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Effect of parental income on child health: A case study on Tsimane' from the Bolivian Amazon

Submitted by

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3. Abstract

Poor child health remains a serious concern in developing nations even in the twenty-first century. Limited research has been conducted on factors influencing child health, which may be the primary reason for many of these countries for not being able to find a sustainable solution to this problem. This paper attempts to find a correlation between parental income and child health among Tsimane' Community in the Bolivian Amazon. Along with the parental income, other family and societal factors is also considered in this study. Results of the analysis suggest that, for children below ten years of age, father's income has significant positive association with child's health. Moreover, education, family size, access to credit, parental wealth, and gender of the credit holder also play significant roles in determining child health status. Policy interventions to enhance the access to education, micro-credit programs especially with women, and other livelihood interventions may, therefore, lead to better child health status in the long run.

4. Executive Summary

In the past two decades, numerous scholars have researched the effects of family income on child health. I have built on this research by estimating the affects of parental income on children's nutritional health status for Tsimane', a highly autarkic community of foragers and horticulturists who live in the Bolivian Amazon. Parental income can be further divided into father's income and mother's income in order to estimate the impact of gender on the relationship between parental income and child health.

I have relied on the notion that parental income is not the sole contributor to individual well-being, but is contingent upon many other family factors such as individual attributes (physical stature and illness frequency of the children), family size (number of immediate family members), household resources (education, father's wealth and mother's wealth) and societal factors such as access to credit (mother's access to credit and father's access to credit) and parental place of birth. Using data from a TAPS survey, 2002-2006, with 2899 Tsimane' children under 16 years of age, I regressed the proxy for child nutritional health status, the BMI and AMA, on the above mentioned explanatory variables in the multivariate analysis. The age and sex of the children and the survey year served as control variables.

The whole analysis was carried out in three steps: Univariate analysis, Multivariate analysis, and Robustness analysis. Up to the Multivariate analysis (for the children below 16 years of age), it was not possible to reach a definite conclusion about the effect of parental income on child health. Therefore, to examine the robustness of the results of the multivariate analysis, all the multivariate regressions were repeated with children below 10 years of age. From the combined results of the univariate analysis, multivariate analysis, and robustness analysis I found:

1. Father's income (with mother's income, individual attributes, family size and household resources) suggests significant positive association with children's nutritional health status only for the children below 10 years of age. In this specific condition a 100 % increase in the father's income is associated with a 0.1 % (P=0.1) increase in the children's BMI and a 0.6% (P=0.05) increase in children's AMA (Table 4).
2. Access to credit for the mother (with father's credit, parental income, individual attributes, family size and parental place of birth) suggests significant positive association with children's nutritional health status for the children below 16 years of age. Under that specific condition, it is seen that 100% increase in access to credit for the mother is associated with 0.3% (P=0.01) increase in children's BMI (Table 2) and 100% increase in access to credit for the mother is associated with 0.5% (P=0.05) increase in children's AMA (Table 3).

3. Family size consistently suggests significant negative association with children's nutritional health status through out the analysis (multivariate and robustness).

This paper discusses possible reasons for such findings with the support of existing research. Based on this analysis, I have made policy recommendations which will contribute to child health status improvement.

5. Acknowledgement

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6. Acronyms

SID	Sustainable International Development
HIPC	Highly Indebted Poor Countries
US	United State
USD	United State Dollar
UN	United Nations
BMI	Body Mass Index
AMA	Arm muscle area
TAPS	Tsimane' Amazonian Panel Study
CV	Coefficient of Variance
HRQOL	Health Related Quality of Life
USA	United States of America
UK	United Kingdom
OR	Odds Ratio
SD	Standard Deviation

7. Introduction

Child health is a serious concern across the developing world. Children living in developing countries are frequently trapped in the cycle of malnutrition, diarrhea, and retarded physical growth (Heaton et al., 2005). The immediate consequence of this phenomenon is "infant mortality rate in less developed regions of the world range between 30 deaths per 1000 live birth in Latin America to 86 deaths per 1000 live births in Africa" (Population Reference Bureau, 2002 in Heaton et al., 2004, p97). Also, in several Asian countries and parts of sub-Saharan Africa, the rate of malnourishment among children under five is approximately 50% (Heaton et al., 2004).

My study is based on the assumption that parental income predominately shapes child health in a household. Additionally, other family factors like education resource, gender role, family size, mother's exposure to work force, age of the children and some societal factors like parental place of birth, and social assistance do play significant role on child health status. In this study, I want to cross- check my presumptions regarding the interconnection between parental income and child health, keeping in mind the mentioned family factors and societal factors. The objective of this analysis is to contribute to the insights of the policy makers in the developing world and thus, meaningfully working for the development of the under-served.

Learning Objectives

From the program I am completing at the Heller School, I want to build a comprehensive knowledge on formulating sustainable programs and policies to address problems in developing countries. Also, I want to acquire skills from this study which will enable me to collaborate with various development agencies who are working for the same cause. Therefore I have been taking courses like:

- Household Economics
- Quality and performance measurement in health care
- Cost effectiveness
- Macroeconomic policy for development professional

The above courses broaden my perspective regarding various policies at the macro level and the way various systems function specially in health sector. Also, I acquired in-depth knowledge on important household factors that hinders development or well-being at the micro-level. In short, I got enough sense of various development issues starting from the micro-level to the macro-level.

Apart from the above mentioned course work, my participation in the SID program at the Heller School gave me enough exposure to courses which enriched my knowledge of:

(1) Concepts and methods regarding planning and implementation of development programs, proposals writing, report writing, building donor relation, and managing organizations.
(2) Knowledgebase required for policy and program evaluation and reaching to policy recommendations based on proper analysis of the development context.
(3) Skills to conduct academic research both qualitative and quantitative and relating research findings with real life situation.
(4) Understanding development from the perspective of human rights and skills to look at environmental consequences before planning any program or while evaluating any development program.

The main objective of my analysis was to estimate the relation between parental income and child health to direct appropriate policy recommendations for any developing countries with a similar background. Therefore, it was essential to make my analysis unbiased. In order to do so, proper identification of family-level and societal factors that affect child health was necessary. Other than parental income there are some family and societal factors which affect child health. Until and unless the magnitude of those effects was measured, it was difficult to reach any errorless conclusion about the topic. However, I could successfully complete my analysis ensuring all the above mentioned aspects by applying the skills I learnt in the following classes:

-Statistics
-Applied Econometrics

Sustainable Development Problem

Why is child health important in development?

Even in the twenty-first century, child health remains a serious concern in the developing nations. Discussion regarding far-reaching consequences of child health status in development remains vague and this may be a primary reason for not being able to find a sustainable solution to this problem. However, recently many social scientists are exploring this topic. Case et al. found that child health status affects adulthood health, employment, and socioeconomic status (Case et al., 2005). Chen and Zhou said that "negative health consequences in early life may translate into negative economic outcomes in adulthood" (Chen and Zhou, 2007, p660). Therefore, the aggregate result of insufficient attention to child health problem is enormous in development.

Childhood health status lays the foundation for adulthood health status. Case et al. confirmed that "Children born into poorer families fall into poorer health as they age. These children arrive at the doorstep of adulthood not only in poorer health but also with lower educational attainment, in part attributable to their poorer health" (2005, p366). This study also found that, "childhood factors affect initial adult social position, which in

turn affects health in middle age" (p387). All this evidence suggests that the childhood health status and the adulthood health status are directly correlated with each other.

Poor childhood health restricts a person's employment opportunities in adulthood. This is because contracting a chronic illness at an early age not only affects health in the later stage but also it affects the factors like school attainment, skill building etc. Therefore, "those who have suffered chronic health conditions in childhood may reach adulthood in poorer health and with less education and poorer labor market skills" (Case et al., 2005, p366). On one hand, it reduces the chances of joining the skilled work force and, on the other hand, it hampers a person's ability of doing hard, unskilled work because of the poor health status in the adulthood.

The aggregation of the individual effects of childhood health status on adulthood health status and employment opportunities determines one's socioeconomic status in adulthood to a large extent. A person with chronic illness in childhood is likely to have poor income during adulthood not just because of limited competence level, but also because of his or her health-related expenditures due to poor adulthood health status. All these effects translate into poor socioeconomic status. The study by Case et al. goes even further to say that "children who have experienced poorer uterine environments and poorer health in childhood have significantly lower educational attainment, poorer health and lower socioeconomic status as adults" (Case et al., 2005, p367) provided their parental income, education and social class are controlled for.

Finally, children are vital for a society as they are the future of a nation. Therefore, problems of child health are not only a development issue on the micro-level, but also pose a serious obstacle to a nation's development. The book entitled *Towards a Better Tomorrow, Child Rights and Health* has rightly said that "most countries postpone the concern for children to better times. But time does not wait for the child. The present of children is important; important as it determines their tomorrow as well; equally important for both girls and boys and for children and adolescents alike" (WHO, p6).

8. Background and development context

In terms of national income, Bolivia is one of the poorest Latin American nation (Godoy et al., 2008). However, the economic status of the country is perceived in different ways by different agencies. According to the Financial Time's poverty survey of 1994, Bolivia ranked a dismal second in the western hemisphere. However, things have improved since then. In 2000, the U.S. Agency for International Development ranked Bolivia as the fifth poorest country in the western hemisphere. Apart from this, the current per capita income of Bolivia is cited as USD 1000, which was USD 856 in 1993. As part of its Highly Indebted Poor Countries (HIPC) program, the World Bank has qualified Bolivia for debt relief. According to the Human Development Report of 2000, Bolivia ranks as a country of "Medium Human Development."

Health is an important human development indicator. The status of child health, which is an important part of the overall health of the community, is not satisfactory at all

in Bolivia. The problem is even worse in rural Bolivia. Statistical indicators of child health include the infant mortality rate, mortality rate of children under age 5, the percentage of children under age 5 who are underweight for their age, and the percentage of one-year-olds fully immunized against measles. There exists a large disparity between rural and urban Bolivia in terms of these child health indicators (Kagis, 2005).

The total indigenous populace in the geographic region of Latin America is approximately 40 million (World Indigenous Conference UN, 1992 in Jha, 2007). Bolivia's majority indigenous population comprises around 60 percent of the total population (World Indigenous Conference UN, 1992 in Jha, 2007). Despite this, since independence in 1825, the indigenous people were isolated from mainstream Bolivian society, mainly in the institutional decision-making process. In 2006, indigenous protestors took to the streets to advocate for political representation. During that same year, Evo Morales won an unusual majority in the presidential elections and became the first indigenous president of Bolivia (Jha, 2007).

My analysis relates to data on the Tsimane', an indigenous community in Amazonian Bolivia. Agriculture, particularly using the method of slash-and-burn, is the primary source of livelihood for the Tsimane'. Additionally, Tsimane' are engaged in hunting, fishing, and plant gathering (Vadez et al.,2004 in Godoy et al.,2008). Approximately 8000 people are settled across 100 villages (Godoy et al., 2008). The size of each village is small, having 24 households in a village (Jha, 2007).

The Tsimane' community belongs to the Beni district along the Maniqui River (Jha, 2007).The nearest town San Borja is located at a mean distance of 25.96 km from the Tsimane' villages. For unskilled workers, San Borja is an important labor market.

The Tsimane' believe in marrying in the same ethnic group and have a "cross-cousin" marriage system which restricts in genetic diversity (Jha, 2007). Conversely, it helps unite the community. After marriage, the couple lives with the wife's family until they are ready to reside as a separate family unit. The Tsimane' have very irregular connections with the outer world, although missionary and non-profit organizations have been working with this community for more than two decades.

Definition of the development question

This paper attempts to see the effects of parental income on child health from various angles. Body Mass Index (BMI) and Arm Muscle Area (AMA) are used as the proxies for child nutritional health. The anthropometric variability in a forager society is not well known (Wong and Godoy, 2003 in Jha, 2007). The end result of this analysis will add to the overall understanding of the pattern of variability of anthropometric indicators in foraging societies.

Hypothesis 1

This study tried to test the validity of the general perception about the association between household income and child health. The commonly-held belief is that enhanced income causes improved child health. Besides this, many research projects have produced a positive association between permanent household income and child health. For example, Case, Lubotsky, and Paxson found that "children's health is closely associated with long run average household income, and the adverse health effects of lower permanent income accumulate over children's lives" (2001, P.1). Based on these previous conclusions, I hypothesized that enhanced parental income improves the status of child health.

Hypothesis 2

The study is further narrowed down by dividing parental income into father's income and mother's income. Whether or not a father's and mother's income has a differential impact on a child's well-being has been the focus of much academic research. For example, "the percentage of household income earned by women in cote d'Ivoire is positively associated with household budget shares for some 'child goods' (in particular, food) and negatively associated with shares for 'adult goods' such as alcohol" (Hoddinott & Haddad, 1995 in Glick & Sahn, 1998). Based on a review of similar literature, the current study further built on the first hypothesis, where parental income is assumed to have positive correlation with child health, by relying on the notion that the magnitude of the impact of mother's income on child health is higher than that of father's. To be more specific I hypothesized that the gender of the parents determines significantly the impact of parental income on child health.

This study will be important for future research of the development practitioner on the issue of income and health. The findings will also help the planners and implementers of development programs to broaden their perspectives. Also, it will add to the understanding of the variability of anthropometric indicators in analysis of forager communities.

9. Data and Methods

This research analyzes data from TAPS. 332 Tsimane' families from 13 different villages were interviewed. In an effort to establish a correlation between parental income and child health, I have used a TAPS panel data set of data collected between 2002 and 2006. The information used was collected by three interviewers from Bolivia and three Tsimane' translators who had worked on this study since its beginning (TAPS).

Dependent Variables

With an objective of measuring the effect of parental income on child health and how father's and mother's income impact child health, I chose two health indicators for the children: BMI and AMA. These indicators mainly represent nutritional health status. Therefore, the current study focused specifically on measuring the impact of parental

income on children's nutritional health. Both of the variables ensured counting only those observations corresponding to children less than sixteen years of age.

BMI is calculated by dividing body weight by the square of the standing physical stature of the subject. In my analysis, BMI played an important role in finding the correlation between child health status and parental income for a particular household. According to U.S. Center for Disease Control, "an absolute BMI calculation for a child or for an adolescent below the age 18 years must be evaluated against age and gender reference standards (3)" (2000, p2). Based on this information, the current analysis treats the age and sex of the children as control variables.

AMA is an important child-health indicator as "muscle mass depletion is the main factor responsible for the negative effects attributable to malnutrition" (John et al., 2005). Studies show that a child's "mid-arm circumference: head circumference ratio and arm muscle and fat areas are the most important derived anthropometry in the prediction for body composition" (Koo et al., 2004). Consequently, AMA was taken into account as an important dependent variable for my analysis with the purpose of finding a correlation between the status of a child's health and the parental income in a particular household context.

Explanatory Variables

The explanatory variables are divided into two broad categories (1) familial factors and (2) societal factors.

Familial factors

(1) Parental Income: Mother's and father's individual income were used as the proxy for parental income.

(2) Household resources: Education resource, mother's and father's wealth represented household resources in this analysis.

Education, as taken into account in this study, was defined as the maximum years of schooling for any member in a family. The rational behind this consideration was that the maximum education of any member of a family contributes to the overall health awareness of the entire family and thus do impact on child health.

Parental wealth, or the total monetary value of all physical assets in a family, was considered as the total household wealth. Total household wealth was then further divided into father's and mother's wealth depending upon the ownership on those assets. The rational behind considering parental wealth as important household resource impacting child health was based on the belief that upon the contraction of any disease by a family member during a lean period, the family would engage in selling or mortgaging of assets to gain cash inflow to protect the child's health.

(3) Individual Attributes: Illness, quantified by the number of bed-ridden days in the last two weeks from the day of the interview, was chosen as a predictor of a child's health status. The basic assumption behind this was chronic illness has a negative impact on a child's normal growth.

Physical stature also serves as an indicator of a child's health status. In a comprehensive study focusing on the short stature of Indian children, "nutritional disorders and chronic systemic disease were the major causes of growth retardation and were the etiologic factor in 60%. In contrast, endocrine problems were responsible for short stature in 10.7% and all the cases were of congenital hypothyroidism" (Colaco, Desai and Choksi, 1991, p57). Therefore, the children's physical stature was chosen as an important independent variable in my analysis.

(4) Family size: Family size determines a child's health status in a household. Family size dictates the distribution of parental investment and thus has significant impact on child health status. The risk of spreading disease is more when the number of family members is more. Therefore, I chose family size as an explanatory variable in the analysis.

(5) Societal factors: Access to credit helps ease any financial burdens in the situation of any sudden health problems amongst the children of a household. Therefore, living in a society where credit is accessible should have a positive association with the society's child health status. In this analysis the access to credit was further separated into the father's and mother's individual access to credit. A father's access to the world outside his community makes it easier for his family to have access to credit in many societies. A mother's accessibility to credit can be restricted in many ways in a society. This analysis tried to see if a mother's accessibility to credit, as the more consistently present parental figure in a household, has a bigger impact on child health than that of the father, who may live and work elsewhere, among the Bolivian Tsimane'.

The parental place of birth is an important health determinant. Birthplace influences child health in a number of ways, including exposure to clean environment, access to modern health facilities, access to other facilities like sports facilities which contribute to proper physical growth of children, etc. Moreover, Birthplace is particularly important for the Tsimane' because they are very homogenous and don't seem to migrate. A household has access to the pooled resources of the extended family and community. This can either be limiting (say, not having relatives who live in the city or near a hospital) or strengthening (a household, if credit is inaccessible, can get support from its extended family).Hence, in this analysis I considered birthplace as an important societal variable for the Bolivian Tsimane' community.

Control variables

I tried to set up control over three variables: The age and sex of the children and the survey year are considered control variables throughout the analysis.

Statistical Analysis

Multiple linear regression coefficients were used to see the extent of variability. The coefficient estimated the strength and direction of the relation between each independent variables and the dependent variable for a particular model. The statistical package STATA 10 was used to do the data analysis.

Limitations: Digit heaping found in stature ending at zero for girls and at five for boys (Godoy et al., 2007 in Jha, 2007). For the age variable, a random measurement error was found. Also, for age variables the digit heaping was marked at multiples of five, such as at age 5, 10, 15, and 20 (Godoy et al., 2005b in Jha, 2007). Finally, the data set for a more extended period would have wielded more precise results.

10. Literature Review

In this section, I will discuss the insights of various authors on the influence of (1) familial factors and (2) societal factors on child health.

10.1 Family factors

A study using demographic and health-related survey data from Latin America, Africa, and Asia reached the conclusion that a family unit contains multiple factors which influence child health (Heaton et al., 2005). Here I would like to discuss the impact of (1) family socio-economic status (2) individual attributes (3) family size (4) household resources and (5) gender roles.

Family socio-economic status

Heaton et al. mention "socioeconomic status has traditionally been based on measures of consumption and income" (2005, p99). A study by Palermo et al. with 56 patients from a mid-Western tertiary referral hospital indicated that socio-economic status (SES) can be divided into three different levels: individual level, family level and community level (2008). Among these three categories, "family socioeconomic conditions are significant independent predictors of physical HRQOL, psychosocial HRQOL, and child-reported functional disability" (Palermo et al., 2008, p838). So, the family-level socio-economic status is divided in this review in two forms: family-level socio-economic status as a measure of consumption and as a measure of income.

Socio-economic status as a measure of consumption indicates a family's ability to expend to ensure all the amenities leading to a healthy life. The socio-economic status of a family is a major determinant of child health (Heaton et al., 2005). Families of higher

socio-economic status are able to provide better healthcare for their children because they can afford healthcare and medical expenses (Heaton et al., 2005, p99). Another study on the effect of poverty on child health reached the conclusion that low socio-economic status is associated with increased infant mortality, greater risk of injuries resulting from accidents or physical abuse, and lower cognitive development scores (Aber, Bennett, Conley, & Li, 1997). In addition, Defo's study in Cameroon reported that better socioeconomic status leads to better sanitary and living conditions, including amenities such as latrine facilities, piped water, and electricity (1997).

In my analysis, the insights of scholars on the socio-economic status of a family as a measure of its consumption capacity enabled me to judge a family's economic status not only from the perspective of income, but also from its pattern of expenditure. This information further contributed to the accuracy of the established relationship between parental income and child health by providing a mechanism to double-check a family's income data from its consumption pattern.

Socio-economic status as a measure of income: Case, Lubotsky, and Paxson in an analysis of panel data on Canadian children suggested that income in adulthood has antecedents in childhood (2001). This particular case considered the family-level long–run average income as an important parameter to determining child health. The long-run average family income plays an important role to guard child health at the time of arrival of any chronic disease. The analysis showed that families with higher incomes are more capable of protecting their children from chronic disease than families with lower income. Existence of chronic illness results in the children's' absence from school for long periods and therefore children from low-income families reach to adulthood with poorer health status and lower competence levels than those from well-off families (Case, Lubotsky, and Paxson, 2001).

In the U.S.A., "for much more extreme measures of child ill health (stunting and wasting) – it is permanent, rather than current, low income that matters" (Koreman and Miller, 1997 in Propper, Rigg and Burgess, 2006, p1257).Chronic poverty, similar to permanent low income, makes a child's health worse. Propper, Rigg, and Burgess's data analysis in the U.K. illustrated that a low-income situation for family over a short period of time does not affect the various health measures of the children, provided the initial birth of the children is controlled properly (2007). As such, "it is permanent low income, rather than current low income that matters" (Propper, Rigg and Burgess, 2007, p1257).

Another study analyzing data from an Ontario Child Health Study in Canada concluded that "child health is more strongly related to low 'permanent income' than to low 'current income', in the sense that the former measure yields larger and statistically more significant coefficients in multivariate analysis" (Curtis et al., 2001, p288). However, the authors agreed with the fact that the "estimated impact of even permanent income on various measures of child health and development is small in magnitude" (p288).

Additionally, Muennig's article explaining the income gradient in health confirmed the fact that "income-health trends by age suggest that income predominantly produces health" (Muennig, 2008, p578). Actually, Muennig's article used a "reverse causal model" to see if income affects health ('forward causality') or if health affects income ('reverse causality'). The author's final conclusion was that the former correlation is much more important than the latter. This article confirmed that the impact of income on child health would have bigger contribution to the field of social science, as it demonstrated that income primarily influences health, and not vice versa.

Therefore, it can be said that socio-economic status as a measure of income is an important predictor of child health in a family. To be more specific, the impact of 'long-run' average income of a family on child health is much more significant than the temporary average family income. However, the magnitude of the impact of even the permanent income on child health is expected to be small.

Individual attributes

Illness: Frequent illness impacts not only the nutritional health status of children, but also the nutritional health status at the adulthoods. Previous research on the Tsimane' community from Amazonian Bolivia mentioned "mild-moderate under-nutrition and high infectious disease load in childhood contribute to small adult body size by diverting energy that would otherwise fuel growth" (McDade et al., 2005a in Godoy et al., 2008). Therefore, the frequency of illness reporting has notable impact on child health.

Physical stature: Height determines the overall health status of a subject to a substantial extent. Many health indicators like 'height-for-age', 'weight-for-height', BMI (weight/height^2) are directly influenced by an individual's height. A study on the growth and nutritional status of Tsimane' children in Amazonian Bolivia found that even though "Tsimane' children are growth stunted" and they are "under weight for their age as comparison to the US reference data," the "weight-for-height measures of Tsimane' children compare quite favorably to US norms" (Foster et al., 2005, p346). Therefore, only 'weight-for-age' among Tsimane' children may not indicate poor health status where as weight and height individually for this children may indicate poor health status.

Therefore, individual attributes like illness and physical stature have significant impact on child health. Frequent illness or a heavy disease load can make children growth retarded. On the other hand, physical stature can influence standard child health indicators like 'weight-for-height', 'BMI' (weight/height^2) etc.

Family size

Household size plays an important role in child health. A large household is limited in the scope of investment allocated to each child because resources are shared among more number of members. "A child's health may be compromised in large families in numerous ways, including through malnourishment, failure to recognize illness, inadequate attention and care, unsanitary living conditions, unfit clothing and

shelter, and failure to take a child to see a doctor" (Heaton et al.,2005, p98). Furthermore, a study from sub-Saharan Africa on the excess mortality of twins compared to single children in the post neonatal and childhood period confirmed that the risk of spreading disease and cross-infection is heightened whenever a large number of people live within close proximity to one another (Justesen & Kunst, 2000).

Therefore, family size shapes factors like resource allocation for child care in a household, risk of disease spread and thus significantly influences on child health status in a household.

Household resources

Household wealth: Long-term high income generates wealth which in turn generates positive impacts on child health. Case, Lubotsky, and Paxson write: "wealthier parents may be better able to purchase medical care , nutritious foods , and safer environments for their children and, in this and many ways , income may have a causal effect on children's health" (2001, p2). Therefore, household wealth not only helps in protecting children from disease during a lean period, but also enhances the parents' capacity to provide their children with all the amenities necessary to lead a healthy life.

Education: Perinatal and infant mortality rate are two important indicators reflecting child health status in a society. Unlike some other indicators, perinatal and infant mortality rate do have a positive association with the level of parental education (Akukwe, 1997, p223). A mother's education level consistently shows a positive association with the above mentioned child health indicators across the world.

Maternal education contributes to improved knowledge about child health, as well as the mother's enhanced income through more skilled labor. Akukew mentioned "Educated women have low rates of infant mortality, do not have early pregnancies, have longer birth intervals, low fertility, better access to health information materials and health services and low maternal mortality" (1997, p223).

However, the amount of schooling needed to have a positive impact on the survival of infants varies by country. For example, in the U.S. more than twelve years of maternal education is needed to double the rate of infant survival. Even in an ethnic minority community like the black population, the more years of maternal education, the lower the chances of infant mortality. Akukew suggests that in developing countries maternal education only up to the completion of primary school shows positive impact on infant survival (1997, p224).

Another study confirmed that "paternal education also increases the probability of child survival" (Heaton et al., 2005, p99). Paternal education also contributes to a father's knowledge regarding child health and child development. Thus, it leads to better child health through proper paternal care.

Therefore, parental education plays an important role in child health in a family. Considering that the mother is typically the maximum caretaker of the children, the impact of a mother's education on child health must be given priority.

Gender Role

Gender roles are an important determinant of a household's parental investment plan for child health care. A study analyzing data from the 1996 Nepal Living Standard Survey found that "gender role not only effects illness reporting but also affects the decision to choose a health care provider and how much to spend on the sick child, i.e. it affects the entire steps of a health seeking action" (Pokhrel et.al, 2005, p107). Across South Asia, parental discriminative investment for child health care has been a serious concern for a long time as girls are highly oppressed.

But this scenario is different in Caribbean region, where the society is "matrifocal". Unlike boys' inclined parental investment in South Asia, in the "matrifocal" society of Caribbean girls receive preferential treatment. As mentioned by Taylor in a study of Northern Thailand, in a "matrifocal" type of society the women are considered as the "breadwinners" or "helping-at-the-nest" (Taylor, 2005). Quinlan's study focusing on the parental investment theory of a matrifocal Caribbean community has referred to the literature by Barrow and Smith to confirm the fact that male economic marginality is one feature of Caribbean matrifocality, suggesting psychosocial mechanisms for female-biased parental investment (Barrow 1999; Smith 1996 in Quinlan, 2006).

Therefore, the victims of sex-based discrimination vary depending on the culture and social structure across the world. For example, the unpredictability of male's contribution to family-wellbeing and maternal fitness motivates the localities to be more interested to invest in daughters (Quinlan, 2006).

A qualitative study by Lindsay et al. with inferences from rural, urban, coastal and indigenous area of Brazil found that for a situation where poverty is not the issue, the gender of the child played an important role on parental investment plan. "Mothers tended to equate thinness with their daughters being physically attractive and acceptable in society. These same mothers aspired for their daughters to enter professions that place high value on thinness and beauty. For their sons, several mothers described an ideal body type as strong and healthy as opposed to the thin body they envisioned for their daughters" (Lindsay et al.,2008, p33).

Therefore, from the above discussion, it is clear that the gender of children determines parental investment strategy for child health care, but the pattern of the associating gender and child health varies from culture to culture.

A study aiming to establish a correlation between mother's time allocation and labor market behavior to children's human capital development in developing countries defined a woman's role as a generator of household income and primary caregiver to her children (Glick & Shan, 1998, p325). On one hand, women's participation in the

workforce or in income generation reduces the amount of maternal time for child care and thus affects the nutritional status of the children. “Female labour force participation, by reducing the time available for household activities related to child development, may place a young child at nutritional risk” (Glick & Sahn, 1998, p325). So in that sense, “additional time devoted by the mother to market work, taken as an inverse proxy for the level and quality of time in household child health-producing activities, is associated with reductions in height-for-age of children under 5” (Glick & Sahn, 1998, p351).

On the other hand, increasing a mother’s labor income leads to greater child height. The same article by Glick and Sahn support this by writing, “a further finding of significant interest is that additions to maternal labour income yield larger increases in child height than do equivalent additions to other (non-mother) household income” (Glick & Sahn, 1998, p352).

Therefore, the tradeoff between negative effects of reductions in the quantity (and perhaps the quality) of childcare and positive effects of additions to income due to mother’s participation in paid work force is situation specific. For example, while an woman gets support from her extended family or husband for child care giving, her income may contribute to the improved health status of her children.

10.2 Societal factors

Here I will discuss about influence of (1) parental place of birth and (2) access to credit.

Parental place of birth

Parental place of birth is an important predictor of child health status. A study on child exposure to secondary smoke due to parental smoking in Sweden found that parental place of birth has direct correlation with the intensity of tobacco smoking and thus, indirectly affects child health status in a society. OR being the key indicator for parental smoking in the study, “the OR for being a smoker was lower if the mother was born in Africa (OR 0.48) compared to Swedish-born mothers. In contrast, ORs for paternal smoking were higher in all birth regions compared with Swedish-born (ORs 1.84–4.70)” (Wallby & Hjern, 2008, p1143).

Another article analyzing the growing dental care problems among Latino children in the U.S.A. found that “several societal sectors or contexts of care significantly intersected to produce or sustain poor oral health care for children” (Barker and Horton, 2008, p472). The article concluded that “parental beliefs and practices, leading for example to delay in seeking care, were compounded by lack of key community or economic resources, and the organization and delivery of professional dental services” (Braker and Horton, 2008, p472).

Moreover, living in an economically distressed neighborhood causes poor child outcomes in terms of health. Neighborhood socioeconomic conditions can affect a child’s physical health in many ways. Children raised in resource-poor neighborhoods do not

have enough sports facilities and other physical activities important for healthy living (Palermo et al., 2008).

Therefore, parental place of birth affects child health in multiple ways. It can cause child health hazards, results in insufficient resources for children's healthy growth, and even restrict availability or access to quality health care.

Access to credit

The role of parental access to credit is a very important determinant of child health status. A study analyzing data from a 1991/92 survey of 1798 households in 87 villages of rural Bangladesh demonstrated how a societal mechanism like group-based credit programs to provide access to credit for the rural poor resulted in improved child health (Pitt et al., 2003). The study further found that the impact of access to credit to women on child health is bigger and more significant than that of men.

This type of literature suggests that not only parental access to credit but also the gender play an important role to determine child health status in a household.

Having reviewed the existing literature on various family factors and societal factors which effect child health I reached to the following conclusion. Even though most of the authors stressed more on the importance of family factors in determining child health status in a household, they didn't explore rigorously on multiple societal factors which might be equally important in this regard.

11. Evidence and Analysis

Statistical analysis was carried out to test the hypothesis of the research. Here, I will present the result of the analysis in three separate sections; univariate analysis, multivariate analysis, and robustness analysis.

11.1. Univariate analysis

Table1: **Definition and summary statistics of dependent and explanatory variables used in multiple linear regression for Bolivian Tsimane' under 16 years of age. Annual panel data, 2002-2006[1] .**

Dependent variables							
Child health variables	Description				Sample size	Mean	Standard deviation
Body mass index	Body mass index of the children and this is the ration of the body weight to standing physical stature (in kg/ m2)				2887	17.43	2.16
Arm muscle area	Arm muscle area of the children (in cm2)				2899	20.13	7.86
Explanatory Variables							
Categories	Sub-categories		Variable Name	Description of the variables	Sample size	Mean	Standard deviation
Family Factors	Parental Income	a	Mother's income	Mother's income in a household (in Bs)	2762	47.52	110.35
			Father's income	Father's income in a household (in Bs)	2645	183.36	313.19
	Individual Attributes	b	Illness	Total number of bed ridden days of the child in last two weeks from the day of the interview	2899	1.24	2.70
			Height	Child's standing physical stature (in cm)	2894	115.20	24.04
	Family Size	c	Members	Number of household members	2899	7.06	2.40
	Household Resources	d	Mother's wealth	Accumulation of twenty two household assets possessed by mother (in Bs)	2746	652.80	675.86
			Father's wealth	Accumulation of twenty two household assets possessed by father (in Bs)	2633	2159.72	1545.75
			Education	Maximum education attained by the subject(in Years)	2795	2.47	2.71
Societal Factors	Access to credit	e	Mother's credit	Amount of credit in mother's name at the time of survey (Bs)	2762	14.59	57.71
			Father's	Amount of credit in father's name	2645	117.1	352.40

[1] In the multiple linear regressions all the dependent and explanatory variables are converted into natural logarithmic forms except the control variables and the parental place of birth.

			credit	at the time of survey (Bs)		6	
	Parental birthplace	f	Birthplace	Place of birth of the subject	2806	45.69	46.06
Control variables		g	Age	Age of the children (in years)	2899	7.36	4.04
			Sex	Sex of the children (Female=0; male=1)	2899	0.52	0.49
			Year	Survey year	2899	2004.10	1.57
Dummy Variables	Village dummy	h					

Dependent variables: In the survey, each and every family member was interviewed except for children below 10 years of age. For these children, the informants were the corresponding mothers. However, BMI and AMA for the children were measured using standard clinical method by the surveyors themselves.

Body Mass Index (BMI): The standard formula for calculating BMI is weight divided by the square of the height. Therefore, from the collected data on individual children's weight and height, the surveyors generated the data on children's BMI.

The mean BMI for the children is 17.43 (SD=2.16). For Tsimane' children "linear growth retardation is a severe problem" and also they are "under weight" (Foster et al., 2005, p349). These may be the possible reasons for getting a lower range of mean BMI, (indicating poor growth) 17.43 for the Tsimane' children.

Arm Muscle Area (AMA): In the standard practice, the AMA is calculated from arm circumference and triceps skin fold thickness from the right arm in a relaxed position (Trowbridge et al., 1982).

Arm muscle diameter= (arm circumference/∏) – triceps skin fold
Arm Muscle Area= ∏/4 (muscle diameter) ^2

The AMA for the Tsimane' children were measured following the same standard formula as mentioned by Frisancho (1990). According to Frisancho, the standard mean value of upper arm muscle area for children in the age group of 1-1.9 years should be 20.7 cm^2 (Frisancho, p.49) to be safe from nutritional risk. For the Tsimane' children of Bolivia up to 16 years of age (mean age 7.36 years) the mean AMA value is 20.13 cm^2 (SD= 7.86) which is less than Frisancho's mentioned standard mean value of AMA for the children of age group between 1-1.9 years (20.7 cm^2).

Explanatory variables: Parental income with other familial factors such as individual attributes (illness of the children, standing height of the children), family size, household resources (mother's wealth, father's wealth and education) and societal factors such as access to credit (mother's access to credit, father's access to credit), parental place of birth are considered as explanatory variables.

Family factors

Parental income: The accumulated income from the wage, sale, and barter in the last two weeks from the day of the interview was counted as the total income. Interviewing with each and every family member made it possible to split the total parental income into mother's income and father's income. This segregation generated further analysis of the gender of the parent's impact on the pattern of variability of child health with parental income.

The mean income of the Tsimane' mothers is 47.52 bolivianos (SD=110.35) where as it is 183.36 bolivianos (SD= 313.19) for the fathers. The possible causes of this significant disparity between maternal mean income and paternal mean income could be because a very small percentage of Tsimane' mothers participate in income generating activities and those who do participate are usually associated with low paying jobs (Mills, 2003).

Individual attributes:

Illness: The total number of bedridden days in the last two weeks from the day of the interview was explored by the surveyors to estimate the illness frequency of the children: (1) by directly interviewing the children above or equal to 10 years of age and below 16 years of age; and (2) interviewing the corresponding mother for the children below 10 years of age.

The mean bedridden days for the Tsimane' children is 1.24 (SD= 2.70). On an average 1.24 days of illness reporting, in a period of two weeks, is an indication of heavy disease load . One of the possible causes for this can be "high infectious disease load" (McDade et al., 2005a in Godoy et al., 2008).

Height: This was the standing physical stature of the children which was measured using the protocol by Lohman (1988). The mean height of the children is 115.20 cm (SD = 24). Presumably an exposure to high level of pathogen (McDade, 2005 a, b; Tanner, 2005 in Godoy et al., 2008) has made Tsimane' children growth stunted (Foster et al., 2005 in Godoy et al., 2008).

Family Size: Bolivia's mean ideal family size, according to number of living children is 2.4 (Bolivia-DHS, 2003 in USAID Country Health Statistical Report, Bolivia, 2007). As compared to this, the interviewed Tsimane' households have a relatively larger family size (mean family size 7.06 , SD= 2.40). Extreme poverty (Godoy et al., 2008) and irregular connectivity with the outside world (Godoy at al., 2006 b in Jha, 2007) which consequently isolated the Tsimane' from mainstream Bolivian society (Jha 2007) can be possible causes for this scenario.

Household resources:

At the time of interview, each of the parents was asked about their ownership on each and every modern and physical household assets. Therefore, in the analysis, total household wealth is further divided into father's wealth and mother's wealth. This creates further room to analyze if the gender of the asset holder determines the pattern of variability of child health with parental income.

Mother's wealth: The accumulated value of the selected modern physical assets owned by the mother of a household. The physical assets are: radios, watches, fishing nets, knifes, bags, shotguns, cooking pots, machetes, mosquito nets, fishing hooks. On an average the Tsimane' mothers own 652.80 bolivianos (SD= 675.86).

Father's wealth: The accumulated value of the above mentioned modern physical assets possessed by the father of a household. On an average the Tsimane' fathers own 2159.74 bolivianos (SD= 1545.75).

Education: The maximum years of education of any member in a family has acquired in the survey. For the Tsimane' households in Amazonian Bolivia the mean level of maximum education attained by any immediate family member is 2.47 years (SD= 2.71, min=0, max=8).

Societal factors:

Access to credit: Asking every respondent in a household with the question about the amount of credit on their name at the time of the interview helped to come up with two separate variables: mother's credit and father's credit.

On an average the Tsimane' mothers access a credit of amount 14.59 bolivianos (SD= 57.71) where as the mean value of the accessed credit for the Tsimane' fathers is 117.16 bolivianos (SD= 352.40). This result shows that in the Bolivian Tsimane' society, men enjoy greater accessibility to credit than that the women.

Birthplace: The mean distance of the respondent's households from San Borja was 45.69 km (SD= 46.06). The analysis attempts to determine if the variance of the distance from the market place San Borja has any effect on Tsimane' children's nutritional health status.

Control Variables: The mean age of the children, considered in the main multivariate analysis, is 7.36 years (SD=4.04; min=0, max=15.98). In the survey the respondents were told to recall the age and most of them could answer with the approximate age for the children. Almost an equal number of girls and boys were interviewed directly or indirectly (mean=0.50, SD=0.49) in the survey.

11.2. Multivariate Analysis

Table 2: Comparison of multiple linear ordinary least-square regression results for child body mass index on parental income of Tsimane' under 16 years of age. Annual panel data 2002-2006[2] .

Categories	Sub-categories		Ex-planatory Variables	Parental income N=2533 (1)	Individual attributes N=2533 (2)	Family size N=2533 (3)	Household Resource N=1716 (4)	Access to credit N=2533 (5)	birthplace N=2452 (6)
Family factors	Parental Income	a	Mother's income	-0.0003 (0.001)	-0.00002 (0.001)	0.0004 (0.001)	0.0009 (0.001)	0.0002 (0.001)	0.0002 (0.001)
			Father's income	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.0005 (0.001)	-0.001* (0.001)	-0.001 (0.001)
	Individual attributes	b	Illness	^	0.004* (0.003)	0.004* (0.003)	0.003 (0.003)	0.004 (0.003)	0.003 (0.003)
			Height	^	-0.33*** (0.039)	-0.33*** (0.039)	0.14*** (0.053)	-0.33*** (0.039)	-0.34*** (0.039)
	Family size	c	Members	^	^	-0.026** (0.006)	-0.02*** (0.007)	-0.02*** (0.006)	-0.02*** (0.006)
	Household resources	d	Mother's wealth	^	^	^	0.002 (0.002)	^	^
			Father's wealth	^	^	^	-0.002 (0.003)	^	^
			Education	^	^	^	0.01* (0.006)	^	^
Societal factors	Access to credit	e	Mother's credit	^	^	^	^	0.003** (0.001)	0.003*** (0.001)
			Father's credit	^	^	^	^	0.0002 (0.0008)	0.0003 (0.0008)
	Parental birthplace	f	Birthplace	^	^	^	^	^	-0.00002 (0.00006)
Controls		g	Age	0.01*** (0.0006)	0.02*** (0.002)	0.02*** (0.002)	0.01*** (0.001)	0.02*** (0.002)	0.02*** (0.002)

[2] The numbers in the parenthesis represent robust standard error

			Sex	-0.002 (0.004)	-0.002 (0.003)	-0.001 (0.003)	-0.01*** (0.004)	-0.002 (0.003)	-0.002 (0.003)
			Year	0.0004 (0.001)	-0.002* (0.001)	-0.001 (0.001)	0.002**(0.001)	-0.001 (0.001)	-0.001 (0.001)
Mean VIF				5.44	5.66	5.49	7.58	5.14	32.94
R-squared				0.19	0.25	0.26	0.45	0.26	0.26
Joint-significance test (F Value)									
a				0.80					
a + b					19.07***				
a + b + c						18.03***			
a + b + c + d							4.64***		
a + b + c + e								13.05***	
a + b + c + e + f									11.94***

Regression includes constant and full set of village dummies (not shown in the table)
significance: ***~1%, **~5%, *~10%
^ variable intentionally left out

Table 2 represents the regression result on the effect of parental income on child BMI for the children below 16 years of age. The parental income is contingent upon other family factors and societal factors mentioned above. The major findings are:

1. None of the variables relating to parental income suggests statistically significant association with child's BMI except in one case. In the regression result (column 5, Table 2) with BMI as the outcome variable and parental income (with individual attributes, family size and access to credit) as explanatory variables, a 100% increase in father's income is associated with a 0.1% (P=0.1) decrease in child's BMI.

2. The data shows a significant correlation between the BMI of the Tsimane children and their height. In regressions 2, 3, 5 and 6 (Column 2, 3, 5 & 6, Table 2), a 100% increase in the height of the children is associated with an approximately 33% (P=0.01) decrease in the children's BMI. But in regression 4 (Column 4, Table 2), a 100% increase in child's height suggests a 14% (P=0.01) increase in the BMI of the children. The change in the direction of the relationship between height and BMI of the children can be further explained as such: In regression 4, unlike all of the other regressions represented in the table, the household resources are considered as the predictors of a child's BMI. So, it can be hypothesized that the variables relating to household resources, such as education and parental wealth, significantly influence the pattern of variability of child's BMI with child's height.

3. The family size consistently indicates negative and statistically significant (5% in Column 3 and 10% in Column 4, 5 & 6 respectively, Table 2) association with

child's BMI. In regression 3 (Column 3, Table 2), a 100% increase in family size is associated with a 2.6% (P= 0.05) reduction in child's BMI. In regression 4, 5 and 6 (Column 4, 5 & 6, Table 2), a 100% increase in family size suggests a 2% (P=0.01) decrease in child's BMI.

4. Education individually suggests significant association with child's BMI. A one hundred percent increases in maximum educational attainment of any member in a family is associated with 1.2 % (P= 0.1) increase in child's BMI for that particular.

5. Access to credit for the mothers is a key influencing factor over a child's BMI. In regression 5 and 6, a 100% increase in access to credit for the mothers suggests a 0.3% increase in the child's BMI (P=0.05 in regression 5 and P=0.01 in regression 6).

Table 3: Comparison of multiple linear ordinary least-square regression results for child arm muscle area on parental income of Tsimane' under 16 years of age. Annual panel data 2002-2006[3] .

Categories	Sub-categories		Ex-planatory Variables	Parental income N=2545 (1)	Individual attributes N=2540 (2)	Family size N=2540 (3)	Household Resource N=2540 (4)	Access to credit N=2540 (5)	Birth place N=2540 (6)
Family factors	Parental Income	a	Mother's income	-0.0006 (0.002)	-0.002 (0.001)	-0.001 (0.001)	-0.001 (0.002)	-0.001 (0.001)	-0.001 (0.001)
			Father's income	-0.002 (0.001)	-0.001 (0.001)	-0.001 (0.001)	0.004** (0.001)	-0.001 (0.001)	-0.001 (0.001)
	Individual attributes	b	Illness	^	0.007 (0.005)	0.007 (0.005)	0.004 (0.006)	0.006 (0.005)	0.006 (0.005)
			Height	^	1.04*** (0.071)	1.04*** (0.070)	1.59*** (0.110)	1.04*** (0.070)	1.03*** (0.071)
	Family size	c	Members	^	^	-0.05*** (0.012)	-0.048*** (0.013)	-0.051*** (0.012)	-0.052*** (0.012)
	Household resources	d	Mother's wealth	^	^	^	0.003 (0.005)	^	^
			Father's wealth	^	^	^	0.0007 (0.006)	^	^
			Education	^	^	^	0.010 (0.010)	^	^
Societal factors	Access to credit	e	Mother's credit	^	^	^	^	0.005** (0.002)	0.005** (0.002)
			Father's credit	^	^	^	^	-0.001 (0.001)	-0.001 (0.001)
	Parental birthplace	f	Birthplace	^	^	^	^	^	0.00004 (0.00009)
Controls		g	Age	0.079*** (0.001)	0.027*** (0.003)	0.027*** (0.003)	0.013*** (0.004)	0.027*** (0.003)	0.027*** (0.003)
			Sex	0.010 (0.007)	0.011* (0.007)	0.013* (0.007)	-0.001 (0.007)	0.012* (0.007)	0.012* (0.007)
			Year	-0.016*** (0.002)	-0.008*** (0.002)	-0.007*** (0.002)	0.002 (0.002)	-0.007*** (0.002)	-0.007*** (0.002)
Mean VIF				5.46	2.75	2.67	2.42	2.59	2.61
R-squared				0.72	0.77	0.78	0.73	0.78	0.77
Joint-significance test (F Value)									
a				0.99					

[3] The numbers in the parenthesis represent robust standard error

a + b		56.73***				
a + b + c			45.89***			
a + b + c + d				31.89***		
a + b + c + e					33.10***	
a + b + c + e + f						28.27***

Regression includes constant and full set of village dummies (not shown in the Table)
significance: ***~1%, **~5%, *~10%
^ Variable intentionally left out

Table 3 represents the regression results on the effect of parental income on child's AMA. Each of the columns in Table 3 represent regression results with same group of predictors as that of Table 2, only the dependent variable is different. So, here the major findings are described with reference to the findings from Table 2:

1. The association between parental income and child's AMA was virtually the same as the relationship between parental income and BMI, except one major difference. Column 4 (Table 3), represents the only regression which included family resources as important predictor for child's AMA. The resulting data shows that a 100% increase in father's income is associated with a 0.4% (P=0.05) increase in child's AMA.

2. Unlike the findings from the Table 2, the height of the children showed positive and statistically significant (in all case 1%) correlation with child's AMA in all regressions. In regression 2, 3, 4, 5, and 6 (Columns 2, 3, 4, 5 & 6, Table 3), a 100% increase in the height of the children is associated with an approximately 104% (P=0.01) increase in children's AMA.

3. Education does not suggest a statistically significant association with child's AMA.

4. The influence of access to credit for mothers on child's AMA is as significant as that of BMI. In regressions 5 and 6 (Columns 5 & 6, Table 3), a 100% increase in access to credit for Tsimane' mothers is associated with a 5% (P=0.01) increase in child's AMA.

Based on the results of the multivariate analysis, it is very difficult to reach to a definitive conclusion about the correlation between parental income and child health. Therefore, I have conducted the robustness analysis with the objective of reaching a solid conclusion.

11.3. Robustness analysis

Table 4: Comparison of multiple linear ordinary least-square regression results for child body mass index on parental income and child arm muscle area on parental income respectively of Tsimane' under 10 years of age. Annual panel data 2002-2006[4] .

Category	Sub-category		Ex-planatory variables	Body mass index as outcome variable (Table 2 repetition)			Arm muscle area as outcome variable (Table 3 repetition)		
				4A	5A	6A	4B	5B	6B
Family factors	Parental Income	a	Mother's income	0.0002 (0.001)	-0.0004 (0.001)	-0.0003 (0.001)	-0.001 (0.002)	-0.001 (0.002)	-0.002 (0.002)
			Father's income	0.001* (0.001)	-0.00008 (0.001)	0.00006 (0.001)	0.006** (0.002)	-0.001 (0.002)	-0.001 (0.002)
	Individual attributes	b	Illness	-0.001 (0.003)	0.00005 (0.003)	-0.0001 (0.003)	0.002 (0.006)	0.005 (0.005)	0.005 (0.005)
			Height	0.01 (0.051)	-0.24*** (0.039)	-0.25*** (0.039)	1.44*** (0.148)	1.12*** (0.087)	1.12*** (0.089)
	Family size	c	Members	-0.05* (0.008)	-0.01** (0.006)	-0.01*** (0.006)	-0.04*** (0.017)	-0.04*** (0.014)	-0.04*** (0.015)
	Household resources	d	Mother's wealth	0.0004 (0.003)	^	^	0.00007 (0.007)	^	^
			Father's wealth	0.0009 (0.003)	^	^	0.008 (0.007)	^	^
			Education	0.026*** (0.008)	^	^	0.009 (0.015)	^	^
Societal factors	Access to credit	e	Mother's credit	^	0.003*** (0.001)	0.003*** (0.001)	^	0.006** (0.002)	0.007** (0.002)
			Father's credit	^	0.0003 (0.0008)	0.0003 (0.0008)	^	-0.001 (0.001)	-0.0009 (0.001)
	Parental birthplace	f	Birthplace	^	^	0.0002 (0.002)	^	^	0.002 (0.004)
Controls		g	Age	0.003* (0.002)	0.009*** (0.002)	0.009*** (0.002)	0.0008 (0.007)	0.007 (0.005)	0.007 (0.005)
			Sex	0.02*** (0.004)	0.01*** (0.003)	0.01*** (0.003)	-0.004 (0.009)	0.01** (0.008)	0.01* (0.008)
			Year	0.004*** (0.001)	0.001 (0.001)	0.0008 (0.001)	-0.0006 (0.002)	-0.009*** (0.002)	-0.009*** (0.002)

[4] The numbers in the parenthesis represent robust standard errors

Mean VIF	10.52	6.14	2.50	10.52	6.14	10.52
R-squared	0.10	0.13	0.14	0.52	0.63	0.63
Joint-significance test (F Value)						
I+II+III+IV	2.47**			17.99***		
I+II+III+V		6.42***			27.67***	
I+II+III+V+VI			6.40***			23.56***

Regression includes constant and full set of village dummies (not shown in the Table)
significance: ***~1%, **~5%, *~10%
^ variable intentionally left out

To ensure the robustness of the results of the multivariate analysis (Table 2 and Table 3) the robustness analysis was carried out. In regressions presented in Table 2 and Table 3, we have already observed the possible changes in the results with the succeeding addition of more and more new variables. Therefore, the method of analyzing the robustness by addition of newly created variables is not adopted here. To carry on the robustness analysis, only the observations corresponding to children below 10 years of age are considered. Thereafter, three sets of multiple ordinary least square regressions, presented by Columns 4, 5, and 6 in Table 2 and Table 3 respectively, is repeated.

Most of the basic findings of the multivariate analysis have remained unchanged. However some of the notable changes are:

1. Father's income reveals a significant positive association with both the nutritional health indicators for the children below 10 years of age under a specific condition. In regressions 1 (Column 4A, Table 4), a 100% increase in father's income is associated with a 0.1% (P=0.1) increase in child's BMI. In regression 4 (Column 4B, Table 4), a 100% increase in father's income is associated with a 0.6% (P=0.05) increase in child's AMA. Regression 1 and 4 (Columns 4A & 4B, Table 4) represent the effect of the same set of predictors on BMI and AMA respectively for the children below 10 years of age.

The consolidated result of the multivariate and robustness analysis has helped to reach the following conclusions:

1. Father's income (with mother's income, individual attributes, family size, and household resources) suggests a significant positive association with children's nutritional health status only for the children below 10 years of age. In this specific condition, a 100% increase in the father's income is associated with a 0.1% (P=0.1) increase in children's BMI and a 0.6% (P=0.05) increase in children's AMA (Table 4).

2. Access to credit for the mother (with father's credit, parental income, individual attributes, family size, and parental place of birth) suggests a significant positive association with children's nutritional health status for the children below 16 years of age. Under that specific condition, it is seen that a100% increase in

access to credit for the mother is associated with a 0.3% (P=0.01) increase in children's BMI (Table 2) and a 0.5% (P=0.05) increase in children's AMA (Table 3).

3. Family size consistently suggests significant negative association with children's nutritional health status through out the analysis (multivariate and robustness).

Therefore, this analysis refutes the first hypothesis that as parental income increases their child's health improves in general. The analysis only confirms that a father's income, under specific conditions, has significant positive influence on the nutritional health status of children below 10 years of age.

The second hypothesis regarding parental gender roles determining the impact of parental income on child nutritional health is partially supported by this analysis. This analysis reveals the significant and positive association of a father's income, under specific conditions, with child's nutritional health status. Additionally, the gender roles suggest a significant impact on the pattern of variability of children's nutritional health status by parental access to credit. A mother's credit has a significant and consistent positive association with both the child health indicators (BMI and AMA) for her children below 10 years of age.

12. Discussion

In completing this study, a mechanism had to be developed to measure overall child health outcomes based on some standard health indicators (BMI & AMA). It also added to the understanding of how child health is influenced by parental income in an interaction with other familial factors and societal factors. All the findings are based on the analysis of a data set collected from a highly autarkic, forager and farmer society in Amazonian Bolivia. Individual attributes, family size, and household resources are counted as important familial factors, where as access to credit and parental place of birth are used as the important societal factors. Among these two primary categories, familial factors demonstrated larger importance for child health than societal factors. Some of the findings from this analysis supported the previous research findings from other developing and industrial nations.

Role of parental income on child health

The combined results of the main regressions and the robustness analysis suggests that father's income has significant and positive association with child's health for the children up to age group below 10 years only when parental income interacts with individual attributes, family size, and household resources, where as mother's income mostly bore negative association with child health for the Tsimane' community in Amazonian Bolivia.

Propper, Rigg and Burgess mention that permanent family income has pronounced positive effect on child's health status where as the impact of temporary

income on child health is negligible (2007). They further found that the association between income and child's health is prominent during a child's initial 7 years of life, but they couldn't find any strong evidence whether or not the association strengthens with age. The panel data (used in the current study) which was collected intermittently during five years confirmed that collected income data represented permanent income condition of the Bolivian Tsimane'. Therefore, findings from the current study were partially in accordance with the results of the Propper, Rigg and Burgess study as it confirmed that father's income, under specific conditions, has significant positive association with child's health for children of age group below 10 years.

The insignificant negative association of mother's income with child's health can be explained by the inferential conclusion from Glick and Sahn's article (1998). According to them, an increase in the hours of a mother's participation in income-generating activities results in a reduced qualitative and quantitative child care, which in turn harms child's nutritional status (1998). Actually, a mother's involvement in low paid work in most cases does not produce enough income to have a bigger positive impact on child's nutritional status than that of negative impact on child's nutritional status from reduced care giving due to participation in the work force (Glick and Sahn, 1998). In the univariate analysis we already saw that there exists a significant disparity between maternal mean income and paternal mean income for the Tsimane' (mean maternal income is almost one forth of the mean paternal income). So probably in Bolivia the mother's income is too small to impact significantly on the child health status.

Role of child's height on child health

Height of the children bore negative association with child's BMI in all cases except one. In the presence of household resources (mother's wealth, father's wealth, and education) children's height demonstrated a positive and significant association with child's BMI (Table 2). This can be explained with the help of previous research findings. Foster et al. found that "for Tsimane' boys and girls nutritional status was most strongly associated with numbers of teachers in the village, a measure of access to education" (2005, p349). Incorporation of household resource like maximum level of education of any member in a family in the regression model ensured a significant positive association between child's height and BMI (which an important indicator of child's nutritional status).

Another explanation could be that the prevalence of stunted growth among Tsimane' children is quite common and yet, at the same time, most of the children are also underweight (Foster et al., 2005).This could bring the weight-to-height ratio of the Tsimane' children closer to that of the U.S. median (Foster et al., 2005). But BMI, which is the ratio of weight and square of the height, usually decreases significantly when height increases, as Tsimane' children are underweight and usually weight does not increase proportionately with height to result in an increased BMI. Addition of a variable like education (household resources) results in an increase of BMI to a large extent and therefore, in that condition, height showed positive and significant association with BMI.

Height of the children demonstrated significant positive association with AMA consistently. This is because the prevalence of low AMA among the Tsimane' children is rare - approximately 1% representing protein sufficiency among Tsimane' children in Amazonian Bolivia (Foster et al., 2005).

Role of family size on child health

Heaton et al. mentioned that "A child's health may be compromised in large families" (2005, p98). Justeson and Kunst write that larger family size has negative impact on child health as it enhances the scope of disease spread and cross infection. The current study included family size as an important predictor of child health and it was seen that family size consistently bore significant negative correlation with child health.

Role of education on child health

Akukew demonstrated the strong impact of maternal education on reduced infant mortality, as education causes improved knowledge about child health (1997). Similarly. Heaton et al. highlighted the significance of paternal education for a child's better survival (2005). In this analysis, I didn't include either maternal education or paternal education. But I think the variable of education in the current study carries almost the same meaning. Education demonstrated significant positive correlation with child's BMI.

Role of access to credit on child health

Pitts et al.'s study on the impact of various woman-focused credit programs on child health in rural Bangladesh found that "women's credit has a large and statistically significant impact on two of three measures of the health of both boy and girl children," where as the credit provided to men didn't bear any statistically significant impact on child's health (2003, p113). Similarly, the current study demonstrated consistent positive and statistically significant association of mother's credit with two of the child's health indicators where as father's credit did not. Additionally, the current study found a significant association between mother's credit and child's BMI in case of Tsimane' children from Amazonian Bolivia. In rural Bangladesh, access to credit in general did not show any significant association with child's BMI. Only child's arm circumference and height-to-age ratio bore significant positive association with mother's credit (Pitts et al., 2003). Therefore, the current study's findings regarding the association between mother's access to credit and child health is supported by the research of Pitts et al. in rural Bangladesh and has contributed further to this topic by demonstrating even the positive correlation between mother's credit and child health.

13. Conclusion and Recommendations

Child health has remained the focus of development concern for numerous social scientists. Case et al. mentioned the strong impact of childhood health on adulthood health, employment and socio economic status (2005). Chen and Zhou highlighted how childhood health status translates in to adulthood economic outcome (2007). The book

Towards a Better Tomorrow, Child Rights and Health conveyed the message that "the present of children is important; important as it determines their tomorrow as well" (p6).

This analysis strongly demonstrated that parental income in isolation does not contribute to child health significantly. Along with parental income education, family size, access to credit, parental wealth, gender of the credit holder play significant role in a family to determine child health status.

There is a significant positive association between education and the health status of the Tsimane' children in Amazonian Bolivia (Foster et al., 2003). Therefore, the findings from this study, along with several research recommendations, strongly support the importance of policy intervention for enhancing the access to education in child health development.

Pitt et al. mentioned about the importance of credit programs in rural Bangladesh as a mechanism to deliver gender-specific resources in improving child health status (2003).This study highlights the importance of a mother's accessibility to credit in improving a child's health status, particularly in the case of Tsimane' children. Savings-led microfinance which establishes a sustainable credit delivery mechanism for women will be a viable way to act on this issue.

Finally, the current study does not undermine the importance of livelihood programs that have the objective of enhancing the income of poor families. But the planners should apply special emphasis on facilitating and monitoring effective utilization of that income. For example, utilization of surplus income from the participation in a livelihood program in household asset creation may help in child health development. As we saw in the current analysis, a father's income bears significant positive association with child health in the presence of household resources like household assets and education.

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