Campino A.C.C.[1], *Monteiro C.A.*[2], *Conde W.L.* [3], *Machado F.M.S.*[4] **Health, human capital and economic growth in Brazil**. São Paulo (BR), 2004.

ABSTRACT

The main objective of the research is to analyze the relationship between population health status, and processes of economic growth and social development in Brazil by exploring the use of the population's nutritional and health variables to assess the quality of human capital and the mechanisms through which these variables may impact the country's economic performance in terms of human capital formation, long-term economic growth, and social development. This research includes considerations on recent advances in the economic growth theory that contains the relationship between health, human capital, and long-term economic growth, as well as empirical evidence obtained from the analysis of an important Brazilian database, the Living Standards Measurement Survey, (Pesquisa de Padrao de Vida - PPV), a household survey conducted between 1996 and 1997 in both the Southeast and Northeast Regions of Brazil. The first part of the study focuses on information from individuals belonging to the group of economically active population (people between 19 and 59 years-old, both genders) to analyze the connection of individuals' health variables, such as height and health status, with socioeconomic variables, like income and educational attainment, controlling by area of residence (rural vs urban) and region (Northeast vs Southeast) The second part of the study focuses on information from individuals belonging to the group of economically active population (19 to 59 years-old both genders) with at least one child to support (2 to 21 years-old, both genders) in order to evaluate the intergenerational transmission of human capital, that is, analyzing the relations among parents data on health and nutritional status, income and educational attainment and the investment he/she is providing to the formation of human capital of his/her own child, controlling by area of residence (rural vs urban) and region

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(Northeast vs Southeast). Results lead to the conclusion that improvements generated through human capital investments made in one individual by the family do not finish at the individual himself, but are propagated to the next generations, independently from mechanisms of income. That is, relevant investments in human capital development, as educational attainment, nutrition, and health, create better opportunities to the individual in terms of employment and income. However, beyond these primary effects, there are secondary effects, mainly based on the transmission of human capital formation through generations, that result in population lifestyle changes, economic growth and development.

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INTRODUCTION

There are databases in Brazil that allow for intertemporal comparisons on the evolution of the population's nutritional status permitting the analysis of correspondence between this evolution and changes in socioeconomic characteristics of the population, as well as associating anthropometric differences (height and weight) to distinct levels of income.

The main objective of this research is to assess the impact of nutrition and health status of the population on the human capital formation and long-term economic growth and social development in Brazil through a cross-section analysis.

Height of the individual will be used as a proxy for human capital investment made on this individual by his family and by the government, as expressed by Fogel (2001). Population data regarding adults in the range of 19 to 59 years old will be used, because this is an age group on the prime of its economic activity. People older than 60 years will not be included, since the precise assessment of height in this age group is more difficult.

The source of the data analyzed in order to reach the proposed goal is the Living Standards Measurement Survey, or Pesquisa de Padrão de Vida (PPV), a household survey conducted between 1996 and 1997 in both the Southeast and Northeast Regions of Brazil.

The PPV program was carried out by the Brazilian Institute of Geography and Statistics (IBGE) in association with the World Bank, in order to enhance the socioeconomic statistics system. It is the Brazilian version of the LSMS and consists of a pilot project of multitheme research to fulfill information needs which: (a) qualify and indicate the determinants of social welfare of different social groups, and (b) allow for the identification of the effects of government policy on household living standards. The main objective of PPV being that of providing adequate information for the planning, following up, and analysis of economic policies and social programs vis-à-vis their impacts on household living standards, especially among low-income populations. Due to its broad thematic approach, PPV generates optimum multidimensional summary of welfare factors

and permits the study of the interaction of several variables associated to welfare (IBGE, 1998).

PPV includes data on age, height, weight, self-reported health status, education, and income of the population. Height was measured up in a standardized manner, from barefoot individuals, by trained teams using metallic measuring tapes graded in millimeters. Data on income represent all revenues from every member of the household. The PPV achievements are very important, moreover since this has been the first socioeconomic and demographic survey carried out in Brazil following the implementation on July 1994 of the stabilization plan known as the ”Real Plan”.

The PPV sample design was discussed with World Bank officials while sample size has been determined by the available budget. In accordance to its pilot-research configuration, it was decided that it would only cover the Southeast and Northeastern Regions of Brazil, taking into consideration 10 geographic strata, namely: Fortaleza, Recife, and Salvador Metropolitan areas; the remaining urban areas of the Northeast; the remaining rural areas of the Northeast; Belo Horizonte, Rio de Janeiro, and Sao Paulo Metropolitan areas; the remaining urban areas of the Southeast; and the remaining rural areas of the Southeast (IBGE, 1998).

THEORETICAL BACKGROUND

Economic development textbooks define economic growth as growth in income *per capita* and economic development as a process that implies transformations in social structure, such as education, health, nutrition, access to housing and sanitation that, on their turn, imply growth in per capita income.

Human capital "is the most fundamental source of economic growth. It is a source of both increased productivity and technological advance".[5] Investment in human capital, as defined by the founding father of the human capital theory, Gary Becker, is the imbedding of resources in people, that influence future real income.[6]

Therefore, the investment in human capital has an important impact on the economic development of a country. One of the forms of investment in human capital is the expenditure in education. It has been proved that expenditures in education are important in explaining the rate of growth experienced by a country. One of the earliest studies in this area, conducted by Edward F. Dennison, has shown that 40% of the rate of growth of the United States in the period 1929-1957 could be attributed to expenditures in education.[7] However, the theory of human capital has its restrictions. For instance, the investment in education once effected cannot be sold. This issue has been raised since the early days of the theory of human capital.[8]

A number of studies in developing countries have shown that there is an important relationship between education and health of the next generation, measured in terms of life expectancy; the mechanism by which this relationship is revealed resides in improvements

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[5] Parkin, Michael Macroeconomics 5th ed. 2000 Addison-Wesley Publishing Co.Inc. p.230.

[6] Becker, Gary S. "Investment in Human Capital: A Theoretical Analysis" chapter 3 in Febrero, Ramon and Schwartz, Pedro S. The Essence of Becker Hoover Institution Press Stanford University Stanford California 1995 p.36.

[7] See Dennison, E.F. Why growth rates differ; postwar experience in nine western countries Edward F. Denison, assisted by Jean-Pierre Poullier. Washington, Brookings Institution [1967] , 494 and also Dennison, E.F.Accounting for United States economic growth, 1929-1969` Washington, Brookings Institution [1974], 355p.

[8] See for instance Shaffer, H.G. "A Critique Of The Concept Of Human Capital" In Blaug, Mark (Ed) Economics Of Education: Selected Readings Vol 1.

in infant and child survival rates (Caldwell, 1986; Cochrane, Leslie and O´Hara, 1982; D´Souza and Bhuiya, 1982; Le Vine, 1987 quoted by McMahon, 1999:82).

The hypothesis is that the knowledge and increased earnings potential gained through education enable parents to provide a healthier environment for their families, although the mechanisms through which this occurs are still unclear (Le Vine, 1987; Eisemon, 1988, referred by McMahon, p. 83). The regressions run by McMahon show that infant mortality rates are dependent on female gross enrollment rates, lagged 20 years (McMahon, p. 84).

Becker and Tomes assume different position on the paper "Human Capital and the Rise and Fall of Families" (Becker and Tomes, 1986), developing a model of the transmission of earnings, assets and consumption from parents to descendants. Becker and Tomes depart from a simple model of the relation between the parents' and children's incomes.

$$I_{t+1} = \alpha + b\, I_t + \varepsilon_{t+1}$$

Where It is the income of the parents, I_{t+1} is the income of children, α and b are constants and the stochastic forces affecting the income of the children ε_{t+1} are assumed to be independent of the income of parents[9].

The second hypothesis is that the endowments of a family are inherited from their parents, but only partially so. Beker and Tomes say this is "a plausible generalization to cultural endowments of what is known about the inheritance of genetic traits, and children with well-endowed parents tend also to have above-average endowments, though smaller, relatively to the mean, than their parents', whereas children with poorly endowed parents tend also to have below-average endowments, but larger, relatively to the mean, than their parents'.'[10] This relation is expressed In terms of an equation as

[9] Acc.Becker and Tomes, p.344.

$$E_{i\,t} = \alpha_t + h\, E_{i\,t-1} + \upsilon_{I\,t}$$

Where $E_{i\,t}$ is the endowment of the ith family in the tth generation, h is the degree of inheritability of these endowments, and $\upsilon_{I\,t}$ measures unsystematic components of luck in the transmission process[11].

Having specified relationships for the transmission of income and of endowments from one generation to the other, the authors elaborate on the relation between earnings and human capital. They assume that adult earnings depend on human capital formed in childhood and market luck (L):

$$Y_t = \gamma\,(T_t, f_t)\, H + L$$

Where Y_t stands for earnings, and the earnings of one unit of human capital γ is determined by equilibrium in factor markets, technological knowledge (T_t) and the ratio of the amount of human capital to nonhuman capital f_t.

This equation allows for the transformation of investments in human capital during childhood in earnings received during adulthood. So the authors say that parents pass their endowments on to their children and also influence their adult earnings by expenditures made on their skills, health, learning motivation, "credentials" and many other characteristics. Part of these expenditures is made by the children's parents and part by the state, and they are not only determined by the abilities of the children.

Therefore, Becker and Tomes are interested in the intergenerational mobility and they assume that cultural and genetic endowments are automatically transmitted from parents to children. The intergenerational mobility of earnings depends on the inheritability of endowments, and the transmission from endowments to earnings would be equal to one if parents could readily borrow to finance the optimal investment in their children (Becker and Tomes, 1986:372).

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[10] Becker and Tomes, p.347.

The study by Becker and Tomes (1986:373) is theoretical, they have not conducted any estimates of their own, probably due to the difficulty in obtaining data. But they have examined about a dozen empirical studies relating the earnings, income and assets of parents and children. They observe that the point estimates for most of the studies indicate that a 10 percent increase in parents' earnings (or income) increases the children's earnings by less than 2% (Becker and Tomes, 1986:366). They also concluded that: "Almost all earnings advantages and disadvantages of ancestors are wiped out in three generations. Poverty would not seem to be a "culture" that persists for several generations" (Becker and Tomes, 1986:373).

The analysis by Becker and Tomes gives interesting insights, but it does have a shortfall. It does not elaborate on what measure or measures of investment in human capital ought to be taken (like expenditures in health and in education), how they should be combined. Also it does not elaborate on the mechanism by which inheritance of endowments and human capital results in inheritance of a given income level.

In this sense a leap forward was given by Fogel (1992, 1994) who linked "aggregate movements in adult height to long-run changes in standards of living, including income, mortality, and …morbidity" (Strauss and Duncan, 1998:768). The big insight Fogel had was the use of height, and variations in height, as measures of previous investments in human capital. The logic of this statement will be elaborated later on, but now it should be said that this was an important breakthrough. Fogel suggested a simple yet precise way of measuring past investments in human capital by its outcome. If the family and the state had invested in the child, he/she would have grown, if this investment was not made the child hasn't grown.

Based on the case made by Fogel, Strauss and Thomas (1998) observed that:

- √ the income generating capacity of the poorest could be enhanced by some health sector investment (p.767),

[11] Becker and Tomes, p.347.

- √ there are "correlations between health and labor outcomes",
- √ "health varies over the life course and is the outcome of behavioral choices both during childhood and in later life" (p. 768)
- √ comparing the evolution of the stature of men and women in four countries, the United States (1910 to 1950s), Brazil (1910 to 1950s), the Ivory Coast (1920 to 1970s) and Vietnam (1920 to 1970s) the authors concluded that "while the secular increases in height are sizable in all four countries, the gaps in height between them are even larger" (p. 770)

To isolate cross-section variations, they focused on the 1950 birth cohort and studied variations in changes in adult stature within a country to understand how the benefits of growth have been distributed within the population (p. 771).

Turning to data at the household level, they concluded that health (measured by height) and productivity are correlated at the individual level (p. 772).

They state that "... in recent years, substantial progress has been made in documenting the existence of a causal impact of health on wages and productivity in low-income settings using both experimental and non-experimental methods...." and that "health has a larger return at very low levels of health and (perhaps) in jobs requiring more strength. With economic development these types of jobs will shrink, and one might expect the labor market impact of improved health to decline, especially relative to the impact of education and skill acquisition."

In the case of Brazil, results of several researches conducted by Monteiro and cols.(1993) with data surveyed in the National Study of Household Expenditures, or *Estudo Nacional de Despesa Familiar* (ENDEF), and the National Research on Health and Nutrition, or *Pesquisa Nacional de Saúde e Nutrição* (PNSN), showed that:

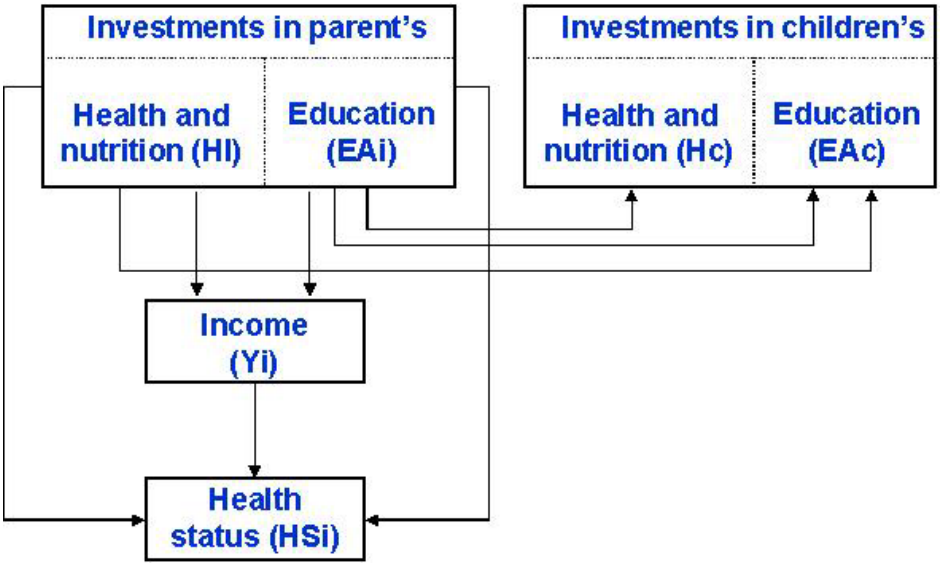
- There was an increase in height of young adults (21-22 years of age), when we compare persons born in 1966-1968 to those born in 1951-53. The increase was of 1.3 cm for males and 1.0 cm for females;
- There was an increase in height of children (7 years of age ± 12 months), comparing children born in 1981-1983 to those born in 1966-68. The increase was of 3.6 cm for males and 3.7 cm for females;
- Height of Brazilian young adults and children was below heights presented in the NCHSI/WHO standard, but the deficit is being reduced. It was reduced in 15% for young adults, both male and female, born between 1951/1953 and 1966/1968; and it was reduced in 50% for children, both male and female, born between 1966-1968 and 1982-1983.

METHODOLOGY

Methodological lines to be followed in the research are the ones developed by Fogel (2001) and Barro (1996).

As main line of analysis, we chose identifying the impact of human capital investment at two privileged points in time: (a) during childhood, involving investments in individuals in terms of health and nutrition; (b) during school age, involving investments on formal education. As outcome of this investment in human capital, we used people's income and their health status. This main line of analysis is expressed on the left column of Diagram 1.

DIAGRAM 1: IMPACT OF THE INVESTMENT IN HUMAN CAPITAL ON AN INDIVIDUAL´S INCOME AND HEALTH STATUS, AND THE INTERGENERATIONAL TRANSMISSION OF THIS INVESTMENT



Our survey population, pertaining to this main line, consists of all 20 to 59 year-old adults who had been surveyed by PPV. For indicator of the investment in human capital during childhood, made either by family and/or by state (per lines of Fogel 2001), we used the final height reached by the individual, a measurement which, in societies such as ours,

reflects outstandingly well the prevailing health and nutrition status of the individual during the first two years of his/her life. As for investments on formal education, we used the number of school years of the individual as indicator. The outcome indicators regarding health and nutrition investments made during childhood were: (a) the education attained by the individual; (b) the income (productivity) he/she earned from work; (c) and the overall status of health (self-referred scale). As for outcome indicators of the formal education of individuals, we used the income earned from work and health status.

Additionally, and on a second line of analysis, we have been pursuing the study of the intergenerational transmission of investments in health, nutrition and education. This second line of analysis is expressed on the right column of Diagram 1[12]. We studied household units formed by father and mother in the age group of 20 through 59, and their children between 2 and 7 years old or 15 through 21 years old.

Investments in human capital whose transmissibility we are in a position to investigate, are investments made on nutrition and health during the first two years of a child's life, reflected in the height attained by this individual as he or she reaches adulthood (Hi), and investments made on education reflected in the schooling attained by the same individual (EAi). In order to investigate the transmissibility of these investments, we have studied households consisting of father, mother, and the couple's children.

The direct transmission of the investments on nutrition and health from parents to child cannot be investigated in view of the impossibility of controlling the genetic fraction of height transmission. We may, however, study the transmission of these investments on nutrition and health made by the parents, in terms of their investments in the child's education.

As to investments made in the parents' education, we may investigate their transmission in the form of investments made in their children's education, and investments in their children's health and nutrition.

[12] This line of analysis is presented on Diagram 3.

Whatever the case, we must control the family *per capita* income. The income control enables us to affirm if those investments made in nutrition and health or in education are transmitted independently from the family income, i.e. if individuals of identical income but on whom more investments in education were made (either by parents' or by state) are more likely to invest more in the education (or on nutrition) of their children than those individuals on whom less investments in education have been made.

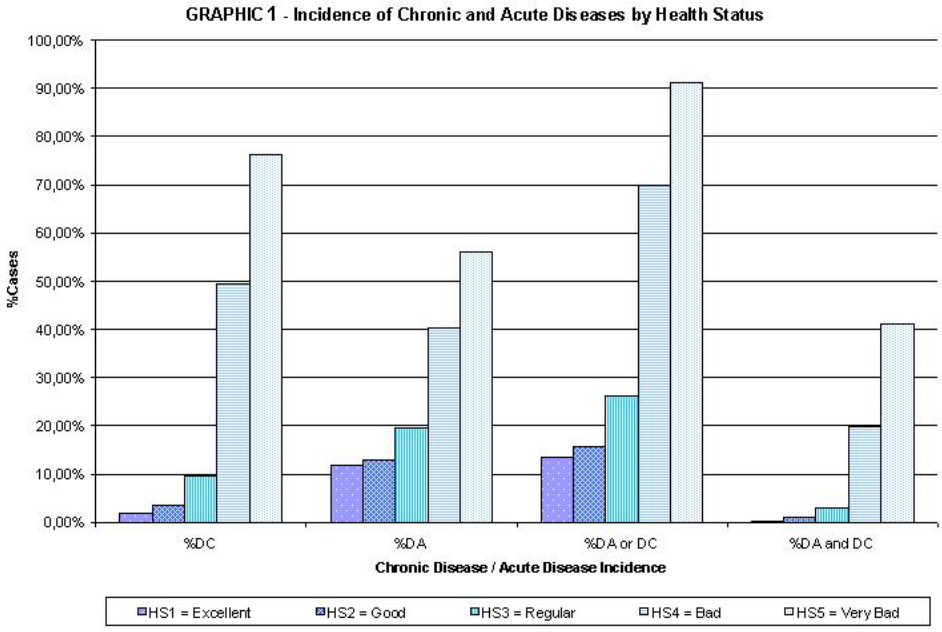
Region and area are control variables. The control of these variables seeks to take into account their possible association with other explanatory variables, such as differentiated offer of services and environmental variables.

We also controlled for the child's age due to: (a) possible variations in the child's nutritional status (z-scores) according to age; (b) the association of age and education derived from the expected positive secular trend in education.

The main variables utilized in this study, which are part of the PPV survey, have the definitions expressed below:

- √ Height (measured in centimeters), an indicator of the individual's linear growth and indirectly of health conditions and nutritional status during childhood and adolescence;
- √ Self-reported health status (HS), scaled from 1 to 5 (from 5, excellent health status, till 1, bad health status) intends to investigate the individual's health history. Based on additional data present in PPV questionnaire that registered presence of chronic and/or acute illness, self-reported health status could be validated as a consistent variable to measure an individual's actual health conditions, showing that individuals with poorer self-reported health status tend to report much more often chronic and/or acute diseases than individuals with better self-reported status (Graphic 1);

- √ Data on income represent total income from working activities only (measured in units of Brazilian currency: real), excluding financial and other non-productive sources of profits;
- √ Age of the individual was measured in months;
- √ Educational attainment is expressed in years of schooling;
- √ Region, refers to the two regions of Brazil in which the survey was conducted, Northeast (comprising the states of Maranhão, Piaui, Ceara, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia, and the Territory of Fernando de Noronha), and Southeast (comprising the states of Rio de Janeiro, São Paulo, Minas Gerais and Espirito Santo);
- √ The variable area refers to urban and rural areas;
- √ Gender, of course, refers to the sex of the individual, male or female.



Models

The model of the impact of the investment in human capital on the individual's income and health status will investigate the impact of health and nutrition investments made during childhood on the overall status of health of the individual, his educational attainment and the income (productivity) he/she earns from work .The outcome indicators of the formal education of the individual, were the income earned from work and health status. This was done using the following seven equations:

1.Relationship Between an Individual's Health Status and Height

The first step is to examine the relation between an individuals' height (H) and self-reported health status (HS), that informs how good a predictor of the health status height really is:

$$HSi = f(Hi)$$

Where H stands for height, HS is the self-reported health status, i stands for the individual. It is expected that the coefficient of this equation will be positive, i.e. as the investment in the child's health and nutrition, represented by H, increases it is expected that the same individual as an adult will present a better health status.

2.Relations Among Health Status, Height, and Educational Attainment of an Individual

The second step is to examine the relations among health status (HSi), height (H) and educational attainment (EA) of an individual I:

$$HSi = f(Hi, EAi)$$

Height measures the environment in which the individual has grown during his first five years and, therefore, measures investment in human capital made on the particular individual in the first stages of life. Educational attainment is a measure of the investment in human capital made in this individual after his/her infancy until his adulthood. The function measures the contribution to health status of the human capital investment during infancy and from infancy to adulthood. It is expected that both variables will have a positive coefficient.

3.Relations Among Health Status, Height, Educational Attainment, and Income of an Individual

The third step is to examine the relations in health status (HS), height (H), educational attainment (EA) and income (Y) of an individual i:

$$HSi = f (Hi, EAi, Yi)$$

This function measures the contribution to health status of the human capital investment during infancy and from infancy to adulthood, using the income of the individual as an adult as a control variable. It is expected that the coefficients of all variables will be positive.

4.Relationship Between an Individual's Educational Attainment and Height

The fourth step is to examine the relation between educational attainment (EA) and height (H) of an individual i:

$$EAi = f (Hi)$$

To analyze how good a predictor of educational attainment height is. It is expected that the bigger the investment made in health and nutrition during infancy, the higher the possibility of the individual having a better educational attainment from infancy to adulthood, so the coefficient of the variable Hi is expected to be positive.

5.Relationship Between an Individual's Income and Height

The fifth step is to examine the relation between height (H) and income received by the individual (Y):

$$Yi = f(Hi)$$

This equation analyzes how good a predictor of income is the human capital investment made during infancy, for which the variable height serves as a proxy. It is expected that the bigger the investment made during infancy, the bigger the income received by the individual as an adult, so the coefficient of the variable Hi should be positive.

6.Relations among Income, Height, and Educational Attainment of an Individual

In the next step, Educational Attainment (EA) is introduced as a second independent variable:

$$Yi = f(Hi, EAi)$$

This equation analyzes how good a predictor of income are the human capital investment made during infancy, for which height serves as a *proxy*, and the human capital investment made from infancy to adulthood, measured by the variable Educational Attainment. It is expected that the highest the investment in human capital the highest the

income received by the individual as an adult, so the coefficients of Hi, EAi should be positive.

7.Towards a More Generalized Model

The last step in the first phase of the study is to examine the relationship between that individual's income (Y), height (H), educational attainment (EA), and health status (HS).

$$Yi = f(Hi, EAi, HSi)$$

This equation shows the following important determinants of an individual's income:

(a) The human capital investment this individual benefited from as a child (Hi);
(b) The human capital investment this individual benefited from infancy to adulthood (EAi);
(c) His/her present health status (HSi).

The coefficients of all these three variables are expected to be positive.

The second phase of the study consists in estimating a group of regressions based on models which allow the analysis of the main mechanisms that determine intergenerational transmission of human capital.

$$Hc = f(EAi) \quad (1)$$
$$EAc = f(Hi) \quad (2)$$
$$EAc = f(EAi) \quad (3)$$

Where Hc and EAc are, respectively, the height and the educational attainment of a child c, and the variables Hi and EAi are the parents' variables already defined. The per capita income, expressed in logarithm, age of the child, area and region were used as control variables. The group of equations indicates the impact of the human capital investment:

- √ On the investment made in the development of the child's human capital (Hc) in the two first years and
- √ On the investment made in the formation of human capital of the child (EAc) during adolescence.

PPV data were analyzed, after data selection, through regression estimates in software EViews (Quantitative Micro Software, 1994-1998). Criteria of data selection to run the regressions were the following:

- √ Data from individuals without height information were excluded from the sample (1,737 data excluded);
- √ Data from individuals under 19 years-old (228 months) or 60 and above 60 years old (720 months) and those with no age information, were excluded from the sample (8,779 data excluded);
- √ Data from individuals with z-score of height lower than -5 or higher than +5 were excluded (13 data excluded).

Sample size after first data selection was 8,880 individuals (4,012 male and 4,868 female individuals). Regressions which included data on individuals' total income from working activities had sample size of 5,539 individuals (3,218 male and 2,321 female individuals), since only data from individuals who reported being engaged in recent

working activities that provide income should be relevant to the analysis.[13] Criteria of second data selection to run the regressions including the variable total labor income were the following:

- Data from individuals without total labor income information were excluded from the sample (199 data excluded);
- Data from individuals with no information about work, neither in the last 7 days nor in the last 12 months were excluded from the sample (726 data excluded);
- Data from individuals who reported not being engaged in working activities, neither in the last 7 days nor in the last 12 months were excluded from the sample (1,608 data excluded);
- Data from individuals who reported being engaged in working activities in the last 12 months, but did not work in the last 7 days prior the interview, were excluded from the sample, since all these individuals reported total labor income equal to zero (591 data excluded);
- Data from individuals who reported not being engaged in working activities in the last 7 days and presented missing information about work in the last 12 months were excluded from the sample.

Intergenerational data were selected according to the following criteria:

- Data from 2 to 7 years-old children were selected to run the regressions which presented child's height as a dependent variable (1,211 data);

[13] Indeed, human capital formation has a relevant influence on the income received by an individual during his entire life; regrettably PPV data just included income received by individuals either in the last seven days or in the last 12 months from date of questionnaire.

- Data from 15 to 21 years-old children were selected to run the regressions which presented child's educational attainment as a dependent variable (901 data);
- Data from both parents of the selected children were used to run the regressions. In order to guarantee comparability of parent's and children's data on adequacy of physical development z score were used as a proxy for health and nutrition in the first two years of the individual's life in the intergenerational regressions, instead of height. Father's and mother's values of z score of height and educational attainment (designated as Hp and Hm, and EAp and EAm, respectively) were associated to their corresponding child in order to determine the group effect of both variables. Additional regressions were run to verify the consistency in the influence of father's and mother's variables on the child's variables separately;
- Data on children's educational attainment were converted in an educational attainment adequacy index (EAc). The 15 to 21 years old children's educational attainment adequacy index is derived from the comparison between the ideal number of school years calculated for each age group and the individual's actual number of school years at that age. The following scale of school years was considered ideal, since in the case of Brazil a child should start his first year of schooling at age 7.

Age (Ic)	**Ideal number of school years (EA*)**
15 years	8
16 years	9
17 years	10
18 years	11
19 years	12

20 years	13
21 years	14

Thus, the educational adequacy level of the child (EAc) was calculated according to the relation between the ideal educational attainment to his/her age (EA*) and the effectively attended years of school declared (EAr) by the child c of the age group Ic:

$$EAc = \frac{EAr}{EA^*}$$

RESULTS

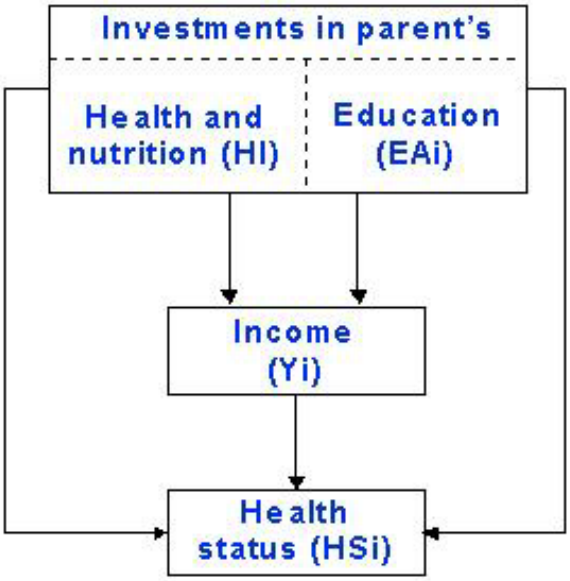
Results are presented for each model described in the preceding section regarding methodology. Regressions were run for the total sample and for both male and female individuals, in order to detect any differences according to gender. However, regression coefficients indicate consistent results for the total population, for males and for females. Gender was included as a control variable only in the regressions run for the total sample.

Correlation and covariance matrices to analyze relations among height, health status, educational attainment, age, age squared, and income, were built. Additional regressions were made to verify the connection between height and age, as well as among self-reported health status and presence of chronic and/or acute diseases, in order to validate the use of self-reported health status data as a consistent health status variable, modeling the subjectivity underlying the self-evaluation registered on the PPV database.

Regressions which included self-reported health status as dependent variable were run with method ordered logit in order to fulfill the requirements of self-reported health status as a discrete variable with cardinal classification.

Diagram 2 will help us to remember the relationships we are estimating in the first phase of this study.

DIAGRAM 2: IMPACT OF THE INVESTMENT IN HUMAN CAPITAL ON AN INDIVIDUAL´S INCOME AND HEALTH STATUS


Investments in parent's
Health and nutrition (HI)
Education (EAi)
Income (Yi)
Health status (HSi)

1.Relationship Between an Individual's Health Status and Height

Dependent Variable: Self-reported Health Status (HSi) (scaled from 1 to 5, being 5 the best HS and 1 the worst HS).

Independent Variable: Height (Hi) as proxy for human capital investment made in the individual during childhood.

Control Variables: Age (I); Age Squared (I^2); Gender (S); Area (A); Region (R)[14].

HSi = f (Hi)

Dependent Variable: HS1

Method: ML - Ordered Logit

Date: 08/02/03 Time: 22:57

Sample: 1 8880

Included observations: 8880

Number of ordered indicator values: 5

Convergence achieved after 14 iterations

Covariance matrix computed using second derivatives

	Coefficient	Std. Error	z-Statistic	Prob.
H	0.019429	0.002772	7.009928	0.0000
I	0.002301	0.001057	2.175873	0.0296
I2	-6.40E-06	1.17E-06	-5.462658	0.0000
S	-0.156509	0.050556	-3.095780	0.0020
A	-0.588521	0.046269	-12.71962	0.0000
R	0.312519	0.039613	7.889284	0.0000
Limit Points				

[14] For all the regressions run, the dummy variables always were set as: Gender (S) = 0 for male and 1 for female; Area (A) = 0 for urban and 1 for rural; Region (R) = 0 for Northeast and 1 for Southeast.

LIMIT_2:C(7)	-0.897133	0.525244	-1.708029	0.0876
LIMIT_3:C(8)	1.397594	0.523226	2.671108	0.0076
LIMIT_4:C(9)	3.266340	0.524194	6.231170	0.0000
LIMIT_5:C(10)	4.582185	0.525069	8.726827	0.0000
Akaike info criterion	2.726684	Schwarz criterion		2.734670
Log likelihood	-12096.48	Hannan-Quinn criter.		2.729403
Restr. log likelihood	-12586.30	Avg. log likelihood		-1.362216
LR statistic (6 df)	979.6543	LR index (Pseudo-R2)		0.038917
Probability(LR stat)	0.000000			

The coefficient of height is positive, leading to the conclusion that human capital investment made in the individual during childhood has a positive impact on the level of self-reported health status.

The probability of having worse health status was significantly higher on individuals living in rural areas. Individuals living in the richest region (the Southeast) presented a significantly higher probability of having a better health status than those living in the poorest region of Brazil (the Northeast). Female individuals had a slightly higher probability of worse health status.

Age influenced positively on the scale of self-reported health status and age squared influenced negatively, i.e., younger individuals have a higher probability of having better health status and older individuals had a slightly higher probability of having worse health status. Age squared was introduced to eliminate any residual influence of age in health status, including non-linear impacts.

2.Relations Among Health Status, Height, and Educational Attainment of an Individual

Dependent Variable: Self-reported Health Status (HSi).

Independent Variables: Height (Hi) as proxy for human capital investment made in an individual at childhood and Educational Attainment (EAi) as proxy for human capital investment made in the individual from childhood through adulthood.

Control Variables: Age (I); Age Squared (I^2); Gender (S); Area (A); Region (R).

HSi = f (Hi, EAi)

Dependent Variable: HSI1

Method: ML - Ordered Logit

Date: 08/02/03 Time: 23:00

Sample: 1 8880

Included observations: 8880

Number of ordered indicator values: 5

Convergence achieved after 14 iterations

Covariance matrix computed using second derivatives

	Coefficient	Std. Error	z-Statistic	Prob.
H	0.007281	0.002858	2.547294	0.0109
EA	0.091030	0.004990	18.24115	0.0000
I	0.001171	0.001062	1.102290	0.2703
I2	-4.79E-06	1.18E-06	-4.069255	0.0000
S	-0.307708	0.051426	-5.983543	0.0000
A	-0.279831	0.049353	-5.669963	0.0000
R	0.299990	0.039754	7.546201	0.0000
Limit Points				

LIMIT_2:C(8)	-2.552264	0.534733	-4.772973	0.0000
LIMIT_3:C(9)	-0.226423	0.532372	-0.425309	0.6706
LIMIT_4:C(10)	1.690995	0.532637	3.174762	0.0015
LIMIT_5:C(11)	3.035609	0.533217	5.693013	0.0000

Akaike info criterion	2.688953	Schwarz criterion	2.697737
Log likelihood	-11927.95	Hannan-Quinn criter.	2.691944
Restr. log likelihood	-12586.30	Avg. log likelihood	-1.343238
LR statistic (7 df)	1316.706	LR index (Pseudo-R2)	0.052307
Probability(LR stat)	0.000000		

Human capital investment made in an individual from childhood through adulthood, evaluated by educational attainment, and human capital investment made in the individual during childhood, measured by his/her height, presented positive impacts on the level of self-reported health status.

Women living in both regions and individuals living in the poorest region of Brazil (Northeast) had a significantly higher probability of having worse health status. Individuals living in rural areas had higher probability of having worse health status than individuals living in urban areas.

3.Relations Among an Individual's Health Status, Height, Educational Attainment, and Family Per Capita Income.

Dependent Variable: Self-reported Health Status (HSi).

Independent Variables: Height (Hi) as proxy for human capital investment made in the individual at childhood, Educational Attainment (EA) as proxy for human capital investment made in the individual from childhood to adulthood and Income (Yi). [15]

Control Variables: Age (I);Age Squared (I^2); Gender (S); Area (A); Region (R).

HSi = f (Hi, EAi, Yi)

Dependent Variable: HS1

Method: ML - Ordered Logit

Date: 08/02/03 Time: 23:05

Sample: 1 5539

Included observations: 5539

Number of ordered indicator values: 5

Convergence achieved after 14 iterations

Covariance matrix computed using second derivatives

	Coefficient	Std. Error	z-Statistic	Prob.
H	0.006740	0.003632	1.855515	0.0635
EA	0.067951	0.006513	10.43349	0.0000
LY1	0.096880	0.015153	6.393499	0.0000
I	0.000959	0.001429	0.671185	0.5021
I2	-4.52E-06	1.59E-06	-2.850057	0.0044
S	-0.252801	0.066123	-3.823157	0.0001

[15] As the effects of income increase at decreasing rates, we preferred to use the logarithm of income (Ln); as for some observations the income could be zero, we took the logarithm of income plus one.

A	-0.205512	0.065295	-3.147423	0.0016
R	0.268396	0.051264	5.235538	0.0000
Limit Points				
LIMIT_2:C(9)	-2.624867	0.683953	-3.837786	0.0001
LIMIT_3:C(10)	-0.089419	0.678881	-0.131716	0.8952
LIMIT_4:C(11)	1.918388	0.679358	2.823824	0.0047
LIMIT_5:C(12)	3.270790	0.680200	4.808570	0.0000
Akaike info criterion	2.645974	Schwarz criterion		2.660315
Log likelihood	-7316.025	Hannan-Quinn criter.		2.650974
Restr. log likelihood	-7694.178	Avg. log likelihood		-1.320821
LR statistic (8 df)	756.3063	LR index (Pseudo-R2)		0.049148
Probability(LR stat)	0.000000			

Height, educational attainment and income presented positive an impact on the level of self-reported health status. However, the probability of the coefficient of height not being significantly different from zero is 6%, approximately. In other words, with a high degree of statistical significance, we can state that human capital investment made in an individual from childhood through adulthood and the individual's (family per capita) income have a positive impact on the level of self-reported health status.The variable income should be interpreted with caution. It is the present income received by the individual, from different sources. It reflects his ability to work, in the case of wages, but it also could reflect the wealth inherited by this individual, in the case of rents. In every case, the present (family per capita)income is here being used as a measure of the individual's capacity of acquiring goods and services; among which only the access to health and

sanitation services and to educational services are relevant to the present study, with positive impacts on the health status.

Women from the Southeast and the Northeast and individuals of both genders living in the Northeast, the poorest region of Brazil, and individuals living in rural areas presented a probability of having worse health status.

4.Relationship Between an Individual's Educational Attainment and Height

Dependent Variable: Educational Attainment (EAi), a proxy for human capital investment made in the individual from childhood to adulthood

Independent Variable: Height (Hi) as proxy for human capital investment made in the individual at childhood.

Control Variables: Age (I); Age Squared (I^2); Gender (S); Area (A); Region (R).

EAi = f (Hi)

Dependent Variable: EA

Method: Least Squares

Date: 05/06/03 Time: 15:05

Sample: 1 8880

Included observations: 8880

White Heteroskedasticity-Consistent Standard Errors & Covariance

EA=C(1)+C(2)*H+C(3)*I+C(4)*I2+C(5)*S+C(6)*A+C(7)*R

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-18.44322	1.128757	-16.33941	0.0000
C(2)	0.139143	0.005971	23.30308	0.0000
C(3)	0.013410	0.002174	6.169070	0.0000
C(4)	-1.96E-05	2.43E-06	-8.073317	0.0000
C(5)	1.653861	0.106674	15.50388	0.0000
C(6)	-3.529442	0.087781	-40.20732	0.0000
C(7)	0.234359	0.085120	2.753274	0.0059
R-squared	0.222791	Mean dependent var		6.263964

Adjusted R-squared	0.222266	S.D. dependent var	4.458431
S.E. of regression	3.931856	Akaike info criterion	5.576888
Sum squared resid	137172.1	Schwarz criterion	5.582478
Log likelihood	-24754.38	F-statistic	423.9164
Durbin-Watson stat	1.606646	Prob(F-statistic)	0.000000

Height presented a positive impact on the dependent variable educational attainment, which means that individuals who received from their parents higher investments in human capital formation during the first two years of their lives have more probability of getting a higher education than individuals who received lower investments at that time.

The point elasticity, calculated for the average values of height (163.3845 cm) and educational attainment (6.26 years of study), was 3.63, meaning that, at this point, an increase of 1% in height – i.e., an increase of 1% in human capital investment made in an individual at childhood - implied an increase of 3.6% on his/her educational attainment.

5.Relation Between an Individual's Income and Height

Dependent Variable: Income (Yi).

Independent Variable: Height (Hi) as proxy for human capital investment made in an individual during childhood.

Control Variables: Age (I); Age Squared (I^2); Gender (S); Area (A); Region (R).

Yi = f (Hi)

Dependent Variable: LY1

Method: Least Squares

Date: 05/06/03 Time: 15:07

Sample: 1 5539

Included observations: 5539

White Heteroskedasticity-Consistent Standard Errors & Covariance

LY1=C(1)+C(2)*H+C(3)*I+C(4)*I2+C(5)*S+C(6)*A+C(7)*R

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-2.923044	0.631399	-4.629474	0.0000
C(2)	0.032478	0.003354	9.683379	0.0000
C(3)	0.014134	0.001404	10.07010	0.0000
C(4)	-1.43E-05	1.58E-06	-9.058067	0.0000
C(5)	-0.463707	0.060398	-7.677557	0.0000
C(6)	-1.857922	0.066962	-27.74609	0.0000
C(7)	0.593754	0.047466	12.50918	0.0000
R-squared	0.271055	Mean dependent var		5.291376
Adjusted R-squared	0.270264	S.D. dependent var		

			2.059974
S.E. of regression	1.759724	Akaike info criterion	
			3.969454
Sum squared resid	17130.55	Schwarz criterion	
			3.977819
Log likelihood	-10986.40	F-statistic	
			342.8414
Durbin-Watson stat	0.470037	Prob(F-statistic)	
			0.000000

Height had a positive impact on the dependent variable (family per capita) income, signifying that investments in human capital made in early childhood implies the individual should be able to earn a higher income from productive activities as an adult.

The point elasticity of income in relation to height, calculated for the average value of height (165.08570 cm) is 5.36, meaning that at this point an increase of one percent in height implied an increase of 5.36% on (family per capita) income[16]. Therefore, an increase of 1% in the investment in human capital made in an individual as a child implies an increase of 5.36% on his income as an adult, that is to say, in his capacity to acquire services such as health, sanitation and education.

[16] We calculated the elasticity of a semilog function according to Allen, RGD. p. 244.

6.Relations Among Family Per Capita Income, Height, and Educational Attainment of an Individual

Dependent Variable: Income (Yi).

Independent Variables: Height (Hi) as proxy for human capital investment made in an individual during childhood, and Educational Attainment (EAi) as proxy for human capital investment made in an individual from childhood through adulthood.

Control Variables: Age (I); Age Squared (I^2);Gender (S); Area (A); Region (R).

Yi = f (Hi, EAi)

Dependent Variable: LY1

Method: Least Squares

Date: 05/06/03 Time: 15:12

Sample: 1 5539

Included observations: 5539

White Heteroskedasticity-Consistent Standard Errors & Covariance

LY1=C(1)*H+C(2)*EA+C(3)*I+C(4)*I2+C(5)*S+C(6)*A+C(7)*R

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.012255	0.001537	7.975013	0.0000
C(2)	0.140332	0.005246	26.74972	0.0000
C(3)	0.011267	0.001237	9.104523	0.0000
C(4)	-1.06E-05	1.41E-06	-7.512962	0.0000
C(5)	-0.791902	0.047082	-16.81969	0.0000
C(6)	-1.315632	0.064843	-20.28964	0.0000
C(7)	0.571260	0.044801	12.75108	0.0000

R-squared	0.344873	Mean dependent var	5.291376
Adjusted R-squared	0.344163	S.D. dependent var	2.059974
S.E. of regression	1.668245	Akaike info criterion	3.862684
Sum squared resid	15395.78	Schwarz criterion	3.871049
Log likelihood	-10690.70	F-statistic	485.3614
Durbin-Watson stat	0.530749	Prob(F-statistic)	0.000000

Height and educational attainment had a positive impact on the dependent variable (family per capita) income. Therefore, an investment made on the formation of human capital, either during childhood or at a later stage, implies the probability of the individual having a larger income as an adult, and better access to health, sanitation and education services.

The point elasticity of income with respect to height, calculated for the average value of height (165.08570 cm) was 2.02313, meaning that at this point an increase of 1% in height implied an increase of 2.02% on income.

The point elasticity of the income with respect to educational attainment, calculated for the average value of educational attainment (6.61 years of study), was 0.92752, meaning that an increase of 1% in the number of years in school implied an increase of 0.927% on income.

Since we are using height and educational attainment as proxies, results are an indication that an increase of 1% in human capital investment made in an individual at childhood implies the probability of this individual having an increase of 2.02% on income

as an adult. An increase of 1% in human capital investment made in an individual from childhood through adulthood implies the probability of this individual having an increase of 0.93% on income as an adult.

4.1.7.Towards a More Generalized Model

Dependent Variable: Family per Capita Income (Yi).

Independent Variables: Height (H) as proxy for human capital investment made in an individual during childhood, Educational Attainment (EA) as proxy for human capital investment made in an individual from childhood through adulthood and Self-reported Health Status (HS) as current health and nutritional status indicator.

Control Variables: Age(I); Age Squared (I^2); Gender (S); Area (A); Region (R).

Yi = f (Hi, EAi, HSi)

Dependent Variable: LY1

Method: Least Squares

Date: 08/02/03 Time: 23:09

Sample: 1 5539

Included observations: 5539

White Heteroskedasticity-Consistent Standard Errors & Covariance

LY1=C(1)*H+C(2)*EA+C(3)*HS1+C(4)*I+C(5)*I2+C(6)*S+C(7)*A+C(8)*R

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.009926	0.001583	6.270389	0.0000
C(2)	0.134838	0.005323	25.33326	0.0000
C(3)	0.138856	0.024446	5.680017	0.0000
C(4)	0.010849	0.001236	8.776106	0.0000
C(5)	-9.96E-06	1.41E-06	-7.041744	0.0000
C(6)	-0.789463	0.047009	-16.79379	0.0000
C(7)	-1.296759	0.064753	-20.02615	0.0000

C(8)	0.552245	0.044761	12.33767	0.0000
R-squared	0.349011	Mean dependent var		5.291376
Adjusted R-squared	0.348187	S.D. dependent var		2.059974
S.E. of regression	1.663118	Akaike info criterion		3.856709
Sum squared resid	15298.54	Schwarz criterion		3.866269
Log likelihood	-10673.16	F-statistic		423.6151
Durbin-Watson stat	0.521281	Prob(F-statistic)		0.000000

Height, educational attainment and health status, had a positive impact on the dependent variable income. Therefore, investments made in forming human capital, either during childhood or at a later stage, and the health status as an adult, imply the probability of an individual having a larger income at adulthood, and better access to health, sanitation and education services. Men earn higher incomes than women. Individuals living in the richest region of Brazil (the Southeast) and urban areas earn more than those living in the Northeast and rural areas. Elder individuals earn a larger income in working activities than younger ones, but with age earnings increase at a decreasing rate.

The point elasticity values of income with respect to height, educational attainment and health status, calculated for their average values, were as follows:

- Elasticity of income with respect to height was equal to 1.63864, indicating that an increase of 1% in height (investment made in the formation of human capital during childhood), implied an increase of 1.64% in income;

- Elasticity of income with respect to educational attainment was equal to 0.89121, meaning that an increase of 1% in education (investment made in the formation of human capital), implied an increase of 0.89% on income;
- Elasticity of income with respect to health status was equal to 0.47245, meaning that an increase of 1% in health status implied an improvement of 0,47% in income.

DEPENDENT VARIABLES ELASTICITY

Sample	Regression	Data	Dependent Variable Label	Independent Variable Label	Coefficient	Mean Value		Elasticity
						Dependent Variable	Independent Variable	
Total Sample	HS=f(H)	8.880	**HS**	**H**	0,010893	3,32005	163,38450	**0,53606**
	HS=f(H, EA)	8.880	**HS**	**H**	0,003988	3,32005	163,38450	**0,19626**
			HS	**EA**	0,049623	3,32005	6,26396	**0,09362**
	HS=f(H, EA, Y)	5.539	**HS**	**H**	0,003528	3,40242	165,08570	**0,17118**
			HS	**EA**	0,037166	3,40242	6,60950	**0,07220**
			HS	**Y**	0,045900	3,40242	5,29138	**0,07138**
	EA=f(H)	8.880	**EA**	**H**	0,139143	6,26396	163,38450	**3,62930**
	Y=f(H)	5.539	**Y**	**H**	0,032478	5,29138	165,08570	**5,36165**
	Y=f(H, EA)	5.539	**Y**	**H**	0,012255	5,29138	165,08570	**2,02313**
			Y	**EA**	0,140332	5,29138	6,60950	**0,92752**
	Y=f(H, EA, HS)	5.539	**Y**	**H**	0,009926	5,29138	165,08570	**1,63864**
			Y	**EA**	0,134838	5,29138	6,60950	**0,89121**
			Y	**HS**	0,138856	5,29138	3,40242	**0,47245**
Families with Youngest Child Between 2 and 7 Years-Old	HAZc=f(EAp, EAm)	1.257	**HAZc**	**EAp**	0,017982	0,49427	5,58234	**0,20309**
			HAZc	**EAm**	-0,077522	0,49427	5,71856	**-0,89690**
Families with Child Between 15 and 21 Years-Old	EAc=f(HAZp, HAZm)	736	**EAc**	**HAZp**	0,108573	6,59773	-1,15733	**-0,01905**
			EAc	**HAZm**	0,137875	6,59773	-1,04145	**-0,02176**
	EAc=f(EAp, EAm)	838	**EAc**	**EAp**	0,089210	6,59773	5,45019	**0,07369**
			EAc	**EAm**	0,175688	6,59773	5,27995	**0,14060**

OBSERVATIONS :

(1) Elasticity estimation for regressions with HS as dependent variable are based on coefficients of regressions run through OLS Method instead of Ordered Logit Method, since it can be considered a proxy of marginal effect value.

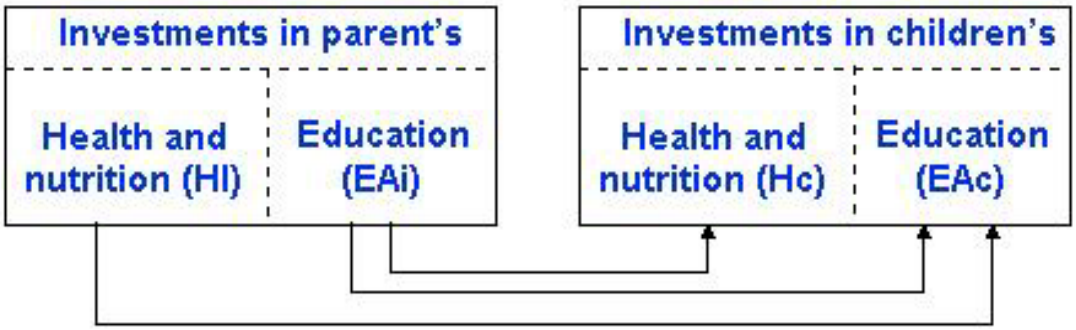
(2) Elasticity values for regressions with Y as independent variable represent the elasticity of log(Y+1).

Intergenerational Transmission of Human Capital

Diagram 3 has been taken from Diagram 1 and will remind us of the relationships we are estimating on this second phase of our study.

DIAGRAM 3

IMPACT OF THE INVESTMENT IN HUMAN CAPITAL ON THE INTERGENERATIONAL TRANSMISSION OF THIS INVESTMENT.



1.Relationship Between the Child's Height (Hc) and Parents' Educational Attainment (EAp, EAm)[17]

A child's height is a proxy of investments on health and nutrition made in children of the age bracket 2 to 7 and the parents' educational attainment is a proxy of the investment in human capital made in parents at a younger age.

Dependent Variable: Child's Height (Hc).

Independent Variable: Parents' Educational Attainment (EAp, EAm).

Control Variables: Family's Per Capita Income (YPC); Child's Age (Ic); Area (A); Region (R).

$$Hc = f(EAp, EAm)$$

FAMILIES WITH YOUNGEST CHILD IN THE 2-7 AGE BRACKET (N=1,257)

Dependent Variable: HAZC

Method: Least Squares

Date: 08/04/03 Time: 13:33

Sample: 1 1336

Included observations: 1257

Excluded observations: 79

White Heteroskedasticity-Consistent Standard Errors & Covariance

HAZC=C(1)+C(2)*EAP+C(3)*EAM+C(4)*LYPC1+C(5)*IC+C(6)*A+C(7)*R

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.755833	0.669132	1.129572	0.2589
C(2)	0.017982	0.034196	0.525855	0.5991
C(3)	-0.077522	0.035376	-2.191380	0.0286
C(4)	0.381426	0.115007	3.316536	0.0009
C(5)	-0.010475	0.004931	-2.124067	0.0339
C(6)	-0.591461	0.230297	-2.568252	0.0103
C(7)	-0.339274	0.184302	-1.840858	0.0659

R-squared	0.024067	Mean dependent var	0.509745
Adjusted R-squared	0.019382	S.D. dependent var	3.226460
S.E. of regression	3.195039	Akaike info criterion	5.166629

[17] In section which deals with the intergenerational transmission of human capital, we used the z scores for the height of the children, of their fathers and of their mothers.

Sum squared resid	12760.34	Schwarz criterion	5.195233
Log likelihood	-3240.226	F-statistic	5.137550
Durbin-Watson stat	1.980957	Prob(F-statistic)	0.000032

Results show a positive impact from a father's educational attainment on the child's height. However, the level of significance of the coefficient was low, which means that the variable father's educational attainment is not a good predictor of the child's height. The introduction of the log of per capita income in the regression significantly reduces the coefficient of education.

Surprisingly, the influence of the mother's educational attainment on a child's height was markedly negative and the level of significance of the coefficient was acceptable. This result indicates that mothers with higher education tend to raise children under worse nutrition and health conditions in the first two years of the children's lives. This could be a consequence of new trends in labor market conditions: the number of women working outside the home to help supporting the family is increasing and the task of raising the children is being passed on to baby-sitters or even domestic employees, with no training on childcare.

One should bear in mind that the parents' education has a two-fold role. It acts directly on the intergenerational transmission of human capital and acts also indirectly, since better educated parents tend to have a higher family per capita income and as a consequence are more efficient in the transmission of human capital to their children in the first two years of their lives.

2.Transmission to Children of Investments in Parents´Health and Nutrition

On this topic, we will study the relationship of the educational attainment of children (EAC) between 15 and 21 and their parents' height (Hp, Hm), as a proxy of human capital investment made in the parents in the first two years of their lives.

Dependent Variable: Child's Educational Attainment (EAc).

Independent Variable: Parents' Height (Hp, Hm).

Control Variables: Family's Per Capita Income (YPC); Child's Age (Ic); Area (A); Region (R).

EAc = f (Hp, Hm)

FAMILIES WITH CHILDREN BETWEEN 15 AND 21 (736 DATA)

Dependent Variable: EAC

Method: Least Squares

Date: 08/04/03 Time: 13:23

Sample: 1 903

Included observations: 736

Excluded observations: 167

White Heteroskedasticity-Consistent Standard Errors & Covariance

EAC=C(1)+C(2)*HAZP+C(3)*HAZM+C(4)*LYPC1+C(5)*IC+ C(6)*A+C(7)*R

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-5.957366	1.093456	-5.448200	0.0000
C(2)	0.108573	0.077988	1.392179	0.1643
C(3)	0.137875	0.077477	1.779566	0.0756
C(4)	1.269484	0.083284	15.24292	0.0000

C(5)	0.034445	0.004119	8.362648	0.0000
C(6)	-1.309337	0.226640	-5.777171	0.0000
C(7)	0.299074	0.177777	1.682292	0.0929

R-squared	0.462945	Mean dependent var	6.667120
Adjusted R-squared	0.458525	S.D. dependent var	3.076230
S.E. of regression	2.263644	Akaike info criterion	4.481294
Sum squared resid	3735.457	Schwarz criterion	4.525056
Log likelihood	-1642.116	F-statistic	104.7337
Durbin-Watson stat	1.978888	Prob(F-statistic)	0.000000

Results indicate that the parents' height has a positive impact on a child's educational attainment adequacy. The impact of the mother's height on the child's educational attainment was higher and more significant than the father's. Which means that, women raised with higher standards of health and nutrition during infancy tend to invest more on their children's education in the future. However, the level of significance of both coefficients is very low. Mothers´ height is significant at the level of 10% (actually at 7.6%), but the father's height is not significant at that level. Therefore only the investment in human capital made in girls (during infancy) is transmitted to the next generation in terms of better educational attainment. Once again, the introduction of per capita income in the regression reduces significantly the coefficient of height, a proxy of the investments made in health and nutrition of the parent's when they were still children.

3.Relationship Between the Educational Attainment (EAc) of individuals in the age bracket 15 to 21 and Parents' Educational Attainment (EAp, EAm)

Educational attainment of individuals in the age bracket 15 to 21 can be considered a measure of the outcome of investments in human capital made in parents when they were younger.

Dependent Variable: Child's Educational Attainment (EAc).

Independent Variable: Parents' Educational Attainment (EAp, EAm).

Control Variables: Family's Per Capita Income (YPC); Child's Age (Ic); Area (A); Region (R).

EAc = f (EAp, EAm)

FAMILIES WITH CHILDREN BETWEEN 15 AND 21 (838 DATA)

Dependent Variable: EAC

Method: Least Squares

Date: 08/04/03 Time: 13:27

Sample: 1 903

Included observations: 838

Excluded observations: 65

White Heteroskedasticity-Consistent Standard Errors & Covariance

EAC=C(1)+C(2)*EAP+C(3)*EAM+C(4)*LYPC1+C(5)*IC+C(6)*A+C(7)*R

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-7.522337	0.903759	-8.323390	0.0000
C(2)	0.089210	0.028807	3.096831	0.0020
C(3)	0.175688	0.029846	5.886470	0.0000
C(4)	0.750559	0.088818	8.450566	0.0000

C(5)	0.041668	0.003626	11.49044	0.0000
C(6)	-0.794105	0.198589	-3.998739	0.0001
C(7)	0.564255	0.152677	3.695731	0.0002

R-squared	0.522839	Mean dependent var	6.650358
Adjusted R-squared	0.519394	S.D. dependent var	3.084349
S.E. of regression	2.138249	Akaike info criterion	4.366169
Sum squared resid	3799.421	Schwarz criterion	4.405688
Log likelihood	-1822.425	F-statistic	151.7584
Durbin-Watson stat	1.964428	Prob(F-statistic)	0.000000

Parents' educational attainment bears a significantly positive influence on the child's educational attainment adequacy. Both parents' educational attainment had significant impact on the child's educational attainment. However, the effect of the mother's educational attainment on the child's educational adequacy was higher. The model presented higher explanatory power than any other in the study.

The elasticity of a child's educational attainment adequacy with respect to the parents' educational attainment is very important. Elasticity of a child's educational attainment adequacy with respect to the father's educational attainment is equal to 0.07369 and with respect to the mother's educational attainment is equal to 0.14060. It means that when the father's and mother's education is increased by 1%, the child's educational attainment adequacy increases by 0.074% and 0.14%, respectively.

CONCLUSION.

Our work is based on two lines of thought. In the first line of thought we worked with data relative to the individual. We tried to verify the impact upon the individual´s present health status of investments in the formation of his/her human capital and of his/her (family per capita) income. We also tried to verify the impact upon the individual´s (family per capita) income of investments in the formation of his/her human capital and of his/her present health status. The main results obtained were:

- ✓ With a high degree of statistical significance, we can state that human capital investment made in an individual from childhood through adulthood and family per capita income have a positive impact on the level of self-reported health status.

  Women from the Southeast and the Northeast and individuals of both genders living in the Northeast, the poorest region of Brazil, and individuals living in rural areas presented a probability of having worse health status.

- ✓ Height, educational attainment and health status, had a positive impact on income. Therefore, investments made in forming human capital, either during childhood or at a later stage, and the health status as an adult, imply the probability of an individual having a larger income at adulthood, and better access to health, sanitation and education services. Men earn higher incomes than women. Individuals living in the richest region of Brazil (the Southeast) and urban areas earn more than those living in the Northeast and rural areas.

The second line of thought was relative to the intergenerational transmission of human capital. The main results were as follows:

- ✓ **Relationship Between the Child's Height and Parents' Educational Attainment -** The impact from a father's educational attainment on the child's height is positive, but with a low level of significance, meaning that the father's educational attainment is not a good predictor of the child's height. Surprisingly, the influence of the mother's educational attainment on a child's height was markedly negative, what could be a consequence of new trends in labor market conditions.

  One should bear in mind that the parents' education has a two-fold role. It acts directly on the intergenerational transmission of human capital and acts also indirectly, since better educated parents tend to have a higher family per capita income and as a consequence are more efficient in the transmission of human capital to their children in the first two years of their lives.

- ✓ **Transmission to Children of Investments in Parents´Health and Nutrition -** Only the investment in human capital made in girls (during infancy) is transmitted to the next generation in terms of better educational attainment.

- ✓ **Relationship Between the Educational Attainment of individuals in the age bracket 15 to 21 and Parents' Educational Attainment** - Both parents' educational attainment bears a significantly positive influence on the child's educational attainment adequacy. However, the effect of the mother's educational attainment on the child's educational adequacy was higher.

REFERENCES

BARRO, R. Health and Economic Growth. Harvard University, 1996.

BARRO, ROBERT AND SALA-Y-MARTIN, J. Economic Growth. p. 453-461

BECKER, G.S. "CHAPTER 3: Investment In Human Capital: A Theoretical Analysis" In: FEBRERO, R. AND SCHWARTZ, P.S. The Essence Of Becker. Hoover Institution Press, Stanford University, Stanford, California, 1995.

BECKER, G.S. AND TOMES, N. "Human Capital And The Rise And Fall Of Families" Chapter 14 in Febrero, Ramon and Schwartz, Pedro S. The Essence of Becker Hoover Institution Press, Stanford University, Stanford, California, 1995.

BLAUG, M.(ED.) Economics Of Education: Selected Readings. Vol. 1 and 2, Penguin Books, Middlesex, England And Baltimore, Maryland, 1968.

CAMPINO, A.C.C. AND DIAZ, M.D.M. "Mensuração da Desigualdade na Área da Saúde no Brasil: Novas Dimensões sobre Qualidade e Resolutividade". ["Measuring Inequality in Brazil's Health Área"]. In: Anais do V Encontro Nacional da ABRES, Salvador, 2000, pp.19-41. [Text in Portuguese].

DENNISON, E.F. Why Growth Rates Differ; Postwar Experience In Nine Western Countries. Washington, Brookings Institution, 1967, 494p.

DENNISON, E.F. Accounting For United States Economic Growth, 1929-1969 Washington, Brookings Institution, 1974, 355p.

FOGEL, R.W. "The Impact of Nutrition on Economic Growth". Lecture presented at 3rd International Conference of International Health Economics Association, July/2001.

IBGE (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA) - THE BRAZILIAN INSTITUTE FOR GEOGRAPHY AND STATISTICS. Pesquisa de Padrão de Vida 1996-1997. [Research on the Standard of Living 1996-1997]. Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro, 1998. [Text in Portuguese].

MCMAHON, W.W. Education And Development: Measuring The Social Benefits. Oxford University Press, 1999.

MONTEIRO, C.A.; BENICIO, M.H.D'A.; GOUVEIA, N.C. "Secular Growth Trends in Brazil Over Three Decades". Annals of Human Biology, 21 (4): 381-90, 1994.

PARKIN, M. Macroeconomics. 5th. Edition, Addison-Wesley Publishing Co.Inc.,2000.

QUANTITATIVE MICRO SOFTWARE. EViews. Version3.0, 1994-1998.

SHAFFER, H.G. "A Critique Of The Concept Of Human Capital" In: BLAUG, M.(ED.). Economics Of Education: Selected Readings. Vol.1.

STRAUSS, J. AND THOMAS, D. "Health, Nutrition and Economic Development". Journal of Economic Literature, Vol.36, June/1998, p.766-817.