, when in reality, given the quantitative inadequacy of the diet, they better could use their resources for cereal preparations.

Table 9. Sources of Calories Among Sample Children by Caste

	Percentage of calories from:							
Group	Breast milk	Supplementary milk	Cereals	Pulses	Fruits	Vegetables	Sugar[a/]	Total
Jats	43.8**	29.7**	11.4	3.5	1.5	0.8	7.8**	98.5%
Ramdasias	50.0	22.6	12.3	3.7	1.2	0.7	8.9	99.4%
Others	45.6	28.2	12.0	2.7	1.3	0.9	8.0	98.7%
Total	46.5	26.6	11.9	3.4	1.3	0.8	8.2	98.7%

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.
a/ Refined and unrefined.

In Table 10 the sources of calories for the children are presented by age group. Here, as would be expected, one finds a highly significant decrease in the percentage of calories coming from breast milk as age increases. Over two-thirds of the calories in the 6-11 month age group come from breast milk, while it accounts for only slightly over one-fourth in the 18-24 month group. In the older groups, as can be seen, the calories are made up for with the other foods, most notably by supplementary milk and cereals. In the case of supplementary milk, these children appear to level off their consumption (as a percentage of total calories) during the second year, while cereal and pulse consumption continue to increase.

Interestingly, pulses, which have received considerable attention by nutritionists, constitute only 3.4 percent of the calories consumed by children in this age group. Given the particularly low income elasticity of consumption for pulses among this age group (discussed in Chapter 5) it is unlikely that increased pulse production, lower pulse prices, or income increments per se will have a major effect on their pulse consumption.

Table 10. Sources of Calories Among Sample Children by Age Group

	Percentage of calories from:						
Age group	Breast milk	Supplementary milk	Cereals	Pulses	Fruits	Vegetables	Sugar[a]
6-11 months	69.5**	19.5**	3.9**	0.8**	0.4**	0.2**	5.6**
12-17 months	45.4	28.1	11.6	3.0	1.2	0.9	8.7
18-24 months	26.3	31.9	19.5	6.2	2.3	1.3	10.3
Total	46.5	26.6	11.9	3.4	1.3	0.8	8.2

** Significantly different from the 18-24 month age group at the .95 level of statistical significance.

{ Indicates figures significantly different at the .95 level of statistical significance.

a/ Refined and unrefined.

Nutrient intake - As discussed in the previous chapter, this food information was converted into calories, protein, vitamin A and iron, which in turn were compared with the official Indian daily allowances. Table 11 presents the average percentages of nutrient allowances by caste.[4/] Table 12 presents the percentage of each caste group falling into four percentile of allowance classifications.

Table 11. Average Percentages of Nutrient Allowances[a/] by Caste Grouping for Sample Children

Group	Calories	Protein	Vitamin A	Iron
Jats	63.6**	87.0	86.1	38.0
Ramdasias	59.2	83.3	83.2	35.1
Others	60.7	85.5	85.6	36.8
Total	61.3	85.3	84.9	36.7

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

a/ Nutrient intake compared with "Daily Allowances of Nutrients for Indians" prepared by the Indian Council of Medical Research, 1968.

As indicated in these tables, the most serious nutrient deficiencies among this age group are those of iron (average intake 36.7 percent of the allowance with just over 4 percent having adequate intake)[5/] and calories (average intake 61.3 percent of the allowance with 7.5 percent having adequate intake). The average vitamin A intake was 84.9 percent

4/ Given the lack of an obesity concern in this study, intakes exceeding 100 percent of allowance were recorded as 100 percent of allowance.

5/ The exceedingly low iron intakes are consistent with the Narangwal RHRC finding that 80 percent of the hemoglobins of children examined were below 10 gm. % (36).

Table 12. Breakdown of Caste Groupings by Percentage of Nutrient Intake Allowances[a]

	Calories				Protein			
	100% of allowance	76-99%	51-75%	50% + below	100%	76-99%	51-75%	50% + below
Jats	10.9%	16.1%	45.5%	27.5%	57.8%	16.1%	19.9%	6.2%
Ramdasias	5.2	14.4	43.8	36.6	45.1	19.2	28.5	7.3
Others	4.5	18.0	42.7	34.8	45.7	25.0	22.8	6.5
Total	7.5	15.8	44.3	32.4	50.6	19.0	23.8	6.7

	Vitamin A				Iron			
	100%	76-99%	51-75%	50% + below	100%	76-99%	51-75%	50% + below
Jats	43.2%	31.4%	19.1%	6.4%	4.8%	7.6%	17.1%	70.5%
Ramdasias	38.5	34.1	18.5	8.8	4.7	3.7	15.1	76.6
Others	35.1	43.3	17.5	4.1	2.2	5.6	18.9	73.3
Total	39.8	34.7	18.6	6.9	4.3	5.7	16.7	73.4

a/ Nutrient intake compared with "Daily Allowances of Nutrients for Indians" prepared by the Indian Council of Medical Research, 1968.

of allowance[6/] (39.8 percent had adequate intake), and the average protein intake was 85.3 percent of allowance (50.6 percent having adequate intake).

With respect to the caloric deficiency there is some possibility that the ICMR caloric allowance used as a reference may in fact be too generous. This is suggested by Table 22 in Chapter 5 indicating that "normal" children in terms of the Gomez classification (over 90 percent of reference weight for age) meet only 65 percent of the ICMR caloric allowance. Even allowing for higher references to provide necessary buffers against stress and infection, the ICMR allowance may err on the high side. Alternatively there is the possibility that caloric intake was generally underestimated for this group. This is somewhat less likely unless the breast milk intake estimates used in the study seriously underestimate the actual breast milk intake of these children.

Unless the caloric allowance is grossly overestimated, however, (and even if food intake is overestimated which would increase protein as well as caloric intake) the findings would tend to substantiate the hypothesis frequently voiced to the effect that protein deficiencies in this part of the world are a subset of a broader protein-calorie malnutrition. Where protein deficiency exists it appears to be largely the result of caloric deficiency and the burning up of otherwise utilizable protein for energy. Using the ICMR allowances, there was no case of a child ingesting adequate calories (i.e. enough food) but inadequate protein. The "enough calories means adequate protein" argument sometimes is made for the population as

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6/ This vitamin A figure is almost four times higher than that (22.1% of allowance) found by the (Indian) National Institute of Nutrition (28) among preschool age children in the Hyderabad area of South India where vitamin A deficiency is particularly serious and debilitating. The average percentage of the recommended iron allowance found among the Hyderabad group (33.7%) was similar to that found in this study (36.7%).

a whole, but rarely for this critical age group, given their much higher proportionate requirements for protein. The findings here would suggest, again assuming the validity of the caloric allowance, that at least in this part of India, even this age group would not be excluded from the generalization.7/

Among certain population groups in low income countries, such a conclusion might be questionable. It has been suggested, for example, that where the quality of protein consumed is particularly low, a higher intake of protein will be required. Similarly, it has been argued that the presence of major infection increases physiological requirements for protein. Both of these factors have been taken into account by the Indian Council of Medical Research in setting its allowances. Beyond this, however, neither the protein quality nor the infection factor present particular problems for this population group. As indicated in Tables 9 and 10, so large a proportion of food intake comes from breast and supplementary milk that the quality of the protein consumed would be quite high. Similarly, as will be seen below, the absence of major parasitic infestation eliminates the need to adjust protein allowances on this count.

Interestingly, the nutrient intake findings in this study are similar to those found in a recent study of preschool age children (0 to 5 years old) conducted under the auspices of the Indian Council of Medical Research (ICMR) in five parts of India (Hyderabad, Vellore, Poona, Bombay, Delhi, and Calcutta) (28). Using the same ICMR standards as employed here, that study found 92 percent of the children deficient in calories (92.5

7/ While true in Punjab and perhaps in India as a whole, this relationship is unlikely to exist in those parts of the world dependent on low protein food staples, notably sub-Sahara Africa.

percent in this study) and 35 percent deficient in protein (49.4 percent in this study -- the differential presumably explained in part by the younger age group studied here). These results have important implications for intervention as will be seen in Chapter 6.

As suggested earlier, the lack of major Jat-Ramdasia differences with respect to nutrient intake would be explained partially by the Jats' heavy reliance on supplementary milk as opposed to other foods with higher caloric density relied upon by Ramdasias.

The most important effect of age on food intake relates to iron intake. Because of the much larger quantities of cereal they consume, iron intakes of children in the 18-24 month age group are roughly twice that of children between 6 and 11 months of age.

Infection and Disease

As discussed earlier, three indices were used to measure infection and disease. The findings with respect to each are discussed separately below.

1. Disease history - Table 13 presents the average number of major diseases for each caste group. As seen, the average for the sample children as a whole is below 1. The Ramdasia figure is significantly higher than the Jat average.

2. Diarrheal infection - Table 14 presents information on diarrheal infection using the index of frequency and severity described in Chapter 3. The mean rating for the children as a whole of just below 2 suggests that the average child has suffered from diarrhea about 25 percent of his life but has not suffered from severe dysentery. Again the Ramdasia figure is significantly higher than that of the Jats.

Table 13. Disease History Rating of Sample Children

(0 = no major illness; 5 = five or more major illnesses)

Group	Medical experience rating
Jats	0.84**
Ramdasias	0.99
Others	0.82
Total	0.89

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

Table 14. Diarrheal Infection Index for Sample Children

(7 = high frequency and severity; 0 = low frequency and severity)

Group	Diarrheal infection rating
Jats	1.74**
Ramdasias	2.29
Others	1.95
Total	1.99

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

In Table 15 this information is presented by age group. The figures indicate that diarrheal infection increases significantly during the first half of the second year, and continues to increase during the 18-24 month period though at a lower rate of increase.

3. Parasitic infection - One of the more surprising results of the study, although consistent with the findings of the Narangwal RHRC, was the virtual absence of hookworm, roundworm or other important parasites. Analysis of stool samples revealed only one case of roundworm and

Table 15. Diarrheal Infection Index by Age Group for Sample Children

(7 = high frequency and severity; 0 = low frequency and severity)

Age group	Diarrheal infection rating
6-11 months	1.48**
12-17 months	2.17
18-24 months	2.32
Total	1.99

** Significantly different from the 18-24 month age group at the .95 level of statistical significance.
{ Indicates figures significantly different at the .95 level of statistical significance.

no hookworm. At the same time 32.1 percent of the samples contained giardia.[8/] Interestingly as shown in Table 16 the point prevalence of giardia was higher among Jats (32.2 percent) than among Ramdasias (29.6 percent) and highest of all among the "Others" (37.2 percent). This presumably is explained by the ingestion (by Jats and "Others") of larger quantities of food, the primary carriers of this cyst. Ramdasias were also lower in the point prevalence of severe giardia which afflicted 5.5 percent of the entire sample.

The point prevalence of giardia found in this sample was almost twice that found for a comparable age group by the Narangwal RHRC (18 percent). The Narangwal data further indicates that giardia prevalence tends to increase with age in the early years of childhood (36).

8/ A unicellular flagellate which lodges in the intestinal tract and, like an intestinal parasite, adversely affects absorption. The extent of malabsorption resulting from giardia is unclear.

Table 16. Prevalence of Giardia Among Sample Children

Group	Percent with giardia	Percent with severe giardia (2+ or higher)
Jats	32.2[a]	7.5[a]
Ramdasias	29.6	5.1
Others	37.2	9.6
Total	32.1	5.5

a/ Jat and Ramdasia figures not significantly different from one another at the .95 level of statistical significance.

Mothers' Beliefs and Education

As stated earlier, mothers of the sample children were asked a series of questions designed to determine their beliefs relating to the nutritional and health status of their children. Questions sought the mothers' conception of the ideal age to initiate supplementary feeding, the appropriate dietary response to infection, and the cause of nutritional marasmus.

On the average, mothers believed solid food should be introduced near the age of one year, although the range of answers varied from six months to two years. Virtually all mothers responded that solid food should be removed during bouts of diarrhea or fever. Suggested cures ranged from breast milk or tea alone to locally procured homeopathic medicines and visits to religious figures known as sianas. Fifty-six percent of the mothers attributed marasmus (a known disease with an

equivalent word in the Punjabi language)[9] in whole or in part to the casting of an evil shadow by a person or spirit. This concept does not appear inconsistent with larger belief patterns in these villages or with the remedies selected.

Parents bringing their marasmic child to a siana might be given one of the following prescriptions:

(a) The green stick ritual - A green twig full of sap is waved over the child's head with an appropriate Sanskrit incantation. The twig is then thrown some distance away. When the twig dries, the child will be cured. If the magic doesn't work, the twig will grow and the child will die.[10] To minimize the likelihood of a reverse transfer of this life force, the parents and child must avoid for three months the spot where the twig lies.

(b) The seven wells ritual - This longer duration prescription calls for the mother to take her child to seven particular wells in seven different villages on seven consecutive full moon nights (one a month). She waits at the well until the moon is at its zenith, then repeats an incantation to the spirit of the well to the effect of "bring water into my child and make it live". After this the mother bathes the child in the water of that well.

(c) Purification by excrement - Cow dung periodically is rubbed on the back of the child. After sufficient rubbing the mother removes what she believes are worms and which in fact probably is a thin outer layer of skin.

9/ The word "soka", literally translates "dried up".
10/ This "transfer effect" is common in anthropological literature from many parts of the world.

A more medically-oriented siana and some practitioners of ayurvedic medicine[11] might prescribe dried goat liver, actually an excellent source of needed vitamins, iron, and some essential amino acids, but usually prescribed in inadequate quantities. One ayurvedic practitioner was found whose entire business is the treatment of marasmic children.[12]

As indicated in Table 17, belief in the shadow concept was highest among the "Others" group (61.3 percent) which contains a large number of Hindus with considerably more ritualism and superstition than normally associated with Sikhism. Fifty-nine percent of the Ramdasias believe in the shadow concept as opposed to 50.2 percent of the Jats.

Table 17. Mothers' Beliefs in Casting of Shadow Cause of Marasmus

Group	Percentage attributing shadow as cause of marasmus
Jats	50.2**
Ramdasias	59.3
Others	61.3
Total	55.8

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

With this information a beliefs index was constructed using a scale of 1 (beliefs detrimental to the child's health) to 4 (beneficial beliefs).

11/ An indigenously developed Indian practice of medical treatment based in part on herbal cures.

12/ These and other interesting anthropological findings are included in presently unpublished papers by D. N. Kakar of the Narangwal Rural Health Research Center.

As shown in Table 18 the average for the entire sample was 2.42, with Jats slightly higher (2.41) than Ramdasias and "Others" (2.37).

Table 18. Nutrition and Health Beliefs Index for Mothers

(4 = beliefs beneficial to child's health;
1 = beliefs detrimental to child's health)

Group	Beliefs index
Jats	2.46[a]
Ramdasias	2.41
Others	2.37
Total	2.42

a/ Not significantly different from the Ramdasia figure at the .95 level of statistical significance.

The Jat-Ramdasia differential here and with respect to belief in the shadow concept, probably is explained in part by significant differences in literacy. As indicated in Table 19, 31 percent of the Jat mothers were literate as opposed to only 7.7 percent of the Ramdasia mothers. The 22.6 percent literacy figure for the sample as a whole is less than half that (48 percent) found by the Narangwal RHRC among a comparable age group of mothers.

Table 19. Literacy of Mothers of Sample Children

Group	Percentage literate[a/]
Jats	31.1**
Ramdasias	7.7
Others	34.4
Total	22.6

** Significantly different from the Ramdasia figure at the .95 level of statistical significance.

a/ In any language.

CHAPTER 5

ANALYSIS AND RESULTS

In the previous chapter, a statistical profile of the sample population was presented using measures of nutritional status and a wide range of explanatory variables. We now can examine the relationships among these factors in terms of the analytical framework introduced in Chapter 3. The analysis basically is a two step process: first, weighing the effects of food intake and infection, the direct determinants of nutritional status[1/]; second, identifying the relative importance of a range of indirect determinants on food intake and infection respectively. The two steps are accomplished using ordinary least squares (OLS) multiple regression analysis[2/] supplemented by tabular presentations of the pertinent relationships.

Estimating Determinants of Nutritional Status

The first step in the analysis is the estimation of the effects of food or nutritional intake and infection on nutritional status. The nutritional status (NUT STAT) measures, defined in Chapter 3, were used as the dependent variable. As independent variables the two nutritional intake (NUT INT) indices and calories (CALOR) alternatively were used to represent intake. Infection was represented by diarrheal infection (DIAR), giardia (GIAR) and disease history (DISEASE) and by the infection index (INFEC) of these three.

1/ As will be seen below, other variables were found to have an independent effect on nutritional status and therefore also are included in this first step.

2/ An attempt to bring these equations into a simultaneous model using the technique of two stage least squares failed to yield meaningful results because of instability caused by particularly low R^2's in two of the equations.

The nutritional status variable which proved best explained by nutritional intake and infection was NUT STAT #1, the straight average of the weight for age, height for age and weight for height percentages. NUT STAT #3 and NUT STAT #4, multiplication of the square roots and cube by cube squared roots respectively of height for age and weight for age, were the next best nutritional status variables. The fact that NUT STAT #1 resulted in higher R^2's than the indices of weight and height for age combinations and higher than any single anthropometric measure indicates that each of the anthropometric measures adds something important to that NUT STAT #1 index.

After NUT STAT #1,[3/] 3 and 4, the nutritional status variables emerged as follows in order of their R^2's: NUT STAT #2 (the average of weight and height for age), weight for age, weight for height, and height for age.

Between the two nutritional intake indices, NUT INT #1 (calories = 40, protein = 30, iron and vitamin A = 15) proved to be a more successful explanatory variable than NUT INT #2 (calories = 45, protein and iron = 25, vitamin A = 5). However, the insertion of calories alone as the nutritional intake variable was better than either. This would be explained both by the great variation in caloric intake and by the general shortage in calories which adversely affects the utilization of other nutrients, and which at this level apparently overwhelms in both a physiological and a statistical sense the other deficiencies.

Among the three infection measures, when used together, diarrheal infection proved to be the most significant by a wide margin. Neither

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3/ Hereafter simply referred to as nutritional status, or NUT STAT in the equations.

Table 20. Estimation of Equations for All Sample Children Using Ordinary Least Squares With Coefficients Expressed as Elasticities

1. NUT STAT = 89.704 + .054 CALOR** - .033 DIAR** - .004 GIAR + .004 DISEASE - .072 AGE** (R^2 = .240)
(4.651) (-6.788) (-1.574) (1.039) (-7.117)

2. NUT STAT = 89.047 + .050 CALOR** - .032 DIAR** - .004 GIAR + .004 DISEASE - .072 AGE** + .011 INCOME** (R^2 = .248)
(4.275) (-6.559) (-1.548) (1.004) (-7.211) (2.236)

3. NUT STAT = 92.092 + .041 CALOR** - .027 DIAR** - .002 GIAR - .001 DISEASE - .068 AGE** + .010 INCOME** - .031 SEX** (R^2 = .369)
(3.865) (-5.965) (-0.962) (-0.276) (-7.404) (2.027) (-9.692)

4. CALOR = 46.815 + .065 INCOME** + .179 BELIEF** + .022 FAM SZ + .002 CASTE 1 - .005 CASTE 2 - .023 SEX* - .003 INFEC (R^2 = .067)
(2.635) (4.160) (0.813) (0.108) (-0.298) (-1.731) (-0.157)

5. CALOR = 50.854 + .033 WEALTH + .184 BELIEF** - .010 FAM SZ - .00[illegible] CASTE 1 - .009 CASTE 2 - .024 SEX* - .004 INFEC (R^2 = .057)
(1.359) (4.246) (-0.423) (-0.010) (-0.553) (-1.786) (-0.193)

6. DIAR = 1.947 + .010 INCOME - .047 BELIEF + .152 FAM SZ** - .053 CASTE 1 + .056 CASTE 2 + .049 SEX - .144 CALOR (R^2 = .037)
(0.146) (-0.378) (2.010) (-1.100) (1.261) (1.299) (-1.112)

7. INFEC = 21.870 - .017 INCOME + .038 BELIEF + .073 FAM SZ - .040 CASTE 1 + .026 CASTE 2 + .032 SEX - .017 CALOR (R^2 = .019)
(-0.281) (0.363) (1.149) (-0.983) (0.696) (1.011) (-0.157)

t values in parentheses
* statistically significant at the .90 level
** statistically significant at the .95 level

giardia nor disease history were found to be statistically significant determinants. Nor did giardia appear as a significant determinant of diarrheal infection. Disease history failed to emerge as significant, presumably because the incidence of major disease among surviving children in this age group is relatively low. When the infection index was used in place of the three components, the result was a more highly significant coefficient than any individual component but a lower R^2 than when the three components were used together in an equation.

In addition to food intake and infection, the differences in the anthropometric measures found for different age groups within the sample (Table 5) suggested that age itself explained a portion of the variation in nutritional status and therefore should be included as an independent variable in the equation.

Using the best index for each variable this first set of relationships for the population as a whole is stated in equation 1 of Table 20. The coefficients for each of the independent variables are presented as elasticities to facilitate their usage. The first equation would be interpreted as follows: Holding diarrheal infection, giardia, disease history and age constant, a one percent increase in caloric intake would improve nutritional status by .054 percent.[4/] Then holding calories, giardia, disease history and age constant, a one percent increase in diarrheal infection would result in a .033 percent decrease (because of the minus sign) in nutritional status. Similarly, the effects of a one percent change in giardia, disease history or age on nutritional status, holding the others constant, are indicated by the magnitude and signs of

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4/ Similarly, a decrease of one percent in caloric intake would result in a decrease in nutritional status by .054 percent.

their coefficients. The t values are noted parenthetically below the coefficients, and asterisks mark the levels of statistical significance. In the first equation, caloric intake, diarrheal infection and age are significant at the .95 level of statistical significance.

The R^2 of .240 indicates that the independent variables (on the right side of the equal sign) in this equation explain 24 percent of the variation found in nutritional status among the sample children. Although cross section analysis, inherently, seems to be characterized by low R^2's, an attempt was made to incorporate other possible explanatory variables into the equation. In equation 2, the addition of per capita income raised the R^2 to .248. This means that above and beyond the effects of income on caloric intake and infection (which will be examined later in this chapter) and hence indirectly on nutritional status, there is a statistically significant independent effect of income on nutritional status. Reasons for such a relationship will be discussed below.

In equation 3 the sex variable was added to those in the previous equation, boosting the R^2 to .369. The increase in the R^2 and the high statistical significance of the variable suggest the major importance of the sex variable in the analysis. Each of the significant variables in this third equation will be examined separately below.

Equation 3 is estimated separately for Jats and Ramdasias as equations 1 in Table 21. Although the same variables prove statistically significant, there are three important differences. First, the coefficients for the calorie variable indicate that caloric intake is a far more important determinant of nutritional status among Ramdasias than among Jats. Hence, increases in food consumption are likely to result in greater improvement in the nutritional status of Ramdasia children who

Table 21. Estimation of Equations for Jat and Ramdasia Children Using Ordinary Least Squares With Coefficients Expressed as Elasticities

JATS

1. NUT STAT = 94.378 + .029 CALOR* - .027 DIAR** - .002 GIAR - .003 DISEASE - .057 AGE** + .003 INCOME - .029 SEX** (R^2 = .376)
(1.839) (-4.472) (-0.712) (-0.615) (-4.168) (0.377) (-6.168)

RAMDASIAS

1. NUT STAT = 88.367 + .063 CALOR** - .029 DIAR** + .001 GIAR + .008 DISEASE - .078 AGE** + .006 INCOME - .028 SEX** (R^2 = .345)
(3.533) (-3.412) (0.234) (1.270) (-5.028) (0.652) (-5.032)

JATS

2. CALOR = 49.838 + .053 INCOME + .173 BELIEF** - .075 FAM SZ - .011 SEX + .006 INFEC (R^2 = .051)
(1.349) (2.695) (-0.116) (-0.545) (0.225)

RAMDASIAS

2. CALOR = 46.786 + .089 INCOME* + .129 BELIEF* + .039 FAM SZ - .052 SEX** + .005 INFEC (R^2 = .069)
(1.799) (1.727) (0.786) (-2.342) (0.171)

JATS

3. DIAR = .802 + .203 INCOME + .153 BELIEF + .196 FAM SZ + .136 SEX** - .070 CALOR (R^2 = .041)
(1.498) (0.346) (1.559) (2.085) (-0.308)

RAMDASIAS

3. DIAR = 3.885 - .418 INCOME** - .238 BELIEF + .006 FAM SZ - .045 SEX + .001 CALOR (R^2 = .063)
(3.097) (-1.249) (0.058) (-0.780) (.004)

t values in parentheses
* statistically significant at the .90 level
** statistically significant at the .95 level

consume less food to begin with, and for whom inadequate food intake is a more limiting factor. Second, age is somewhat more important among Ramdasias than Jats, suggesting that Ramdasia children depart more sharply from the anthropometric standards during the latter half of the first year and during the second year than do the Jat children. Finally, although statistically significant for neither group, the independent effects of income on nutritional status are greater among Ramdasias than among Jats.

Another way of looking at the relationships between these explanatory variables and nutritional status for the population as a whole is presented in Table 22 which breaks down the sample population by Gomez classification groupings. Although such a tabular breakdown does not address the matter of causality implied by multiple regression analysis, it does illustrate dramatically the differences in the explanatory variables associated with differences in nutritional status (in this case using the weight for age proxy). The table indicates that "normal" children consume 25 percent more calories than those with 3rd degree malnutrition, have less than a third of the diarrheal infection, and have had about a third as much major disease. In addition, the "normal" children average 5½ months younger than those with 3rd degree malnutrition and their incomes are roughly 50 percent higher. Even more striking are the sex differences. While females constitute 19 percent of the normal children, they account for over 87 percent of those with 3rd degree malnutrition. Similarly Ramdasias constitute less than 20 percent of the normal cases, but almost 60 percent of the 3rd degree cases.

Returning now to Table 20 we will examine in more detail the primary direct determinants of nutritional status for the population as a whole (those with statistically significant coefficients in equation 3), namely caloric intake, diarrheal infection, age, income and sex.

Table 22. Tabular Profile of Sample Children by Gomez Classification Grouping

Gomez grouping	Number of cases	Average age (months)	Percentage female	Percentage Jat	Percentage Ramdasia	Average number of live siblings	Average number of dead siblings
Normal (over 90% of "Harvard" reference weight for age)	73	10.5**	19.2**	54.8	19.2**	2.4	0.5**
1st degree malnutrition (76-90%)	181	14.8	34.8	46.4	37.6	2.2	0.6
2nd degree malnutrition (60-75%)	202	16.1	60.4	37.7	44.1	2.2	0.6
3rd degree malnutrition (below 60%)	40	16.1	87.5	20.0	57.5	2.6	1.1
Total	496	14.8	47.2	42.1	39.1	2.2	0.6

Gomez grouping	Average percentage of caloric allowance	Average number of major diseases	Average diarrheal infection rating a/	Average mother's belief's index rating b/	Average percentage literacy of mothers	Average monthly income of child's family	Average monthly per capita income
Normal (over 90% of "Harvard" reference weight for age)	65.0**	0.5**	1.1**	2.4	36**	Rs. 285 ($38)**	Rs. 53 ($7.06)
1st degree malnutrition (76-90%)	63.1	0.8	1.7	2.5	22	Rs. 245 ($33)	Rs. 47 ($6.27)
2nd degree malnutrition (60-75%)	60.4	1.0	2.2	2.4	21	Rs. 231 ($31)	Rs. 44 ($5.87)
3rd degree malnutrition (below 60%)	51.8	1.4	3.5	2.2	13	Rs. 192 ($26)	Rs. 34 ($4.53)
Total	61.3	0.9	2.0	2.4	23	Rs. 241 ($32)	Rs. 46 ($6.13)

** Significantly different from the 3rd degree malnutrition figure at the .95 level of statistical significance.
{ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.
b/ 4 = beliefs beneficial to child's health; 1 = beliefs detrimental to child's health.

Determinants of Caloric Intake

Having determined the significance of caloric intake as a determinant of nutritional status, particularly among the Ramdasias, we can proceed to identify the determinants of caloric intake, as we will do subsequently with diarrheal infection. In equations 4 and 5 of Table 20, caloric intake is expressed as a function of per capita income (equation 4) or wealth (equation 5) plus beliefs, family size (FAM SZ), caste (two dummy variables to express three castes, with CASTE 1 being Jats and CASTE 2 Ramdasias), sex (again a dummy variable where 0 = males and 1 = females), and the infection index. In spite of particularly low R^2's for these, and for the infection equations which follow, several determinants prove statistically significant. The most significant determinant for the population as a whole is beliefs, followed by income. The wealth index used as an explanatory variable in equation 5, failed to prove statistically significant, in spite of the fact that it appeared more satisfactory with respect to precision of calculation than income. This would seem to suggest that food consumption, at least that given to young children, is more significantly affected by short-run income flows than by non-liquid, accumulated assets. Sex emerges as a significant determinant of caloric intake, but only at the .90 level of statistical significance.

More revealing is the estimation of equation 4 separately for Jats and Ramdasias as presented in equations 2 of Table 21. For the Jats, beliefs is clearly the most important determinant suggesting that interventions solely designed to affect their belief patterns probably would have significant effects on their food intake. Among the Ramdasias, beliefs is a less important determinant while income is a more important one than among the Jats. This would seem to suggest that unlike the Jats, the

Ramdasia family probably requires income supplementation before it can take full advantage of information dissemination programs.

While sex is not a significant determinant of caloric intake among Jats, it is a highly significant one among Ramdasias where major differentials in caloric intake exist between male and female children. As will be discussed later in a discussion of the sex variable, such a differential is closely related to the income constraint affecting this group.

The relationship between food intake and income, introduced above, is a critical one with major policy implications. As noted in Chapter 2, there probably is no more important determinant of food intake for the population as a whole than income. Among the 6-24 month age sample population, however, the effects of income are somewhat less clear. Though a statistically significant determinant of caloric intake for the sample population as a whole, and presumably a prerequisite at the low end of the income spectrum, the coefficients estimated for the income variable are far lower than would be expected for the population as a whole. The relationship is clarified somewhat by looking at income elasticities of demand (or more accurately, of consumption) for food items and nutrients among the sample children broken down into 6 month subgroups in Table 23. For purposes of rough comparison these elasticities are accompanied by total expenditure elasticities of demand for all age groups in rural India.[5/] Among the young children the amounts of pulses, fruits and vegetables are

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5/ The differences in meaning of these two sets of figures should be noted, however. For the sample children the elasticities are derived from quantities of food consumed among different per capita income groups, while the other elasticities are derived from expenditures on food purchased among different per capita total expenditure groups. In addition, somewhat different statistical functions are used in estimating the two sets of elasticities. Nonetheless, the essential meaning is similar and rough comparisons are not unwarranted.

Table 23. Income Elasticities of Consumption[a] and Total Expenditure Elasticities of Demand Among Sample Children by Age Group and for All India (Rural) Respectively

Item	Income elasticities of consumption among sample children aged: 6-11 months	12-17 months	18-24 months	Total sample children	Total expenditure elasticities of demand for all age groups[b] in rural India
Supplementary milk	.159	.176	.282	.242	1.66
Cereals	-.160	-.099	.011	.010	0.50
Pulses	-.107	.178	-.073	.026	0.71
Fruits	-.049	-.077	.009	.036	1.43
Vegetables	.470	.232	.115	.218	0.69
Calories	.070	.041	.082	.071	
Protein	.045	.033	.034	.042	
Vitamin A	.013	.036	.065	.035	
Iron	-.055	-.057	.020	.012	

a/ Using the double-log function: $\log C_i = a + b \log Y$

where:

C_i = per capita daily consumption of a particular item

Y = per capita income

b/ Calculated by Sinha (61) using the log-log inverse function:

$$\log E_i = a - \frac{b}{X} + C \log e X$$

where:

E_i = per capita expenditure on a particular item

X = total per capita expenditure (as a proxy for income)

using 1957-58 data from the 13th Round of the (Indian) National Sample Survey.

so small and their consumption so erratic among these children that the elasticities are less meaningful than those for supplementary milk and cereals. The figures are given, nonetheless, to permit comparison with the all-age group figures.

The figures[6/] indicate clearly that the effects of income per se on the food consumption of the young children are far less pronounced than for the population as a whole. The income elasticities of consumption for calories, even among the 18-24 month age group with a lesser dependence on breast milk, is only .082 meaning that if a family somehow succeeded in doubling its income (assuming everything else, including prices remained constant) their child's caloric intake would increase by only 8 percent. (The increase in an adult's caloric intake might be 10 times that great.) The young child's protein, vitamin A and iron intake would increase by even less. This would suggest that, for the sample population as a whole, a simple income supplement program unaccompanied by other interventions is unlikely to have a major effect on their food intake.

At the same time the elasticities indicate that income becomes an increasingly important determinant of supplementary milk and cereal intake (representing 75 percent of non-breast milk calories) as the children get older. In the case of cereals, their use among lower income groups as a partial substitute for larger quantities of higher status, more expensive supplementary milk account for the negative cereal elasticities among the youngest age groups. This also would explain the negative elasticities for iron, largely a function of cereal intak

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6/ The milk elasticity of .242 would be interpreted as follows: "A 10 percent increase in income would result in a 2.42 percent increase in milk consumption."

Finally the income-food intake relationship can be examined in the per capita income group breakdowns and frequency distributions presented as a group in Appendix III. Tables III-1, 2, 3, 5, 7 and 9 give data for each of five per capita income groups, while Tables III-4, 6, 8 and 10 present the same information pooling the two top income groups and the two bottom ones respectively.7/ Tables III-3 and 4 indicate the positive although irregular effects of income on calories, protein and vitamin A intakes. Iron intake, again because of its largely cereal source, is not significantly affected by income. The frequency distributions presented in Tables III-7 and 8 indicate, nonetheless, the extent of the calorie and hence nutritional intake problem even among the highest income groups. Table III-8 using the pooled income groups indicates that in the high income group only 35 percent attain over 76 percent of their caloric allowance, while 20 percent meet 45 percent of the allowance or less. Thus, there is little question of the need for nutritional improvement even among children of economically advantaged families in this area.

The important male-female differentials in these tables will be examined in the discussion of the sex variable below.

Determinants of Diarrheal Infection

As indicated in equations 1-3 in Table 20, the one infection variable to emerge as a significant determinant of nutritional status was diarrheal

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7/ It should be noted that, ideally, grouping by total expenditure would be preferable to income grouping in such tables, since total consumption expenditure, and hence expenditure on children, could be financed not only from current income, but also from past savings and borrowings. In fact, the considerable amount of dissaving among the lowest income group may result in their spending as much as the next group up. Nonetheless, the income groupings, particularly the pooled figures, probably represent a reasonable proxy for total expenditure.

infection.[8] The variable proved highly significant, even more so than caloric intake. Estimating, in turn, the determinants of diarrheal infection resulted in the same low R^2's encountered in the caloric intake equations, probably suggesting the need for more sensitive measures of environmental conditions, water supply and food preparation procedures, preferably using time series data. Nonetheless, the equations reveal several interesting findings.

Equation 6 in Table 20 examines the determinants of diarrheal infection for the population as a whole. The primary determinant to emerge in this equation is family size. The high positive correlation with diarrheal infection would indicate either that the spread of diarrheal infection is facilitated by the crowding found in densely populated households, or that parents tend to provide less good care to later born children. Either conclusion would add still another dimension to the set of population-nutrition relationships presently being explored in many countries. Interestingly, as seen in equations 3 of Table 21 the family size determinant is far more important among Jats than Ramdasias. This would be consistent with either explanation of the family size-diarrheal infection relationship. If the spread of infection hypothesis is valid, the differentials are likely to be greater among the Jats whose households and level of environmental sanitation, while hardly ideal, are far more infection-free than those of Ramdasia families. It would be reasonable to assume that environmental conditions among Ramdasias are so poor to begin with, and the frequency and severity of diarrheal infection already so high,

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8/ Nonetheless, the infection index of diarrhea, giardia and disease history was used as a dependent variable in equation 7 of Table 20. Because of the lack of any statistical significance in the equation, discussion in the text is limited to equation 6 using diarrheal infection alone as the dependent variable.

that the addition of more children would have an umimportant additive effect. If the less-good-care-to-later-born-children hypothesis is valid, one could assume that Jats have the resources which permit such differentials. As will be suggested in the following sections, the low income Ramdasia woman at present may not be in a position to provide adequate care to a young child, even if these are only a small number of children to care for.

The other important finding in equations 3 of Table 21 is the far greater effect of income on diarrheal infection among Ramdasias than among Jats. To deal with this relationship and the ensuing analysis, it probably would be useful to think of income among Ramdasias as both a resource and a time factor. As discussed earlier, the Ramdasia woman, although usually living amidst abject poverty, is, unlike most of her Jat counterparts, a fully employed person. During sowing and harvest seasons she works in the fields. Throughout the year she collects fuel and fodder and cares for the animals above and beyond her household duties. When the income of a Ramdasia family increases, the increment will not only increase the woman's purchasing power but will at a certain level permit her to dispense with many of her responsibilities outside of the home and increase the time she has for herself and her children. This has major implications for child health. Child illness is even under the best circumstances a difficult process. Recurring diarrheal infection is among the most problematic. For the harried Ramdasia mother it is well-nigh an impossible one. In such a situation, income alone is unlikely to be a panacea. Responses to questions on the treatment of diarrheal infection indicate that a general lack of knowledge on this subject is pervasive.[9/]

9/ This lack of a major differential in beliefs and knowledge pertaining to diarrheal infection would explain the absence of a significant beliefs coefficient in these equations.

The existence of considerable diarrheal infection among upper income groups as indicated by the frequency distributions in Tables III-9 and 10, would further support the contention that more than income is necessary to deal effectively with the problem. Nonetheless the upper income Ramdasia woman with more time to devote to the problem apparently is able to deal more effectively with it even lacking adequate knowledge.

The Age Variable

The importance of the age variable, as discussed earlier, simply indicates the increasing severity of malnutrition problems as children progress beyond the age of six months. As noted earlier, these children are plagued by the combination of increased nutritional intake requirements which cannot be met with breast milk alone, and the debilitating syndrome of weanling diarrhea, so well described by Gordon, Chitkara and Wyon (29). The significance of this age variable reinforces the contention made in Chapter 1 of the need to focus the thrust of intervention programs on children of this age. The closer to the six month age group the program can come, the greater effect it is likely to have.

Income as a Proxy

The significance of per capita income as a determinant of nutritional status independent of its effects on food intake and infection (and hence on nutritional status) would seem to suggest that the income variable here represents other variables not explicitly measured in the study but highly related to income. Three such variables would seem to be most plausible:

a. Pre-natal environment - The height and weight of the child's mother (primarily a function of environmental factors during her lifetime) and her food intake during pregnancy (particularly when her height and weight are substandard) are likely to affect the birthweight of the child.

Here, as in industrialized nations, one finds significantly lower birthweights among lower income groups.

b. Demand breast feeding - Ramdasia mothers who spend a large part of each day out of the home are less available for breast feeding than are their Jat counterparts. Even if the Ramdasia mothers fed an equal quantum of breast milk during a 24 hour period, the fact that this is accomplished through fewer feedings[10/] probably makes it somewhat less efficient. In actuality, however, the Ramdasia mother probably feeds a smaller quantum of breast milk, particularly during the sowing and harvest seasons, leading to what Jelliffe refers to as "breast starvation" (35).

c. Psychological effects of a mother's presence - Although least easy of all to quantify, the psychological effect of a mother's presence may explain some of the variation in growth (54, 64).[11/]

The Sex Variable

In terms of equation 3 in Table 20, the most statistically significant determinant of nutritional status is sex. In other words, a child's sex per se would more consistently account for variations in nutritional status than any of the other variables. Similarly, sex has emerged as a determinant, although less statistically significant of caloric intake for the population as a whole, and of diarrheal infection among Jats. Thus, the sex variable clearly represents a critical determinant in the analysis and requires careful examination.

10/ Bailey (5) refers to this phenomenon of breast feeding when the mother gets a chance as "opportunity feeding" as opposed to "demand feeding".

11/ An excellent discussion of the relationship of these factors to anthropometric measures should be published shortly by Dr. DeSweemer of the Johns Hopkins Department of International Health.

To aid in this examination the major variables are broken down by caste and sex in Table 24. As seen in this table the most significant sex differences are in the anthropometric measures used as proxies for nutritional status. The magnitude of these differentials reinforces the highly significant coefficient of the sex variable in equation 3 of Table 20, indicating an important effect of sex on nutritional status independent of its effects on caloric intake and infection. There may be two explanations for such an effect. First, it is likely that the establishment of India-specific or Punjab-specific reference growth curves, like those in other low income parts of the world, would provide somewhat greater differentials in the reference growth curves of males and females even for this age group than do the Harvard standards. At the same time the greater premium placed on sons than on daughters clearly results in major differentials in their care and upbringing[12/]. Some of these differences discussed below are picked up by the data. Others relating to such factors as extra time, attention and affection devoted to male children are not accounted for statistically, yet might have major effects on child growth.

These differences reflect an economic as well as a cultural premium placed on living sons, with roots deep in Indian tradition, yet reinforced by present-day realities. Sons represent an economic asset to their parents as a bread winner and a source of social security. Daughters are considered unproductive and an expensive economic drain, particularly the cost of the dowry when they marry[13/].

12/ Our own experience in Punjab paralleled that of the Narangwal RHRC which spent "an inordinate proportion of time saving baby girls."

13/ Conversations recorded by Dr. Helen Gideon while collecting information on family size as part of the Khanna Study (66) are particularly revealing. After realizing that she was receiving information only on male children, she confronted the next woman with the dilemma and was told, "Of course, we have girls; you only asked about children and said nothing about girls."

Table 24. Tabular Profile of Jat and Ramdasia Sample Children by Sex-Caste Groupings

	Sex-caste group			
	Jat male	Jat female	Ramdasia male	Ramdasia female
Number of cases	111	98	98	96
Average percent reference weight for age	84.2	73.5	77.8	69.0
Average percent reference height for age	95.5	91.8	93.4	89.9
Average percent reference weight for height	90.1	85.3	87.0	84.0
Average percent of caloric allowance	64.4	62.7	62.6	55.7
Average percent of protein allowance	86.1	88.0	84.9	81.7
Average percent of vitamin A allowance	89.7	81.9	86.0	80.4
Average percent of iron allowance	35.1	41.3	37.5	32.7
Percent breast fed	84	70	87	82
Percent receiving supplementary milk	88	93	91	80
Percent receiving solid food	72.1	81.6	79.6	67.7
Average age of initiating solid food (months)	10.5	10.3	10.5	11.1
Average supplementary milk consumption (gms.)	204	217	164	146
Average cereal consumption (gms.)	22	31	27	25
Average pulse consumption (gms.)	8.5	8.7	6.2	9.3
Average vegetable consumption (gms.)	10.8	7.1	9.2	4.4
Average fruit consumption (gms.)	15.7	14.5	15.7	10.0
Average number of major diseases	0.91	0.75	1.08	0.89
Average diarrheal infection rating	1.52	1.98	2.38	2.21

⌣ Indicates figures significantly different at the .95 level of statistical significance.

The most serious male-female differentials in the explanatory variables occur at the lower end of the income spectrum, among the Ramdasias. This indicates the severe resource and time constraint at that income level resulting in serious consequences for the young female child who often is not particularly wanted in the first place. Only with increases in income and time, adequate for the woman to meet what are, to her, higher priority responsibilities, is she likely to turn her attention to the female child. When resources and time are no longer serious constraints, as in the case of many Jat families, the young girl can be cared for adequately, although there still will be male-female differences in the quality of that care, and, interestingly, in the length of breast feeding. Apparently both Ramdasia and Jat mothers feel obliged to breast feed male children somewhat longer, believing it will increase the likelihood of their survival and well-being.

The sex-caste differential is most dramatically illustrated in the case of food intake. Table 24 indicates that except for vitamin A and vegetable intake, the feeding of Jat females largely compensates for the shorter breast feeding noted above. The Jat female child consumes almost as many calories, more protein, more iron, more supplementary milk and more cereal than the Jat male. The Ramdasia female child not only is breast fed for a shorter time period than the Ramdasia male, but consumes less supplementary milk and less solid food, begins consuming solid food later, and receives less of each of the nutrients. The relationship similarly is seen in Tables III-1 to 4 in Appendix III. Although more erratic, they indicate that while roughly equalling the males with respect to food intake among upper income groups, female children are far less well off at the low end of the income spectrum.

The sex differences in diarrheal infection and disease among Ramdasias might appear to contradict the conclusion that male-female differences are greatest among lower income groups. According to Table 25, Ramdasia females actually have slightly less major disease and diarrheal infection that Ramdasia males. In fact, it is likely that the malnourished Ramdasia female stricken with a major disease or with severe diarrheal infection simply does not survive. This contention would be supported by the much higher infant mortality rates for females (196 per 1000) than for males (125 per 1000) found by the Narangwal RHRC (36). Among low income families these differences would be even more pronounced. Thus, a Ramdasia female child who remains in the sample would likely have somewhat less frequent and severe diarrheal infection, although more than her Jat counterpart, and probably would not have had more than one major disease.

Discussion

The above analysis demonstrates rather strikingly the difficulties in dealing uniformly with different socioeconomic groups, even within a narrow age group. The health of a young Jat child probably approximates the norm for children of his age in low income countries as a whole, although male-female health differentials may be somewhat greater in Punjab. His caloric intake is low, and this, coupled with diarrheal infection, limits his physical growth. His family is, on the average, economically better off than similarly placed families in other low income countries. Yet, though his mother has both the resources and the time, she lacks the facilities in her rural surroundings to translate this income and time into major health improvement for the child. Evidence from Calcutta (30) suggests that were she living there or in other urban centers her family income would be a far more significant determinant of her child's well-being.

This would seem to suggest that only where facilities exist which permit easy translation of improved income into such advantages as better health care and advice, improved environmental sanitation and perhaps better education, are income increments likely to make much of a difference in a child's food intake and his health.

Were such facilities, in the form of clinics or education programs, available to the Jat mother living in the Morinda area, she probably would be in a position to benefit significantly from them. Coming from a landed family she is somewhat more worldly than her Ramdasia counterpart, she may have studied in a school for a few years, she may be literate or at least have a literate husband, and she has both the resources and the time to put into practice the messages of a feeding demonstration program or health clinic. Perhaps most important, she is not living on the edge of poverty and therefore, like her husband faced with new seed varieties or fertilizer, is somewhat more willing to innovate.

For the Ramdasias the situation is quite different. The child in a Ramdasia family is considerably more malnourished, often reaching the point where survival depends on escaping a bout of measles or severe diarrhea. If the child is a girl, the situation is that much worse. The child spends much of the day in the care of an older sibling while its mother is working outside of the house. In some extreme cases the family simply lacks the resources to provide even minimal care for the child. More often its mother lacks the time to deal explicitly with the need. From her own experience and that of her neighbors, she knows that giving her child supplementary food probably will result in a severe attack of diarrhea which she would just as soon avoid. If her child is a girl, there are that many more priorities which must be met first.

Providing education alone to women in such circumstances is virtually doomed from the start. The annals of well-meaning educators are filled with episodes of neatly arranged demonstrations attended only by the well-to-do. The educators track down the lower income mother and deliver their message to a nodding, acquiescent woman who then totally ignores it. The educator throws up her hands in horror and stomps away to write another report about the ignorant villager.

In fact, the Ramdasia woman and her counterparts in other societies rarely can afford the leisure of visits to a demonstration program or health clinic. Furthermore, being more reticent and fatalistic and less worldly than the Jat mother, she is far less willing to take the initiative often required for such participation. Should she actually attend the clinic or demonstration she is unlikely to fully understand the message. And if she does understand the message, she is unlikely to have the resources, time or security to translate this information into practice. Finally, even if the mother can get past the child's first few years without income supplements by reallocating existing resources with the aid of newly acquired education, how is she to deal with the increasing expenses of feeding and caring for a child as it grows older and until it becomes a productive unit? Should the child be a girl, in this society a less productive unit, with the major expense of a dowry in her mid-teens, the question becomes that much more ominous.

In sum, one probably could conclude that any intervention would have a far greater positive effect on the Jat child than on the Ramdasia, and have the ultimate effect of further widening existing differentials.

CHAPTER 6

CONCLUSIONS AND INTERVENTIONS

On the basis of the analysis presented in the preceding two chapters the following conclusions might be drawn about this population of young children in rural Ropar District near Morinda:

1. The extent of malnutrition in this population, in spite of its location on the outskirts of the "Green Revolution," is more serious than that found in most other parts of the low-income world. It also is more severe than that found in the heart of the Indian "Green Revolution" (Ludhiana District) although nutritional status of the comparable age population in that area is seriously substandard. While all groups are affected, the two most severely malnourished subgroups of young children in both areas are the Ramdasias and the females.

2. When anthropometric measures are used to measure nutritional status in cross section analysis, nutritional intake (at a point in time) and infection are both highly significant determinants. Among Ramdasia children whose nutritional intake is lower and a more severely limiting factor, this intake variable is a more important determinant of nutritional status than among Jats.

3. Another important explanatory variable of differences in nutritional status is age which is inversely related. Beyond the age of about six months the children become increasingly vulnerable to protein-calorie malnutrition and weanling diarrhea, and begin to depart sharply from the reference anthropometric standards.

4. Beyond these, income has a significant effect on nutritional status independent of its effects through food intake and infection.

This effect probably reflects such income-related, growth affecting factors as pre-natal environment (largely a function of the weight, height and nutritional intake of the child's mother), demand as opposed to opportunity breast feeding throughout the child's lifetime, and perhaps the psychological advantage to the child of the mother's presence.

5. Finally, sex has a significant effect on nutritional status, independent of its effect on food intake and infection. This might be partly attributable to insufficient sex differentials in the reference standards used. It also would be explained by the premium placed on living sons in this society, and the resulting difference in the quality of care and in the affection given to male and female children, factors not fully accounted for in the other explanatory variables.

6. Caloric intake is, by a wide margin, the most important component of nutritional intake. It emerges, in fact, as a better explanatory variable than weighted indices of calories, protein, vitamin A and iron. In terms of the deficiencies per se, the most serious are calories (average 61.3 percent of allowance) and iron (36.7 percent of allowance) although there would seem to be some question about the validity of at least the caloric allowance. Protein deficiency appears less serious and not a significant problem independent of the calorie one. Similarly, vitamin A deficiencies do not appear as serious as in other parts of India.

7. Among both Jats and Ramdasias, caloric intake is a function both of beliefs and income, although the variables as a whole explain little of the variation in caloric intake. Among Jats, beliefs clearly is most important suggesting that interventions solely designed to affect these belief patterns would have significant effects on food intake. Among Ramdasias, beliefs is less important than among Jats but income more

important suggesting that the income problem in these families probably has to be addressed before education programs can have the desired effects At the same time, as indicated by particularly low income elasticities of consumption, income supplementation alone will have a limited effect on the overall problem of inadequate food intake for the children as a whole in this age group.

While sex is not a significant determinant of caloric intake among Jats, it is important among Ramdasias where major differentials in caloric intake exist between male and female children. Given particularly tight income constraints, plus major demands on the time of a Ramdasia woman, coupled with the much higher premium placed on male children, even near-adequate feeding of a young female child is the exception rather than the norm.

8. The beliefs measured and found to be a significant determinant of caloric intake particularly among Jats, related to mothers' views on the optimal age of food supplementation, her dietary response to infection, and her beliefs on the cause of a Punjabi language equivalent of nutritional marasmus. The practice of delayed solid food supplementation emanates from the association of such supplementation with diarrheal infection and gastrointestinal disorders in general, and the association of these, in turn, with child mortality.

9. Diarrheal infection is, again by a wide margin, the most important component of infection. Neither disease history nor giardia proved significant. As in the case of caloric intake little of the variation in diarrheal infection is explained by variables in this study, and probably requires more sensitive measures of environmental sanitation, water supply, and food preparation practices. While income has an insignificant

effect on diarrheal infection among Jats, it is highly significant among Ramdasias. For the sample population as a whole, family size is the most important determinant of diarrheal infection, suggesting either that the spread of diarrheal infection is facilitated by the crowding found in more densely populated households, or that parents tend to provide less good care to later born children. Diarrheal infection and disease is higher among Ramdasia males than females, probably suggesting that the malnourished female, stricken with severe diarrhea or disease, is less likely to survive.

10. In general, because of a greater availability of time and resources coupled with somewhat less fatalism and a more basic sense of security, the Jat mother and hence the Jat child (who also suffers from malnutrition) are likely to derive higher benefits from any intervention program than will their Ramdasia counterparts. For the Jat woman, most of the preconditions would seem to be met for the effective translation of her income and time into improved health for her children once the facilities to permit such translation (education programs, health clinic or other interventions) are established. For the Ramdasia, largely bypassed by the development process, these preconditions generally have not been met.

Intervention Strategies

To the extent possible the discussion of interventions will be carried out in the context of a nutrition planning model developed by Levinson and Call (37) for the U. N. Protein Advisory Group in 1970. The relevant portion of that model, for our purposes, permits the comparison of alternative nutrition intervention programs or program proposals by rough estimation of their benefits or their effectiveness and of their costs according

to a particular objective. Generally such an objective is cast in terms of economic efficiency. As discussed in Chapter 1, however, there is virtually no empiricism on which to support an economic efficiency base. Alternatively one could employ an equity objective either with respect to economic class, or perhaps as in this case, with respect to sex. Even here, however, one encounters major difficulties in quantifying benefits for a particular economic class or sex. Given these difficulties it probably makes sense to select a somewhat narrower objective such as decreasing malnutrition-related mortality or meeting a specific nutritional deficiency (e.g. low iron intake) or a particular nutritional disease (e.g. prevalence of nutritional marasmus in a population).

Direct benefits of a proposed program then would be measured in terms of its projected effectiveness in meeting that specific objective. Beyond the direct benefits with respect to the nutrition objective, the indirect multiplier effects of a proposed program on other development sectors or goals must be considered. A school feeding program even with negligible direct nutrition effects might be justified on the basis of increased school registration and performance. A labor-intensive dairy or fruit and vegetable program may not be the best means of meeting, say, vitamin deficiencies, but might be justified on the basis of their positive effects on income-generating employment (with, perhaps, increased nutritional benefits in the long run). Similarly, nutrition intervention programs might have multiplier effects on agricultural or industrial productivity or on family planning motivation.

On the cost side one first would examine direct production, distribution and administrative costs of a proposed program. It might also be necessary to isolate and examine the foreign exchange component of the

costs. Beyond these, one would examine the expected consumer acceptability of a program, its expected speed of implementation (with calculations using a discount rate), and its viability, each of which could substantially affect the real cost of a program. Finally one would project the program's political effects which could be a benefit or a cost.

On the basis of projected or actual data, a proposed program would be measured by each of these benefit (or effectiveness) and cost criteria. It then would be necessary to assign appropriate weights to each of the criteria based on their perceived political and socioeconomic importance (weights which in actuality usually are assigned by political leadership). Having assigned such weights, the benefits or effectiveness and costs of the alternative program proposals can be compared.

Although no such quantitative cost-benefit or cost-effectiveness analysis is undertaken in this study, it nonetheless is possible to examine the relevance of certain types of interventions in the context of the criteria outlined above. This discussion constitutes the remainder of the chapter.

The fact that the food intake problem among this group relates more to calories and beliefs than say to protein and availability would eliminate at the outset a number of interventions which have been considered or attempted in other areas. For example, although any of these conceivably might be justified on other grounds or for other groups, the primary needs of this group would not suggest the development of protein supplements or the production of oilseed or fish protein concentrates or of single cell protein from petroleum or algae. In terms of the above-discussed cost-benefit model, the direct benefits to the target group of such interventions would be too small to warrant their consideration.

Similarly, neither the production of synthetic amino acids nor the development of cereal strains with higher protein or better amino acid profiles would seem to be a priority here.

Since the availability of particular food commodities does not appear to constitute an important constraint to improved nutritional status among this group, the utilization of price policy as an intervention to aid this group would similarly seem out of place. Neither would commonly employed positive price policies[1/] have a beneficial longer run effect on the objective of improving the economic status of low income groups. In general, these positive price policies have an income transfer effect from the consumer to the producer. The result is a welfare improvement in the agricultural sector at the expense of a decline in urban welfare. Within the urban sector, increases in food prices will most seriously affect low income groups, who spend a larger percentage of their incomes on food. Within the agricultural sector, since benefits of a positive price policy are in proportion to sales, they will accrue to the large producer who markets the bulk of his goods rather than to the small subsistence farmer who markets little or nothing (49). Thus, while a positive price policy may increase production of desirable commodities and hence be a sensible course of action under certain conditions, it will not often, in and of itself, improve the nutritional well-being of urban and rural low income groups in greatest need of assistance. On the contrary, it may well adversely affect their welfare. In the context of the model, commonly employed price policy would have low direct benefits and potentially very high costs including the need for scarce administrative resources with particularly

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1/ A policy maintaining support or incentive prices for food producers.

high opportunity costs. In addition, it has a negative multiplier effect on the process of economic transformation or the transfer of resources from the agricultural to the industrialized sector, a general requisite for economic growth (48).

As noted earlier, virtually any nutrition intervention program initiated in this area is likely to have a significantly greater beneficial effect on Jat children than on Ramdasias. At the same time, the malnutrition problem among Jat children is a serious one and probably deserving of attention even if the interventions employed have a less significant effect on the Ramdasias. The interventions discussed in the following sections are likely to fall into this category. They are followed by some comments on the Ramdasia problem per se and the prerequisites needed to bring about viable change for that group.

Information Dissemination

In terms of intervention the problems of inadequate food intake, delayed food supplementation, diarrheal infection and beliefs, each of which exists at all points on the economic spectrum, might best be addressed as a group. If so, this might suggest some combination of information dissemination, geared initially at the Jats, and the provision of a specially prepared easily digested weaning food. Both are exceedingly difficult. In fact to date there have been few if any successes in either on anything beyond a demonstration scale in terms of significantly affecting the nutritional status of those in need among this age group.

Ideally what is called for is the effective dissemination of a rather simple message, perhaps as simple as "If you want to increase the likelihood of your child's survival and improve his health, you must begin giving him solid food at the age of 4 to 6 months, even if this results initially

in some diarrheal upset. To decrease the chances of severe diarrhea, feed him a well cooked easily digestible food such as 'dahlia' (porridge) or 'halwa' made from sooji (samolina) and 'ghee' (unrefined butter)."[2] Secondary messages, equally simple, might stress hygiene and in some cases inoculations.[3] They also could emphasize the need for increased food consumption by women in their last trimester of pregnancy. Again, to the extent any of these messages are directed at the Ramdasias, they should take into account the severe resource and time limitations of that group.

There is evidence from Narangwal, Khanna, and our own study that on a small scale this message can be effectively disseminated with rather dramatic results in the case of malnourished children. The question is how best to disseminate it on the massive scale required. Traditionally, two basic approaches have been available for such a purpose, the person to person extension approach and the mass media one. The former has been undertaken as part of U. N.-assisted Applied Nutrition Programs and by government extension agents, health clinics, and voluntary agencies. In some cases it is incorporated into the formal education curriculum. Ideally it permits firsthand demonstrations, firsthand responses to expressions of scepticism, and the necessary followup.

The critical questions to be answered in the case of "person to person" information dissemination are two. First, what is the cost and

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2/ The fat content of the diets of these children probably has to be increased. Given the bulk constraint on diets of young children, such a source of concentrated calories would clearly be desirable.

3/ Information collected in this study on inoculations indicated that virtually all children were vaccinated against smallpox and about half received BCG inoculations against tuberculosis (the latter depending almost solely on whether or not the local inoculation unit reached the child's village). No other inoculations were given. A child's inoculation history was not significantly related to belief patterns or disease history.

time period necessary to reach the bulk of the population in a medium or large sized low income country? While nutrition rehabilitation centers have had considerable success in Haiti, the cost of similarly reaching the pre-school age population of India, for example, would exceed 1.5 billion dollars.

The second question is the effectiveness of such intervention as measured by the ultimate criterion of improved nutritional status. Equally important are the carryover effects over time and space. Does the mother who has received such education continue to observe the recommended practices a year later? Does she observe them with her subsequent children? Does she effectively pass the knowledge to her neighbor or must the neighbor also be reached directly? Unfortunately few nutrition education programs gather such information, which would be of considerable value in refining existing programs and designing new ones.

Mass media efforts are carried out through newspapers and magazines, cinema, billboards, radio, television, and through messages on everything from buses and rickshaws to calendars and yo-yos. Operating on a "mass" basis they circumvent the basic problems of cost and time cited above in relation to person to person efforts. While many mass media initiatives may lack the human, personal approach of more traditional nutrition education, others may provide it more effectively through the broadcast speech of a prime minister or important religious figure. Furthermore, mass media efforts are usually undertaken by groups better capable of communicating than traditional nutrition educators. They must of course be provided with the right messages -- as they sometimes haven't been -- if this communication is to have the desired effect.

The primary questions to be answered by advocates of increased investment in the mass media approach would be the following:

1. How much does the approach depend on the skills or sophistication of the lowest income groups in need of the assistance? Where literacy is required these groups automatically would be largely eliminated in rural Punjab. Similarly, Westernized techniques of selling a product or concept which might have considerable appeal to the communicators and to the well educated segments of the population might well bypass most of the lower income group in rural Punjab for whom the communication was intended (24, 35).

2. What is the cost of introducing large scale but decentralized broadcasting or television capable of reaching the bulk of the populace but still keeping the messages relevant and in the right language or dialect?

3. While presumably capable of successful motivation if handled intelligently, how effective are the media (television aside) in disseminating the techniques of new practices to an illiterate populace?

4. Can low income groups translate the messages into improved practice and well-being without income increments, or will they merely widen their expectations gap with possible social and political consequences (25.

With respect to the cost-benefit model, person-to-person extension efforts would have potentially high benefits assuming adequately skilled extension personnel plus sufficient income among the recipients. On the other hand, such programs imply high costs (particularly the opportunity costs of trained extension personnel) and lengthy implementation periods. Mass media efforts might have somewhat lower direct benefits but involve lower costs and more rapid implementation. In terms of actual programs,

person-to-person and mass media efforts actually constitute two ends of a spectrum with many possible points in-between. Among them are such entities as under-five clinics serving one or several villages and requiring minimal staffing. Equipped to provide uncomplicated health care and utilizing simple height-weight charts, such units can claim many of the advantages of the extension effort at lower cost.

In the context of rural Punjab, the level of overall economic growth coupled with the existence of a rather impressive network of extension services would suggest the possibility that a well planned, well financed and highly focussed information dissemination program largely utilizing existing facilities could be successful in reaching the Jat mother and her child. With respect to health extension there presently exists a cadre of public health nurses, lady health visitors and village attendants who already provide basic health and family planning services to a portion of the population. By significantly increasing the number of such persons (probably accomplished without major difficulty if their status and salaries were made commensurate with their responsibilities) and providing training in the effective dissemination of the message, this group could begin to have an effect on the problem. Similarly, the network of maternal child health centers and family welfare planning centers currently being geared up to provide improved family planning services could also be an instrument for the dissemination of this message.

With respect to mass media, the major instrument presently available is the radio. Of the families whose children were included in this study 47 percent own radios, almost all of them Jats. Although only slightly over a third (36 percent) of the mothers in these radio owning families listen to the existing "women's programs" which include information on

child care and family planning, the time spent listening to such programs proved a significant determinant of beliefs which, in turn, was found to be the primary factor affecting the nutritional intake of children. One wonders what kind of impact might be possible if these programs were improved and made more attractive while, at the same time, means were found to increase the availability and decrease the cost of transistor radios in these areas.[4/] Beyond radios there is room for considerable imagination in reaching the target audience through mobile film shows, and many of the same techniques effectively used in selling everything from soap and cooking oil to cigarettes and batteries in rural India.

Weaning Foods

It is possible that efforts to disseminate the child care message would be facilitated if accompanied by the distribution of food. If the food were a precooked, easily digestible weaning food, it also might aid directly in alleviating the nutritional intake problem. Finally, if family planning centers were among its distribution outlets, the availability of food might considerably strengthen the effectiveness and drawing power of these centers. Success in population control in turn, aside from its obvious importance to overall development, would, according to these findings have a positive effect in decreasing infection among children of this age group. There already is a sizeable body of evidence that children from smaller families eat better. Though that relationship failed to emerge in this study, it probably would be found among slightly older children whose food consumption is less affected by family belief patterns.

4/ In addition to their utility for information dissemination (and in spite of their noise) it is generally accepted that the existence in rural areas of such mechanized items, representing a tangible means of translating earnings into satisfaction, serve as a necessary component of the earnings incentive (48).

There have been numerous efforts in low income countries to commercialize such food products supposedly geared to nutrition, and more specifically protein, problems. During the past two decades, and beginning with dried skimmed milk, numerous such products have been developed and marketed with such an orientation: Vitascy in Hong Kong, Pro-Nutro in South Africa, Incaparina in Central America, Fafa in Ethiopia, Laubina in Lebanon, Saci in Brazil, and many others. Other processed foods, particularly baby foods, have been promoted in these countries on nutritional grounds but make no pretext of aiming for other than the middle and upper income markets.

A wide range of problems has faced producers of such products but one basic one has faced them all. This in simplest terms is the conflict between nutritional impact and profits. The fact that the two have been mutually exclusive in virtually all such efforts represents the basic dilemma facing this type of intervention. In Punjab as elsewhere the disposable incomes of economically disadvantaged groups in these countries are often inadequate to afford even the regional food staple. In the production of a processed food, even with negligible margins, the cost of the raw materials represents no more than a third to a half, and usually much less, of the total product cost, which is dictated by costs of processing and packaging in these countries and by the normal marketing costs involved in any commercialization. This leaves the product well beyond the reach of most of those who need it.

It would seem apparent, therefore, that if such a product, in this case a processed weaning food, is considered desirable the market mechanism alone is unlikely to suffice. If it is desirable to commercialize such a product at all, and it may well be, this would have to be done

through government subsidy and control. In terms of its non-commercial production and distribution the government's role seems reasonably clear. The basic need is to institutionalize the feeding into the domestic food distribution system where this has not yet been done. Where this is not done, low income countries will remain dangerously dependent on existing international assistance in child feeding, which in and of itself is problematic and which, if withdrawn, might leave little if any structure remaining. Mechanisms to accomplish this usually needn't be developed from scratch. Where governments are actively engaged in the buying and selling of food commodities, particularly as the supply of these commodities begins to exceed effective demand, portions of government stocks might automatically be earmarked for child feeding. Beyond this, an agricultural planning body projecting supply requirements to meet domestic demand, buffer stock and export needs, could without major complication add a fourth category, namely, child feeding requirements. Within this larger framework there may be a role for the local food processing industry.

Looking at weaning foods per se in the context of the cost-benefit model, the extent of their direct benefits would seem to be dependent on their cost, the effectiveness of their distribution, and the efforts made to overcome initial consumer resistance. Given the belief patterns noted in this part of Punjab it is unlikely that the introduction of such a weaning food would meet with much receptivity unless coupled with an effective motivational effort. If such production permitted reasonable profits it could become a relatively viable program. More likely, however, a weaning food production and distribution program resulting in significant nutritional benefits to this age group not only would preclude

profit margins but would entail major, recurring government expense. On the other hand, an effective distribution, aside from its direct benefits, could as noted above have the important multiplier effect of strengthening the institutions used to distribute it.

Iron Supplementation

Even though the specific effects of low iron intake on the morbidity, mortality and general health of these children may be difficult to isolate with precision, the extent of severe iron intake deficiency found in Chapter 4 suggests the need for explicit intervention. The problem might be addressed by an enlarged network of extension personnel and health centers through the distribution of iron and folic acid supplements to women and children. This already has been undertaken in parts of India with some success. Given the dimensions of the problem and its existence in severe form well beyond the target group, however, it may be useful to consider the iron fortification of a food item such as salt (44) consumed by the entire population. Such fortification, in terms of the cost-benefit model would have potentially high benefits for those in the target populace who regularly consume solid food. It would have no effect on exclusively breast-fed or supplementary milk fed infants. Given the major iron deficiencies existing in other population groups, such mandatory fortification could have direct health benefits well beyond the target group. Production, distribution and administrative costs would be relatively low, and assuming no adverse effects on the appearance or taste of the salt, acceptability should be high permitting relatively rapid implementation.

The Ramdasia Problem

As indicated earlier, most of the interventions discussed above are likely to have a more significant effect on the Jat child than on the

Ramdasia[5/]. Such programs can be justified on the basis of the significant malnutrition found among Jat children and the expectation that reasonably efficient programs will bring about major improvement in their well-being. But what about the Ramdasia child and his even more severe malnutrition problem?

To assume that slightly more resources or more governmental commitment behind such programs will, in and of themselves, meet the needs of these children, is, as discussed in the previous chapter, probably unrealistic. Even if the services were available the Ramdasia woman is unlikely to have the resources, time, or basic sense of security to take advantage of them. And even if she should express receptivity there is little assurance she will be able to fully avail of existing programs. In the usual case where demand for scarce services exceeds supply, they usually end up going to the more economically advantaged. In addition, where such programs are controlled by existing rural elites there may be little effort to extend these services to the poor. An evaluation of the Indian Applied Nutrition Program, currently underway, has found considerable evidence of the difficulties involved in reaching the intended poor when programs at the local level were controlled by these rural elites.

As seen in the Chapter 5 analysis, the most basic and limiting constraint facing the Ramdasia child is income. Both with respect to food intake and infection, income increases are necessary both to provide resources and to permit the child's mother more time at home. The potency of any other intervention directed at this group is likely to be minimal until this basic limiting factor is addressed.

5/ Free weaning food distribution and salt fortification might be exceptions.

The major developmental thrust in rural Punjab, namely technological change in agriculture, probably has had little if any positive effect on this problem. While new seed varieties and multiple cropping have increased the demand for agricultural labor, the consolidation of holdings by landowners (meaning less intensive cultivation) and the increase in mechanization probably have had a somewhat offsetting effect. Meanwhile, there has been major economic advantage to the landowning Jats, thus widening previous economic differentials.

To some extent the problem could be addressed through an increase in labor intensive income generating employment. This would include not only rural works schemes and small scale industrial developments (e.g., brick kilns or agricultural implement manufacturing) but also labor intensive milk production and fruit and vegetable cultivation (50)[6/]. While such efforts might well have the important effect of reducing the number of non-participants in the growth process, it would still leave largely unaffected the major population group at the bottom of the economic spectrum.

Stated simply, neither the range of alternative nutrition intervention programs nor the available means of generating income through employment is likely to have the desired effect on the most economically disadvantaged. Programs attempting to reach the Ramdasias through these means are not only

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6/ If the Ramdasia child's nutritional status suffers significantly during harvest and sowing seasons because the mother, needed in the fields, is absent for much of the day, it may be worse if additional employment opportunities for which she is eligible are created. It is likely, however, that even the Ramdasia woman's income elasticity of demand for leisure is sufficiently high that once her family income level has reached a tolerable point she would opt to follow the ways of her Jat counterpart and spend increasingly more time at home. In addition, increasing technological change in agriculture will have the longer run effect of evening out seasonal labor requirements, and by leveling off the peak sowing and harvest seasons, reduce the need for woman labor.

likely to be unsuccessful, but might have the negative effect of permitting complacency in regard to the basic plight of these highly disadvantaged, and largely ignored enclaves. One can only conclude that the plight of the poorest poor will continue unless and until they themselves become substantially involved in the income growth and development process. Until they are permitted active political participation in the processes of change and development which surround them, there is little likelihood these persons will be able to take advantage of such change or restructure it in ways necessary to ameliorate their own condition and that of their children in some viable fashion.

In conclusion, the study would seem to suggest two rather different approaches to the malnutrition problem. For the landed Jats (and probably for most of the heterogeneous "others" group and even a small portion of higher income Ramdasias) a program of information dissemination related to child care and feeding probably would be the single most important intervention. Such information dissemination might be facilitated by a weaning food distribution which, in turn, could strengthen the outlets selected for such distribution, among them family planning institutions. For the Ramdasia, a substantial improvement in his economic position appears to be a prerequisite for viable improvement in the nutritional status of his children. Only when this basic income constraint is overcome, are his children likely to be able to derive significant benefits from the kinds of nutrition intervention programs discussed in this chapter. Such economic betterment, in turn, probably requires rather basic changes in social and political organization through which the poor can restructure and more fully avail themselves of the opportunities inherent in the development process.

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APPENDIX I

DATA COLLECTION SHEET

Number _____

A. General Information

Name of village _____ Patti or Vehra _____

Name of child _____

Name of child's father _____

Age of child (months) _____ Date of birth _____

Sex: M / F (circle) Caste: Jat / Ramdasis (or Harijan)/ Other _____ (specify) (circle)

Weight _____ Height _____

B. Demographic

List living children by age and sex

	Sex	Age
1.		
2.		
3.		
4.		
5.		

No. of liveborn children who died _____

To be filled in later:

Nutritional intake per 24 hours: Calories _____ _____
Protein _____ _____
Vitamin A _____ _____
Iron _____ _____

Parasite measure _____

Medical experience rating _____

Family wealth index _____ Family income _____

Beliefs index _____ Inoculations index _____

C. Medical

		Circle	At what age (months)
Has child had:	Smallpox (Bara mata)	Yes No	_____
	Measles (Khasra)	Yes No	_____
	Other matas (Impetigo, Rubella, Chicken pox)	Yes No	_____
	Severe diarrhea (dysentery, or stools with blood or mucous)	Yes No	_____
	Pneumonia	Yes No	_____

Does child have a smallpox scar? Yes No

Does child have a BCG scar: Yes No

Does child have diarrhea now? Yes No

On how many days during past 7 days has child had diarrhea? _____

How much diarrhea has the child had during its life?

Circle: almost none 10% of time 25% 50% 75% 90%

D. Mother's Beliefs and Education

In your opinion, at what age should child be given supplementary milk?_____ solid food?_____

What would you do to the child's diet if child had

diarrhea? _____

fever? _____

mata or typhoid? _____

What is the cause of marasmus (soka)? _____

Does explanation involve evil spirits or shadows? Yes No (circle)

What should be done if child has soka? _____

Years of schooling of mother_____ Literacy (any language) Yes No (circle)

No. of days during past 7 days that mother listened to a women's program on the radio (12:30 afternoon, 7:30 evening, 11:30 Sunday)_____

E. Child Feeding

Is child breast fed? Yes No (circle) If no, at what age was breast feeding stopped? _____

Is the amount of breast milk normal? Yes No (circle) If no, explain _____

Does the child receive supplementary milk? Yes No (circle)

If yes, at what age was it started? _____

Does the child receive solid food? Yes No (circle)

If yes, at what age was it started? _____

If yes, why is it that some other mothers don't give solid food? _____

If no, why is it that some other mothers give solid food? _____

Was food given in the past 24 hours normal for the child? Yes No (circle)

If no, explain _____

Are any vitamin pills consumed by the child? Yes No (circle) If yes, which _____

Food consumed by child yesterday

Item	Volume	Weight	Calories	Protein	Vitamin A	Iron

F. Family Wealth Index

Father's occupation _____

1. Housing (circle)

Walls: All brick / Mixed / All mud

Floor: Paved / Dung / Other _____ (specify)

Roof: Brick / Thatched / Other _____ (specify)

Total number of rooms _____ Electricity in house Yes / No

2. Animals

Oxen _____ (number) Cows _____ Buffalo _____

Camels _____ Other, specify _____

3. Sanitation

Water source	Drinking	Other uses	Ownership	Jt. ownership
Open well				
Hand pump				

Distance of drinking water source from kitchen (in yards) _____

4. Mechanical possessions (Yes or No) (Put fraction if joint ownership)

Bicycle _____ Radio _____ Sewing machine _____

Cart _____ Persian wheel _____ Borewell _____

Thrasher _____ Mechanical fodder cutter _____

Sugar cane crusher _____ Other (specify) _____

5. Economic Status

House owned: Yes / No

Land owned: Cultivatable

	kub / pub / ki / a
Rented in	
Rented out	
Sharecropped in	
Sharecropped out	

Income from other than one's own land

Source	Cash	Kind	
			D / M / Y
			D / M / Y
			D / M / Y

Total income _____ D / M / Y

APPENDIX II

FAMILY WEALTH INDEX

House walls:	Brick = 20	Mixed = 15	Mud = 10	multiply by $\frac{1}{2}$ if house is not owned
House floor:	Paved = 10	Mixed = 6	Dung = 2	
House roof:	Brick = 20	Mixed = 17	Thatched = 15	
Rooms:	20 per room			
Electricity:	Yes = 12	No = 0		
Animals:	Ox = 5	Cow = 3	Buffalo = 5	
	Camel = 5	Other = 1		
Source of drinking water:	Open well = 2	Hand pump = 10		multiply by: ownership = 1, part ownership = 2/3, not owned = 1/3
Source of water for other uses:	Open well = 2	Hand pump = 10		
Possessions:	Bicycle = 2	Radio = 1	Sewing machine = 2	
	Cart = 5	Persian wheel = 10	Bore well = 50	
	Thrasher = 20	Mechanical fodder cutter = 10		
	Fodder cutter = 2	Sugar cane crusher = 5		
Land owned:	Acre = 40	Kucha Bigha = 8	Pucca Bigha = 4	Kila = 32
Income from other than family-owned land:	Divide annual income in rupees by 140			

APPENDIX III

PER CAPITA INCOME GROUP BREAKDOWNS AND FREQUENCY DISTRIBUTIONS

Table III-1 Tabular Profile of Male Children by Per Capita Income Groups

	Monthly per capita income				
	Rs. 24 and below (Jats=6.3% Ramdasias=81.3%)	Rs. 25-39 (Jats=22.0% Ramdasias=47.5%)	Rs. 40-50 (Jats=55.6% Ramdasias=27.8%)	Rs. 51-75 (Jats=52.1% Ramdasias=25%)	Rs. 76 and above (Jats=75.5% Ramdasias=7.5%)
Number of cases	48	59	54	48	53
Average percent reference weight for age	77.7**	79.6	83.2	83.3	84.4
Average percent reference height for age	93.7**	93.4	94.9	95.2	95.9
Average percent reference weight for height	86.5**	88.7	90.0	89.5	89.8
Average percent of caloric allowance	62.3	55.0	63.6	68.3	66.8
Average percent of protein allowance	84.0	79.3	87.0	89.3	88.7
Average percent of vitamin A allowance	85.3	83.1	89.2	87.6	91.1
Average percent of iron allowance	36.3	32.3	34.6	38.8	37.2
Percent breast fed	85.4	89.8	81.5	79.2	81.1
Average daily supplementary milk consumption (gms)	191	124	182	234	223
Average daily cereal consumption (gms)	25	21	24	26	24
Average number of major diseases	1.17	1.00	0.89	0.65	1.09
Average diarrheal infection rating[a]	2.65**	2.17	1.85	1.46	1.28

** Significantly different from the "Rs. 76 and above" figure at the .95 level of statistical significance.
⏟ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.

Table III-2 Tabular Profile of Female Children by Per Capita Income Groups

	Monthly per capita income				
	Rs. 24 and below (Jats=7.5% Ramdasias=77.4%)	Rs. 25-39 (Jats=25.5% Ramdasias=52.7%)	Rs. 40-50 (Jats=45.0% Ramdasias=27.5%)	Rs. 51-75 (Jats=60.0% Ramdasias=24.4%)	Rs. 76 and above (Jats=82.9% Ramdasias=9.8%)
Number of cases	53	55	40	45	41
Average percent reference weight for age	69.5	69.2	71.2	74.2	71.8
Average percent reference height for age	90.1	90.1	90.9	91.5	91.3
Average percent reference weight for height	84.3	83.2	83.7	86.7	84.7
Average percent of caloric allowance	53.2**	60.4	55.3	63.6	66.4
Average percent of protein allowance	77.4**	86.9	85.8	85.6	91.2
Average percent of vitamin A allowance	82.5	79.0	77.6	87.9	84.8
Average percent of iron allowance	34.1	39.7	42.3	35.1	38.6
Percent breast fed	88.7	69.1	65.0	82.2	75.6
Average daily supplementary milk consumption (gms)	116**	188	156	216	247
Average daily cereal consumption (gms)	25	28	33	28	27
Average number of major diseases	0.91	0.98	0.78	0.64	0.68
Average diarrheal infection rating[a]	2.36	2.44	1.70	1.49	2.49

**Significantly different from the "Rs. 76 and above" figure at the .95 level of statistical significance.
⌣ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.

Table III-3 Tabular Profile of All Sample Children by Per Capita Income Groups

	Monthly per capita income				
	Rs. 24 and below (Jats=6.9% Ramdasias=79.2%)	Rs. 25-39 (Jats=23.7% Ramdasias=50%)	Rs. 40-50 (Jats=51% Ramdasias=27.7%)	Rs. 51-75 (Jats=55.9% Ramdasias=24.7%)	Rs. 76 and above (Jats=78.7% Ramdasias=8.5%)
Number of cases	101	114	94	93	94
Average percent reference weight for age	73.4**	74.6	78.1	78.9	78.9
Average percent reference height for age	91.8**	91.8	93.3	93.4	93.9
Average percent reference weight for height	85.3	86.0	87.3	88.2	87.6
Average percent of caloric allowance	57.6**	57.6	60.0	66.0	66.6
Average percent of protein allowance	80.5**	83.0	86.5	87.5	89.8
Average percent of vitamin A allowance	83.8	81.1	84.2	87.7	88.3
Average percent of iron allowance	35.1	35.9	37.9	37.0	37.8
Percent breast fed	87.1	79.8	74.5	80.6	78.7
Average daily supplementary milk consumption (gms)	151**	155	171	225	233
Average daily cereal consumption (gms)	25	24	27	27	26
Average number of major diseases	1.03	0.99	0.84	0.65	0.92
Average diarrheal infection rating[a]	2.50**	2.30	1.79	1.47	1.81
Average mother's beliefs index rating[b]	2.27	2.41	2.43	2.46	2.55

** Significantly different from the "Rs. 76 and above" figure at the .95 level of statistical significance.
⌣ Indicates figures significantly different at the .95 level of statistical significance.
a/ 7 = high frequency and severity; 0 = low frequency and severity.
b/ 4 = beliefs beneficial to child's health; 1 = beliefs detrimental to child's health.

Table III-4 Tabular Profile of Lower and Upper Per Capita Income Groups by Sex

	Monthly per capita income					
	Males		Females		All Children	
	Rs. 39 and below (Jats=15.0% Ramdasias=62.6%)	Rs. 51 and above (Jats=64.4% Ramdasias=15.8%)	Rs. 39 and below (Jats=16.7% Ramdasias=64.8%)	Rs. 51 and above (Jats=70.9% Ramdasias=17.4%)	Rs. 39 and below (Jats=15.8% Ramdasias=63.7%)	Rs. 51 and above (Jats=67.4% Ramdasias=16.6%)
Number of cases	107	101	108	86	215	187
Average percent reference weight for age	78.7	83.9	69.4	73.1	74.0	78.9
Average percent reference height for age	93.5	95.6	90.1	91.4	91.8	93.7
Average percent reference weight for height	87.7	89.7	83.7	85.7	85.7	87.9
Average percent of caloric allowance	58.3	67.5	56.9	64.9	57.6	66.3
Average percent of protein allowance	81.4	89.0	82.2	88.3	81.8	88.6
Average percent of vitamin A allowance	84.1	89.4	80.7	86.4	82.4	88.0
Average percent of iron allowance	34.1	38.0	36.9	36.8	35.5	37.4
Percent breast fed	87.9	80.2	78.7	79.1	83.3	79.7
Average daily supplementary milk consumption (gms)	154	228	153	231	153	229
Average daily cereal consumption (gms)	23	25	27	28	25	26
Average number of major diseases	1.08	0.88	0.94	0.66	1.01	0.78
Average diarrheal infection rating[a]	2.38	1.40	2.40	1.97	2.39	1.64
Average mother's beliefs index rating[b]	-	-	-	-	2.34	2.50

~ Indicates figures significantly different at the .95 level of statistical significance.

a/ 7 = high frequency and severity; 0 = low frequency and severity.

b/ 4 = beliefs beneficial to child's health; 1 = beliefs detrimental to child's health.

Table III-5 Frequency Distribution of Gomez Classification Groupings by Per Capita Income and Sex

Per capita monthly income	Percent normal (over 90% of "Harvard" reference weight for age)	Percent with 1st degree malnutrition (76-90%)	Percent with 2nd degree malnutrition (60-75%)	Percent with 3rd degree malnutrition (below 60%)
		ALL CHILDREN		
Rs. 24 and below	9.7	29.1	51.5	9.7
Rs. 25 - 39	11.6	33.0	41.1	14.3
Rs. 40 - 50	18.1	38.3	35.1	8.5
Rs. 51 - 75	16.1	44.1	35.5	4.3
Rs. 76 and above	19.1	35.1	43.6	2.1
		MALES		
Rs. 24 and below	14.0	40.0	42.0	4.0
Rs. 25 - 39	14.0	47.4	36.8	1.8
Rs. 40 - 50	30.2	41.5	24.5	3.8
Rs. 51 - 75	25.0	50.0	25.0	0
Rs. 76 and above	30.2	43.4	26.4	0
		FEMALES		
Rs. 24 and below	5.7	18.9	60.4	15.1
Rs. 25 - 39	9.1	18.2	45.5	27.3
Rs. 40 - 50	2.4	34.1	48.8	14.6
Rs. 51 - 75	6.7	37.8	46.7	8.9
Rs. 76 and above	4.9	24.4	65.9	4.9

Table III-6 Frequency Distribution of Gomez Classification Groupings for Lower and Upper Per Capita Income Groups by Sex

Per capita monthly income	Percent normal (over 90% of "Harvard" reference weight for age)	Percent with 1st degree malnutrition (76-90%)	Percent with 2nd degree malnutrition (60-75%)	Percent with 3rd degree malnutrition (below 60%)
		ALL CHILDREN		
Rs. 39 and below	10.7	31.2	46.0	12.1
Rs. 51 and above	16.6	39.6	39.6	3.2
		MALES		
Rs. 39 and below	14.0	43.9	39.3	2.8
Rs. 51 and above	27.7	46.5	25.7	0
		FEMALES		
Rs. 39 and below	7.4	18.5	52.8	21.3
Rs. 51 and above	5.8	31.4	55.8	7.0

Table III-7 Frequency Distribution of Percentage Caloric Intake Allowance by Per Capita Income and Sex

Per capita monthly income	Percentage ingesting 76 - 100% of allowance	Percentage ingesting 59 - 75% of allowance	Percentage ingesting 46 - 58% of allowance	Percentage ingesting 45% of allowance and below
		ALL CHILDREN		
Rs. 24 and below	17.5	23.3	32.0	27.2
Rs. 25 - 39	14.9	27.2	30.7	27.2
Rs. 40 - 50	15.2	35.9	28.3	20.7
Rs. 51 - 75	37.9	18.9	18.9	24.2
Rs. 76 and above	32.3	32.3	19.4	16.1
		MALE		
Rs. 24 and below	25.0	25.0	29.2	20.8
Rs. 25 - 39	13.6	20.3	32.2	33.9
Rs. 40 - 50	19.2	44.2	21.2	15.4
Rs. 51 - 75	41.7	22.9	14.6	20.8
Rs. 76 and above	30.2	35.8	22.6	11.3
		FEMALES		
Rs. 24 and below	10.9	21.8	34.6	32.7
Rs. 25 - 39	16.4	34.5	29.1	20.0
Rs. 40 - 50	10.0	25.0	37.5	27.5
Rs. 51 - 75	34.0	14.9	21.3	29.8
Rs. 76 and above	35.0	27.5	15.0	22.5

Table III-8 Frequency Distribution of Percentage Caloric Intake Allowance for Lower and Upper Per Capita Income Groups by Sex

Per capita monthly income	Percentage ingesting 76 - 100% of allowance	Percentage ingesting 59 - 75% of allowance	Percentage ingesting 46 - 58% of allowance	Percentage ingesting 45% of allowance and below
		ALL CHILDREN		
Rs. 39 and below	16.1	25.3	31.3	27.2
Rs. 51 and above	35.1	25.5	19.1	20.2
		MALES		
Rs. 39 and below	18.7	22.4	30.0	28.0
Rs. 51 and above	35.6	29.7	18.8	15.8
		FEMALES		
Rs. 39 and below	13.6	28.2	31.8	26.4
Rs. 51 and above	34.5	20.7	18.4	26.4

Table III-9 Frequency Distribution of Diarrheal Infection Groupings by Per Capita Income and Sex

Per capita monthly income	Percentage with low frequency and severity	Percentage with low-moderate frequency and severity	Percentage with high-moderate frequency and severity	Percentage with high frequency and severity
		ALL CHILDREN		
Rs. 24 and below	20.8	15.8	32.7	30.7
Rs. 25 - 39	22.8	21.1	24.6	31.6
Rs. 40 - 50	26.6	22.3	34.0	17.0
Rs. 51 - 75	40.9	19.4	25.8	14.0
Rs. 76 and above	28.7	23.4	28.7	19.2
		MALES		
Rs. 24 and below	16.7	14.6	37.5	31.3
Rs. 25 - 39	22.0	22.0	30.5	25.4
Rs. 40 - 50	27.8	18.5	33.3	20.4
Rs. 51 - 75	39.6	20.8	25.0	14.6
Rs. 76 and above	37.7	32.1	18.9	11.3
		FEMALES		
Rs. 24 and below	24.5	17.0	28.3	30.2
Rs. 25 - 39	23.6	20.0	18.2	38.2
Rs. 40 - 50	25.0	27.5	35.0	12.5
Rs. 51 - 75	42.2	17.8	26.7	13.3
Rs. 76 and above	17.1	12.2	41.5	29.3

Table III-10 Frequency Distribution of Diarrheal Infection Groupings for Lower and Upper Per Capita Income Groups by Sex

Per capita monthly income	Percentage with low frequency and severity	Percentage with low-moderate frequency and severity	Percentage with high-moderate frequency and severity	Percentage with high frequency and severity
		ALL CHILDREN		
Rs. 39 and below	21.9	18.6	28.4	31.2
Rs. 51 and above	34.8	21.4	27.3	16.6
		MALES		
Rs. 39 and below	19.6	18.7	33.6	28.0
Rs. 51 and above	38.6	26.7	21.8	12.9
		FEMALES		
Rs. 39 and below	24.1	18.5	23.2	34.3
Rs. 51 and above	30.2	15.1	33.7	20.9