Lifetime Health Consequences of Child Labor in Brazil

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Health consequences of child labor may take time to manifest themselves. This study examines whether adults who worked as children experience increased incidence of illness or physical disability. The analysis corrects for the likely endogeneity of child labor and years of schooling using variation in number of schools per children, number of teachers per school, low skill wages and local income at the time the adults were children. Results show that the effects of child labor on adult health are complex. When considered in isolation, child labor appears to increase the likelihood of poor health outcomes in adulthood. However, when education is also considered, the child labor effect is shown to work through the negative effect of child labor on years of schooling, and evidence that child labor directly harms adult health disappears. This result is consistent with evidence that early entry into the labor market and early exit from school is correlated with entry into atypically hazardous adult occupations.

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I. Introduction

The International Labor Organization (ILO) Convention 182 calls for the prohibition and elimination of the worst forms of child labor. In addition to universally condemned occupations such as child slavery, prostitution, pornography and drug trafficking, the worst forms include work that is likely to jeopardize the health, safety or morals of young persons (ILO, 1999). The ILO estimates that there are 171 million children aged 5 to 17 involved in hazardous work.[1] Children engaged in such activities are presumed to face immediate health threats by the nature of the work. However, child labor could also have health consequences that only become manifest in adulthood. Such long-term health risks can develop from early exposure to dust; toxins; chemicals such as fertilizer and pesticides; inclement weather; heavy lifting; or the forced adoption of poor posture. Hazards may also threaten psychological health through exposure to abusive relationships with employers, supervisors or clients (ILO, 1998).

The linkage between working as a child and health status later as an adult has not been widely explored. This study aims to fill that knowledge gap by examining whether adults who entered the labor market early in life suffer higher rates of chronic diseases and functional limitations in adulthood. We address the question using the 1998 Pesquisa Nacional por Amostra de Domicilios (PNAD) which included a series of questions on health and disability status. It also included questions on whether current adults worked as children.

Estimating the causal effect of early entry into labor market on adult health is complicated by the selection process which sorts children into the labor market. On the one hand, we might expect that only reasonably healthy children would be sent to work at young ages as sickly children would not be capable of work. On the other hand, children from the poorest

[1] All children aged 5-17 are considered by the ILO to be engaged in hazardous work if they are working in mining or construction or in occupations or processes considered hazardous by their nature or if they work more than 43 hours per week.

households are the most likely to work, and growing up in poverty may be correlated with adverse health outcomes.[2] Thus, the early incidence of child labor may be correlated with unobservable positive or negative health endowments that could affect adult health in addition to any direct impact of child labor on health. These unobserved health endowments cloud the interpretation of simple correlations between child labor and adult health outcomes.

Another confounding factor is that child labor may affect a child's years of schooling completed, and education has been shown to positively affect adult health.[3] The effect of child labor on education in Brazil is uncertain. Because the average school day lasts only four hours, many children in Brazil both work and attend school. Child labor may help the household afford more years of schooling. On the other hand, child labor may retard child cognitive attainment per year of schooling, and it may also lead to earlier exit from school into full time work.[4] A complete assessment of the effect of child labor on health must consider the indirect effect of child labor on schooling.

In this study, adult health is measured by the incidence of chronic diseases and by functional limitations in performing activities. We estimate the relationship of these adult health outcomes to child labor first by assuming that age of labor market entry and years of schooling completed are exogenous. We then use variation in the supply and quality of local schools, average household incomes, and low skill wages in the state the adult was born at the time the adult was a child as instruments for endogenous age of labor market entry and years of schooling

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[2] Case et al. (2002) and Currie and Stabile (2003) present evidence that children in poorer families have significantly worse health than children in richer families.

[3] Studies have consistently found a large positive correlation between education and health (Van Doorslaer, 1987; Wagstaff, 1993; Grossman, Michael and R. Kaestner, 1997; Lleras-Muney, A, 2005).

[4] Evidence of the impact of child labor on schooling attainment is mixed with some studies finding negative effects (Psacharopoplous, 1997) while others (Patrinos and Psacharopoulos (1997), Ravallion and Wodon(2000)) finding that schooling and work are compatible. There is stronger evidence that child labor lowers test scores, presumably because it makes time in school less efficient (Post and Pong (2000), Heady (2003), Rosatti and Rossi (2003), Gunnarrson et al (2006)).

completed. These variables affected the relative value and cost of child time in school versus work and of household ability to support child time in school and so they should have influenced labor supply and schooling decisions during childhood. However, these factors should have no direct impact on the child's health a quarter century later in adulthood.

When treated as exogenous, child labor is positively correlated to with a higher incidence of adult chronic diseases and functional limitations. These effects become even larger when correcting for endogeneity of child labor and schooling. The largest effects are found for health conditions that are plausibly related to occupational status, while ailments that are influenced more by heredity or by lifestyle choices are not correlated with early entry into the workforce. Additional investigation shows that the adverse effect of child labor on adult health works primarily through the adverse effect of child labor on years of schooling and resulting occupational choices. There is no evidence that child labor has a detrimental effect on adult health beyond its indirect on health through the reduction in years of schooling.

The next section summarizes the literature on child labor and long-term health. In section III, we describe our estimation strategy. Section IV provides data and descriptive statistics. In section V, we present empirical results. In section VI, we summarize our findings and their implications for policy and further research.

II. Literature Review

Until recently, most studies linking child labor and health have focused on the health of currently working children. The comprehensive review by Graitcer and Lerer (1998) presented a mixed picture of international evidence regarding the impact of child labor on health, primarily because of data limitations. Data on the extent of child labor itself is subject to considerable error, but data on the incidence of child injuries on the job are even more problematic. Sources of information come from government surveillance, sometimes supplemented by data from worker's compensation or occupational health and safety incidence reports. These latter sources are less likely to be present in the informal labor markets in which child labor is most common, and government surveillance is often weak. Nevertheless, reported injury rates are not small: of working children aged 10-14, 9% are estimated to suffer injuries annually, and 3.4% are estimated to suffer disabling injuries.

Information on longer term health consequences of child labor such as occupational diseases or repetitive motion injuries is even more limited and subject to errors. In a rare example of longitudinal data applied to the question, Satyanarayana et al (1986) examined anthropometric data on 410 children over a 17 year period in a rural area in India. They found that children who worked in agriculture, small-scale industry and services had worse growth in height and weight when followed through to adulthood than those who attended school. They did not consider the issue of nonrandom selection into work or industry.

Two larger-scale studies using different Brazilian data sets provide some evidence on the negative long term effect of child labor on adult health. Kassouf et al (2001) found that the probability of self-reported poor health increases as the age of labor market entry decreases. However, this result should be interpreted with caution in that child labor and schooling are treated as exogenous and no other control variables are used. Giuffrida et al (2005) found that starting to work under age 9 has a negative and significant effect on adult health. Their estimates control for age, race, education, wealth, housing conditions, and unemployment status. However, if child labor alters wealth, housing status or unemployment later in life, some of these controls are jointly determined with child labor and adult health, again raising concerns about endogenous child labor.

Rosati and Straub (2004) used a sample of Guatemalan siblings which allowed control for unobservable household attributes in assessing the impact of child labor on adult health. However their strategy still treats child labor and possible resulting decisions regarding schooling and income as exogenous. In addition, their sample is restricted to adults who are still living with their parents, and so their sample is heavily weighted toward relatively young adults. Moreover, if the decision to live with parents is conditioned on health outcomes, as would be the case if healthy children are more likely to live on their own and children suffering illness or disability are more likely to remain with their parents, then their sample will be biased toward finding adults with health problems. Selection might explain why they find such large adverse health consequences: having worked as a child increased by 40% the probability of having health problems as an adult. Nevertheless, their finding of very large health consequences from child labor illustrates the importance of further examination of the link between child labor and adult health.

There does appear to be a *prima facie* case that starting to work early in life can lead to the early onset of physical disabilities and chronic illness in adulthood. Figure 1 shows the relationship between age of labor market entry and various health conditions for several birth cohorts in Brazil. Adults who started working earliest as children have a higher incidence of back problems and arthritis than do their contemporaries who entered the labor market at older ages. Older cohorts have a higher incidence of these problems than younger cohorts, but the downward pattern between health problems and age of labor market entry is found in all cohorts. Interestingly, there is no apparent pattern between the incidence of hypertension and age of labor market entry. Presumably, the incidence of hypertension would be tied more closely to heredity and life style and less to years of work.

The downward pattern between age of labor market entry and adult adverse health outcomes are found for self reported problems walking, bending, lifting, pushing, climbing stairs, and kidney disease (see Appendix 1). Other than the last measure, these health problems appear to be physical and potentially associated with repeated physical stress. Patterns similar to the hypertension case are found for self-reported asthma, diabetes, cancer, tuberculosis, cirrhosis, depression, heart disease, and tendonitis. Other than the last indicator, these health conditions tend to reflect heredity and life style choices. The balance of the paper examines whether we can identify the nature of the link between child labor and adult health.

III. Estimation Strategy

1. Model: Identification

We use a simple two period model, (designated by superscript *t* =1, 2) to illustrate the estimation issues. Working and schooling decisions during childhood are made in period 1, and adult health status is observed in period 2. Individual *i* in state *j* and cohort *t* has period 1 age of labor market entry C_{ijt}^{1}; and years of schooling S_{ijt}^{1}. In period 2, the individual has health status H_{ijt}^{2}. These outcomes are conditioned on a vector of exogenous demographic attributes X_{ijt} that includes gender, race, state of birth and age. All individuals in cohort *t* are of the same age, But economic, work and school environments as children that can differ greatly between cohorts.

In Brazil, many children who work are also enrolled in school, and so school and work are not mutually exclusive states. Decisions regarding child schooling and work will be shaped by demographic factors, individual time-invariant unobserved ability (a_{ijt}) and unobserved health endowment (h_{ijt}), and a vector of factors that alter the opportunity cost of time and the value of schooling for period 1 children in state *j* and cohort t (Z^1_{jt}). Equations describing the age of labor market entry and years of completed schooling decisions are given by [5]

$$C^1_{ijt} = X'_{ijt}\varphi^C_X + Z^{1\,'}_{jt}\varphi^C_Z + \varepsilon^C_{ijt} \quad (1)$$

$$S^1_{ijt} = X'_{ijt}\varphi^S_X + Z^{1\,'}_{jt}\varphi^S_Z + \varepsilon^S_{ijt} \quad (2)$$

where the error terms are given by

$$\varepsilon^k_{ijt} = \alpha^k_a a_{ijt} + \alpha^k_h h_{ijt} + \xi^k_{ijt}; k = C, S. \quad (3)$$

The last term ξ^k_{ijt} is an iid random error. In equations (1) and (2), parental choices on age of labor market entry and child time in school will depend on parental observations of the child's endowments of ability and health. If, for example, the parameters in (3), α^k_a and α^k_h are positive, then children who are born with better health and ability will both work more and attend school more in period 1.

In period 2, these endowments of health and ability will carry over to observations of adult health. Let the equation explaining adult health be given by

$$H^2_{ijt} = X'_{ijt}\beta_X + \beta_C C^1_{ijt} + \beta_S S^1_{ijt} + \varepsilon^H_{ijt} \quad (4)$$

where as before, the error term has the form $\varepsilon^H_{ijt} = \alpha^H_a a_{ijt} + \alpha^H_h h_{ijt} + \xi^H_{ijt}$. Because adult health is conditioned on unobserved health and ability endowments, $COV(\varepsilon^H_{ijt}, C^1_{ijt}) \neq 0$ and $COV(\varepsilon^H_{ijt}, S^1_{ijt}) \neq 0$. Ordinary least squares applied to equation (4) will yield biased estimates of β_C and β_S. To continue our hypothetical example, if the parameters α^H_a and α^H_h are also positive, β_C and β_S will overstate the impact of child labor and years of schooling on observed health. If the true value of β_C <0, then the coefficient on child labor will be biased against finding an adverse effect of child labor on adult health.

Elements of the demographic attributes X_{ijt} only include time invariant race or gender or clearly exogenous age. We do not include occupation, employment status, marital status, presence of children or other choices that would be conceivably correlated with health or ability endowments. To the extent that these variables are choices conditioned on schooling or child

[5] Emerson and Souza (2006) employed a similar approach to identify causal relationships between child labor and adult earnings.

labor choices earlier in life, they would be endogenous to adult health outcomes and must therefore be excluded from the empirical model.

Our point is not to predict the direction of bias, but simply to indicate that unobserved health and ability endowments in childhood will carry over to cloud our interpretation of the consequences of decisions made in childhood on adult health. However, because adult health is not directly influenced by the period 1 distribution of schools, school quality, or the opportunity costs of schooling, the vector Z^1_{jt} offers a convenient battery of instruments with which to identify the true effect of child labor and years of schooling on adult health. Inserting the expected values of C^1_{ijt} and S^1_{ijt} into (4), we obtain

$$H^2_{ijt} = X'_{ijt}\beta_X + \beta_C(X'_{ijt}\varphi^C_X + Z^{1\,'}_{jt}\varphi^C_Z) + \beta_S(X'_{ijt}\varphi^S_X + Z^{1\,'}_{jt}\varphi^S_Z) + \upsilon^H_{ijt} \quad (5)$$

Provided there are at least two elements of Z^1_{jt}, we will have independent variation of child labor and years of schooling that are uncorrelated with the unobserved ability and health endowments, and so we can derive unbiased estimates of β_C and β_S. Our strategy is to estimate equations (1), (2), and (5) jointly in order to derive efficient estimates of the coefficients of interest. Because equations (1) and (2) have interest in and of themselves, insomuch as they show how the economic and school environment affects decisions on years of schooling and child labor, we also report those estimates as well. Finally, to provide a frame of reference for the estimates in (5), we estimate (4) directly to illustrate the nature of the biases.

2. Model: Direct and Indirect Effects of Child Labor on Health

There are different channels through which working as a child can affect adult health. Child labor may have a direct impact on adult health because it increases the possibility of being exposed to risk factors such as debilitating injury or exposure to chemicals. Alternatively, child labor can affect the child's schooling attainment which would in turn affect adult health. While it is possible that child labor improves educational outcomes by raising household resources that can be used to fund education, the weight of evidence suggests that child labor increases at the expense of education. A lower level of educational attainment can adversely affect adult health by lowering adult earnings, by limiting knowledge of health, or by limiting occupational opportunities to sectors with increased exposure to chronic diseases or injuries.

To distinguish empirically between the direct and indirect health consequences of child labor, suppose we estimated a variant of (5) where years of schooling was suppressed. Dropping superscripts and subscripts for notational ease, the equation would be of the form

$$H = X'\gamma_X + \gamma_C \hat{C} + \upsilon_{ijt}^{H'} \tag{6}$$

The coefficient on child labor, γ_C, would reflect the direct effect of child labor on adult health plus the indirect effect of child labor on health through its correlation with years of schooling:

$$\gamma_C = \frac{\partial H}{\partial C} = \beta_C + \beta_S \frac{\partial S}{\partial C} \tag{7}$$

Presuming we can generate legitimate estimates of equations (5) and (6), the estimate of γ_C in (6) would be $\beta_C + \beta_S \frac{\partial S}{\partial C}$, while equation (5) will yield estimates of β_C and β_S. The total effect of child labor on adult health is γ_C, the direct effect of child labor on adult health is β_C, and the indirect effect of child labor on adult health through schooling is the difference between the two.

In addition, the estimate of β_S will allow us to assess the direction of the partial effect of child labor on schooling, $\frac{\partial S}{\partial C}$. Our empirical application uses negative measures of health, and so $\beta_S < 0$ so that increased schooling reduces the incidence of poor health. Then in our estimates,

$$\operatorname{sgn}(\gamma_C - \beta_C) = \text{-}\operatorname{sgn}(\frac{\partial S}{\partial C}) \tag{8}$$

In our study, C is measured by age of labor market entry, and so $\frac{\partial S}{\partial C}>0$ will mean that delayed entry into the labor market will increase years of schooling completed.

2. The Instruments

We observe health outcomes in period 2 when the individual is an adult, but decisions on child labor and schooling occur in period 1 when the individual is a child. Both child labor and years of schooling are period 1's household decisions that reflect unobservable characteristics of the individual's family. To properly control for the potential endogeneity of child work activity and years of education in the adult health production function, we need instruments that would affect age of entry into the labor market and years of schooling completed but would not directly affect health during adulthood. We do not have information on family background measures for adults during period 1 when they were children, and so we need to look to other sources of information for factors that should affect these schooling and labor market choices.

One set of variables that may satisfy the conditions reflect the availability and quality of schools in the area where the adult grew up.[6] The presence of more schools per child residing in the state lowers the average travel costs of attending schooling in the state. Similarly the number of teachers per school can be used as a proxy for school quality in the state. Since age 7 is the age of school entry in Brazil, we use the number of schools per child and the number of teachers per school at age 7 in the state in which the individual is born as our measures of period 1 school availability and school quality.

[6] Bedi and Edwards (2002), Gertler and Glewwe (1990), Duflo (2001, 2004), Glick and Sahn (2006), and Alderman et al (2001) all found evidence that schooling decisions are influenced by distance and/or school quality.

Another factor that has been commonly used to explain variation in schooling investments and child labor is the opportunity cost of schooling.[7] Because even children who work do not work for wages, information on average pay for children is extremely limited and subject to selection problems. Instead, we use the average wage rate for workers in the state who have four or fewer years of schooling as an indicator of the value of time for illiterate labor in period 1.[8] We date the measure at the time the adult was 12 years old in the state of birth, the youngest age at which a child could legally work in Brazil.

It is commonly found that household income is positively associated with schooling and negatively associated with child labor.[9] We do not have measures of household income. Instead, we use as our period 1 income measure the average income in the individual's state of birth at age 12, taken as aggregate income divided by the number of adults.

As we will see, these instruments have strong predictive power for both the age of labor market entry and for years of schooling completed. In addition, they have signs that are consistent with the presumed roles of these variables in shaping the attractiveness of schools, the opportunity cost of child time, and the ability to pay for schooling on the endogenous variables. However, they do not have direct predictive power for adult health, and so they meet the empirical criteria for valid instruments.

IV. Data and Descriptive analysis

1. Data

The main source of data used for the analyses is 1998 Pesquisa Nacional Por Amostra de Domicilios (PNAD), the Brazilian equivalent of the Current Population Survey in the United

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[7] Card (1995) and Cameron and Taber (2004) used local labor market conditions as opportunity cost of schooling. Rosenzweig (1980) used agricultural day wages in India.

[8] It is commonly presumed that on average, it takes about five years of schooling to attain permanent literacy.

[9] For recent evidence of the inverse link between household income and child labor, see Edmonds and Pavcnick (2005) and Edmonds (2006).

States. The PNAD98 collected information from 112,434 households and 344,975 individuals and included information on labor force participation and earnings in conjunction with standard demographic characteristics such as age, gender, race, schooling, state of birth and state of residence. Periodically the PNAD survey contains extra questions on such topics as marriage, health, migration, nutrition and social mobility. The 1998 edition of the PNAD uniquely fits our needs. It included information on the age the respondent first entered the labor market. It also included a special health module which included questions eliciting the respondent's self reported health status. Questions related to twelve specifics chronic diseases or conditions (back problems, arthritis, cancer, diabetes, asthma, hypertension, heart disease, kidney disease, depression, tuberculosis, tendonitis, and cirrhosis) and to seven physical disabilities (difficulty feeding and bathing, raising objects, going upstairs, bending down, carrying and pushing, walking 1 kilometer, and walking 100 meters).

The remaining sources of data are related to construction of the instruments described in the previous section. Data on the number of primary schools, the number of teachers, and the population by state and year are taken from the IBGE Historical Series 2003.[10] Data on the average low skilled wage rate for each year and state were computed from data in the Integrated Public Use Microdata Series (IPUMS) International. Our measure is the average wage rate in each state relative to the average wage rate across all states in each year. Use of relative wages controls for changes in currency values over time. Average income measures are computed from data from the IPEA historical series.[11] Their summary statistics are included in Table 1.

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[10] We are grateful to Patrick Emerson and Andre Souza for providing us the historical data on schools and teachers by state.

[11] IPEA is the research institute of the Ministry of Planning of the Brazilian Federal Government. These series can be obtained on line at http://www.ipeadata.gov/ipeaweb.dll/ipeadata?1026025750.

The sample was selected to include only household heads or their spouses aged 30-55. We exclude older people because we wish to concentrate on the early onset of health complications. As individuals age, all health complications become more common, and so the potential impact of early labor market entry becomes more difficult to isolate. We exclude younger workers to concentrate only on those who have completed their potential years of schooling. Additionally, we restrict the sample to those who first entered the labor market at or before age 25. To allow for differential health outcomes by gender related to fertility and to possible occupational differences between men and women, we constructed two sub-samples: adult women aged 30-55, adult men aged 30-55. The total number of cases in the two sub-samples, after deletion of cases with missing data on the variables used, was 27,103 adult women and 39,736 adult men.

2. Descriptive Analysis

Table 1 reports the summary statistics for the variables used in the study. Average age of labor market entry is 13.1 years. Male adults entered the labor market one year earlier. The average years of schooling is 6.4 years with women receiving 0.5 years more schooling than men. Men constitute around 60 percent of sample.[12] 54.5 percent of the sample is White, 39.4 percent Brown (or mixed), 6.1 percent Black.

Self-reported adverse health status ranged from almost 30 percent for back problems to less than 1 percent for cancer, tuberculosis, cirrhosis and inability to walk 100 meters. Other than kidney disease, responses differed significantly between men and women. In most cases, women have higher rates of chronic ailments. There are also seven questions related to the individual's

[12] In the initial sample, men and women are equally represented, but women were less likely to report age of labor market entry.

ability to accomplish tasks.[13] The highest incidence of physical limitation was the 9% reporting difficulty lifting heavy things. Women also report having more task-related disabilities.

In our sample, there are 25 states and 26 birth years from 1943 to 1968.[14] Thus, the maximum possible number of different values for each instrument is 650. To illustrate the range of values, we selected Piaui and Sao Paulo, the poorest and the richest states in Brazil. We also report statistics for Santa Catrina whose GDP per capita is the closest to the country average. Figures 2.a to 2.d show real income per adult, the number of schools per 1000 children, the number of teachers per school and the relative average wage rate of low-skilled people to average wage rate across states respectively. In Figure 2.a, we can see the 'Brazilian economic miracle' years during the 1970s when GDP per capita almost doubled. The average number of schools per 1000 children increased from 4 to 6.5 for 25 years. While the number of schools per thousand children in Piaui increased by a factor of 4 from the 1950s to 1975, changes in other states were more modest. On the other hand, teachers per school rose steadily in Sao Paulo but not in the average Brazilian state. Average relative wages of low-skilled people remained relatively stable from the mid 1950s to the late 1960s. As the economy boomed in 1970s, the gaps of low-skilled wage rate across states widened with relative low skill wages rising in Sao Paulo and falling in Piaui. The patterns show sizeable variations in the instruments across states at a point in time and across cohorts within states.

[13] For chronic conditions, responses were absence or presence of the condition. For disabilities, respondents evaluated their degree of disability as "unable to perform tasks"; "great difficulty performing tasks"; "little difficulty performing tasks"; or "no difficulty performing tasks". We treat the first two responses as indicating disability.

[14] Brazil has 27 states currently. Following the classification in Appendix E of Emerson and Souza (2006), we collapsed the states of Goias and Tocantines, and the states of Mato Grosso and Mato Grosso do Sul. Tocantins and Mato Grosso do Sul were created recently from a division of the old Goias and old Mato Grosso, respectively. Some territories were transformed into states and some states were merged along the 20th century. See Appendix E of Emerson and Souza (2006) for detail information.

Figures 3 and 4 show the distribution of the age the individuals in our sample first entered the labor market, and their educational attainment. The most common age of labor market entry is 10, but there is substantial variation across individuals. About one-third of children enter the labor market before the legal working age. A larger percentage of boys than girls started working under age 15. The years of schooling attained are similarly broadly dispersed. Figure 5 shows that the cohort average age of labor market entry increased by only 1.7 years from 11.8 years for those born in 1943 to 13.5 years for those born in 1968. Over the same period, years of schooling increased 2.8 years from 4 years to 6.8 years.

Table 2 breaks the sample into age groups: 30-34, 35-39, 40-44, 45-49 and 50-55. This stratification allows us to explore the age-gradient of excess occurrences of chronic diseases by age of labor market entry. We concentrate on the three most common of the 12 diseases for which we have information, back problems, arthritis, and hypertension. Among women aged 30 to 34, approximately 36 percent of those starting work when under 10 had back pain. For those who began working after age 14, only 20% reported back problems. The incidence of back pain increases with cohort age. These patterns are similar for males, although fewer males report back problems even when age of labor market entry is held fixed.

Both males and females who started working before age 10 are significantly more likely to have arthritis. The same pattern is reported for early onset of the incidence of hypertension, although for men, differences in the incidence of hypertension by labor market entry disappear after age 45. The average incidence rates for the rest of diseases by age group are reported in Appendix 2. Overall, the descriptive analysis suggests that starting to work at an early age is correlated with earlier onset of some but not all adverse health problems in adulthood. Most common problems correlated with early labor market entry are physical ailments. In the next section, we examine if this pattern remains after controlling for other factors and for nonrandom sorting into school and work.

V. Empirical Results

1. Child labor and morbidity treating child labor and education as exogenous

We first examine the sets of health indicators that were considered chronic diseases or disabilities. We will repeat these exercises later using health indicators that measure physical disabilities.

Table 3 reports the marginal effects of a probit specification of equation (4), taking into account demographic factors such as age, gender, race and region of birth. These specifications ignore the endogeneity problems. When individual educational attainment is excluded, the coefficient on age of labor market entry will capture the total effect of child labor on health. When years of schooling enters the equation, the coefficient on age of labor market entry will capture only the direct effect of child labor on adult health.

The first column (A) of each health indicator shows the estimates where years of schooling is excluded; column (B) includes the schooling measure. Early onset of child labor increases the probability of having spinal disorders. An adult who started to work one year earlier is 1.3% more likely to report back problems. The second column results indicate that the incidence of spinal disorders decreases by about 1% for each additional year of schooling, controlling for child labor. After controlling for schooling, the effect of delaying entry into labor market becomes smaller: the likelihood of having spinal disorders decreases by 0.8% per year of waiting to initiate work. The other coefficients show that incidence of self-reported spinal disorders increase with age, are larger for women than men, and are larger for minority groups.

Similar results are obtained for the impact of child labor on adult incidence of arthritis and hypertension. Delaying labor market entry by one year lowers the probability of having arthritis by 0.8% and reduces hypertension by 0.3%. After controlling for educational attainment, the benefit of to delaying entry by one year falls to 0.5% for arthritis and 0.2% for hypertension.

Table 4 presents the related estimation for other chronic diseases. Even after controlling for educational attainment, child labor increases significantly the incidence of heart and kidney disease, depression and tendonitis.

Our results indicate that when child labor is treated as exogenous, child labor consistently is associated with adverse health consequences. Early entry into the labor market increases the probability of having more physical-related chronic diseases (i.e., back problems and arthritis), but they seem to be related to other health problems that would be less obviously tied to child labor. Of course, the correlation may be due to the unobserved ability and health endowments and not to a true causal relationship.

2. Child labor and morbidity considering child labor and education as endogenous

Our labor supply and schooling educations (1 and 2) are used to identify child labor and schooling in equation (5). We first demonstrate that our instruments can significantly explain variation in the age at which children first start working and the years of schooling completed. We regress age of labor market entry and years of schooling completed on state-level income per capita, number of schools per child, number of teachers per school, and the relative wage for less-educated workers that prevailed at the time the adult was a child. The regression also includes time invariant demographic attributes and age. Table 5 presents the first-stage regression results. Better access to schools delay labor market entry. Individuals born in states with more schools per children and more teachers per school enter the labor market at older ages.

On the other hand, stronger demand for low skill labor, as indicated by higher relative wages for workers with less than five years of schooling, induces children to enter the labor market earlier in life. These findings are consistent with previous studies that found that the incidence of child labor decreases with better school access and/or lower opportunity costs of schooling.[15] Also consistent with earlier studies, children born in wealthier states, as indicated by higher income per adult, delay labor market entry. The null hypothesis that the coefficients on these four variables are jointly equal to zero was easily rejected, as seen by the *F*- statistic reported at the bottom of the table.

The second column of Table 5 shows the first stage regression for years of schooling completed. Individuals born in states with easier access to grade schools and with more teachers per child in the population completed more years of schooling. Those born in states with higher per capita incomes also completed more years of schooling. Higher state average low skill wages were also associated with completing more years of schooling. This may mean that older family members specializing in work earn sufficient amounts to help subsidize their siblings' schooling, or it may reflect the frequent practice of combining school and work for Brazilian children. The null hypothesis that the four coefficients are jointly equal to zero was again easily rejected.

Table 6 presents the results of estimating equation (5) jointly with equations (1) and (2). Separate results excluding (column A) and including (column B) years of schooling are shown. The estimated effects of early entry into labor force on the incidence of selected chronic disease are shown in the second row of each column. The IV probit estimates of child labor effects on health are significantly higher than the probit estimates in table 3 when years of schooling are excluded. For example, treating labor market entry as exogenous, delaying entry by one year

[15] See Emerson and Souza (2006) and Cameron and Taber (2004)

decreases the incidence of spinal disorders by 1.3%; but treating labor market entry as endogenous implies a one year delay decreases incidence by 2.4%.

When years of schooling are included in the analysis, the adverse impact of child labor on adult back problems disappears.[16] In fact, holding years of schooling constant, the coefficient on age of entry into labor market turns positive but not significantly different from zero. These patterns are repeated for the other chronic conditions reported in Table 6. For arthritis, the significant effect of child labor on adult health (2.1% reduction when delaying child labor by one year) becomes negligible in magnitude and significance. In the case of hypertension, the negative effect of early entry into labor force on health outcomes becomes positive when schooling is included. On the other hand, the marginal effect of years of schooling on health is larger, ranging from a 2.9% to 5.1% decrease in the incidence of chronic disease from an additional year of schooling. The implication is that the adverse effect of child labor on adult health works its way entirely through the indirect schooling channel, a result that holds in almost all the 18 health outcomes we examine.[17] We conclude that the hypothesis that adverse health consequences follow directly from early entry into the labor market cannot be supported by the data. Instead, early entry into the labor market limits schooling which does result in increased incidence of chronic conditions in adulthood.

Turning to equation (8), we can treat the column A coefficient on age of labor market entry as γ_C and the coefficient on the same variable in column B as β_C. The coefficient on years of schooling in column B is an estimate of β_S which is almost always negative for all the health

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[16] We experimented with another specification that allowed an interaction term between child labor and years of schooling. The hypothesis was that child labor may make schooling less efficient in producing adult health. In all of the specifications we tried, the interaction term failed tests of statistical significance, and so we restrict our discussion to the specifications excluding the interactions.

[17] The two cases where delaying child labor lowers the incidence of disease or disability after controlling for schooling are diabetes and cirrhosis. In three cases (cancer, diabetes and tendonitis), schooling significantly increases the incidence of the condition or disease.

indicators we examine. In all cases in Table 6, $(\gamma_C - \beta_C) = \beta_S \frac{\partial S}{\partial C} < 0$, which implies that $\frac{\partial S}{\partial C} > 0$ because β_S <0. The implication is that as age of labor market entry rises, years of schooling also increase, and that increased education has long term positive implications for eventual health as an adult.[18]

The incidence of all chronic diseases or ailments rises with age. Women are more likely to suffer these ailments than men. Generally, minorities are less likely to report chronic diseases than are otherwise observationally equivalent Whites. There are no systematic effects of birth region on the incidence of disease or disability.

3. Child labor and disability

We complete our analysis of the long-term impact of child labor on health by examining the connection between child labor and measures of physical limitations. The objective is to corroborate the morbidity evidence with results for other health indicators. As explained in section IV, the functional disability question provides important information on the long-term health of individuals. The same approach used for chronic diseases is applied to examine the effect of early entry into labor market on the probability of having functional limitations. We examine the effects of child labor and schooling on the probability of having health problems that impede an individual from performing activities such as raising objects, climbing stairs or walking 1 kilometer.[19] Treating child labor and schooling as exogenous, results in Table 7 show that delaying labor market entry by one year consistently lowers the probability of adverse health

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[18] As we will see, the only cases for which $(\gamma_C - \beta_C) > 0$ and/or $\beta_S > 0$ are the cases of cirrhosis, cancer, diabetes, tendonitis, and inability to walk 100 meters. Of the 18 health conditions we investigate, these are 5 of the 6 least frequently occurring in the population, with diabetes the most frequent (2%) and the other four incidence rates below 1%. The coefficient pattern implying $\frac{\partial S}{\partial C}$ >0 is found for the 12 most frequently occurring health conditions we examine. We conclude that the patterns are sufficiently consistent to hold as general for health.

[19] The remaining estimates of the other functional disabilities are reported in Appendix 4.a.

outcomes by small but statistically significant magnitudes. The effects are only marginally smaller after controlling for years of schooling. Compared to the results in Table 4, the implied adverse effects of child labor on health are larger for physical ailments than for chronic ailments with the exception of hypertension, kidney disease and depression for which impacts are of comparable size.

Again, when child labor and schooling are treated as endogenous, as reported in Table 8, the IV estimates show that early labor market entry has even larger effects on the incidence of work-limiting disabilities when only child labor is incorporated into the estimation. When years of schooling are included, the harmful effects of early entry into the labor market on functional disability disappear.[20] Again, the implication is that the negative effect of child labor on adult health works through the indirect channel of child labor on years of schooling completed. As age of labor market entry rises, children spend more time in school, improving adult health outcomes.

4. Child labor and adult health by occupation

If child labor's impact on adult health operates through reduced human capital, it is likely that the avenue works through limiting occupational status. Low skilled individuals may end up in atypically hazardous occupations. To explore this hypothesis, we divide our adult workers into occupations and compute occupational averages of years of schooling, age of labor market entry and incidence of various adverse health outcomes.[21] Simple correlations between these occupational averages are reported in Table 9. There is a very high positive correlation between occupational averages of year of labor market entry and years of schooling completed. There are large negative correlations between the incidence of early onset of physical disabilities and age

[20] Appendix 4.b includes the IV estimates for other functional limitations: pushing and carrying; bending down; walking 100m. They show a similar pattern like other work-limiting disabilities.
[21] See Appendix 5.

of labor market entry and a similarly large inverse correlation between years of schooling and injury or disease rates. In general, there are insignificant correlations between age of labor market entry and the chronic diseases. This is consistent with our interpretation that early labor market entry both limits years of schooling and limits occupational choices to occupations with greater risk of physical disabilities.

5. Child labor and adult health by gender

Another examination of the linkage between child labor and adult health is related to gender differences. Because girls and boys may perform different tasks, the effect of child labor on adult health might be different between males and females. As shown above, females have a higher incidence of adverse health outcomes than males. Replicating our estimation procedure separately for males and females, we test whether estimated coefficients of age of labor market entry and years of schooling differ across the genders. There is no differential effect of child labor on adult health between males and females except for asthma, hypertension (see Appendix 6.a) and difficulty lifting heavy objects (see Appendix 6.b).

VI. Conclusions

This study examines the consequences of child labor on the individual's self-reported health as an adult. It utilizes a unique Brazilian labor market survey that incorporates both contemporaneous measures of health status with retrospective data on child labor. The health measures include both morbidity and work-limiting disabilities. This study takes into account the endogeneity of child labor and years of schooling completed using instrumental variables that measure the direct cost and opportunity cost of schooling and the ability to pay for schooling at the time the individual was a child and in the state in which the individual was born.

Without correcting for endogeneity, the results show that earlier labor market entrants suffer consistently from higher incidence of chronic diseases and disabilities. The effects remain even after controlling for education. Controlling for endogeneity, we find that the adverse health consequences of child labor on adult health become larger. However, the effect works entirely through the impact of child labor on reduced years of schooling. When years of schooling is included in the analysis, the evidence of a direct adverse effect of child labor on adult health disappears.

Our estimates suggest that the negative effect of early entry into the labor market comes from forgone education rather than child labor itself. The results also raise the possibility that child labor could have a direct positive effect on adult health. In circumstances of extreme poverty, entering the labor market as a child can be crucial for maintaining a subsistence level of food, clothing and shelter. In turn, this would have a long-term positive impact on the lifetime health. It should be noted that it would be wrong to conclude that there is no deleterious effect of early entry into labor market on health status as an adult. Our results suggest that it is more important to eliminate the types of child labor which may limit years of schooling which in turn can limit health status when they become adults.

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Figure 1: Age of labor market entry and self reported adult health conditions in Brazil, by age cohort
Source: Authors' compilation based on data from the 1998 PNAD

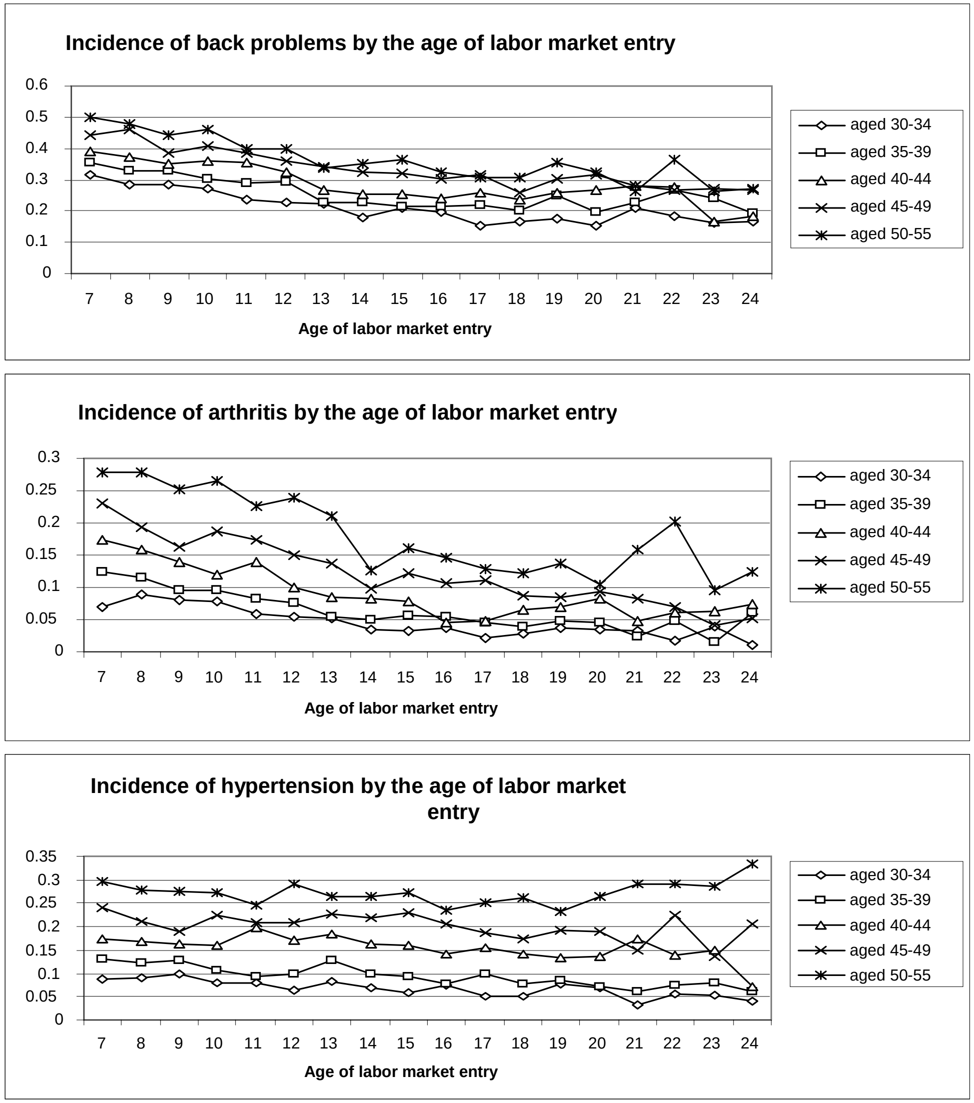


Figure 2.a: Real income (in thousands) per adult by year cohort was age 12: Brazil and Selected States (in 2000 Reals)

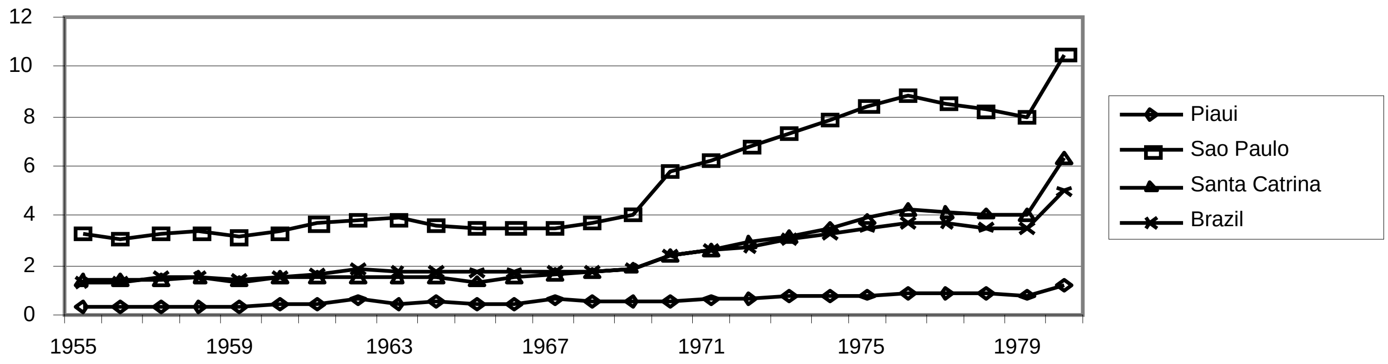


Figure 2.b: Number of Schools per 1000 Children by year cohort was age 7 Brazil and Selected States

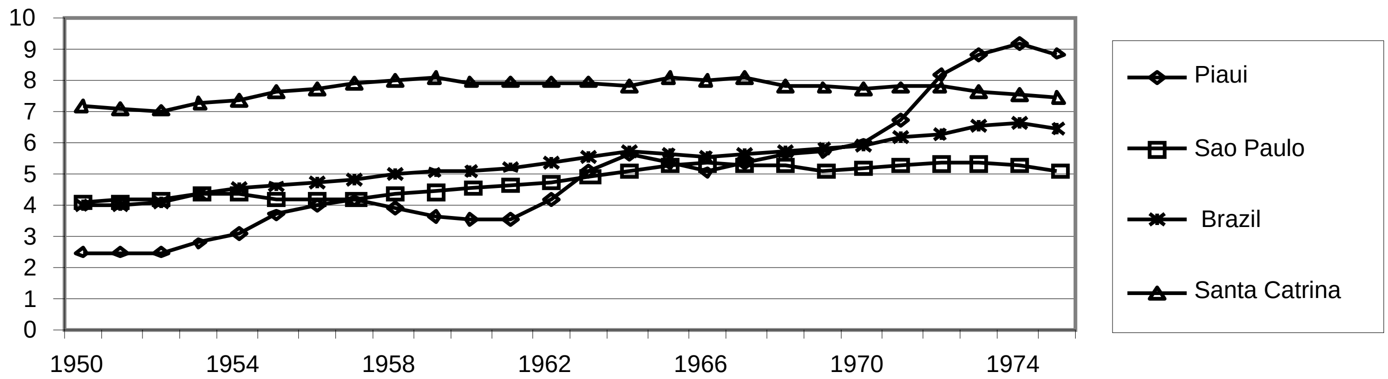


Figure 2.c: Number of Teachers per School by Year (at age 7): Brazil and Selected States

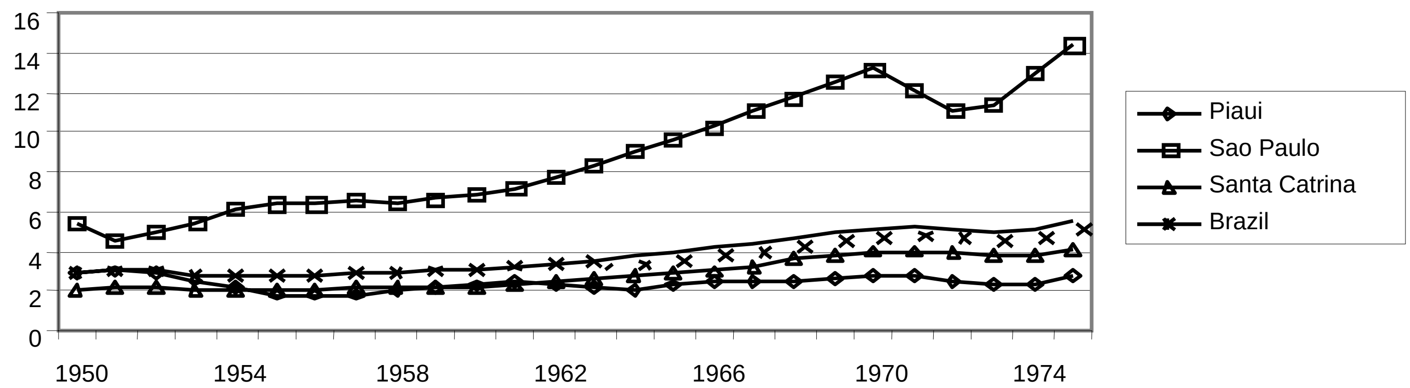
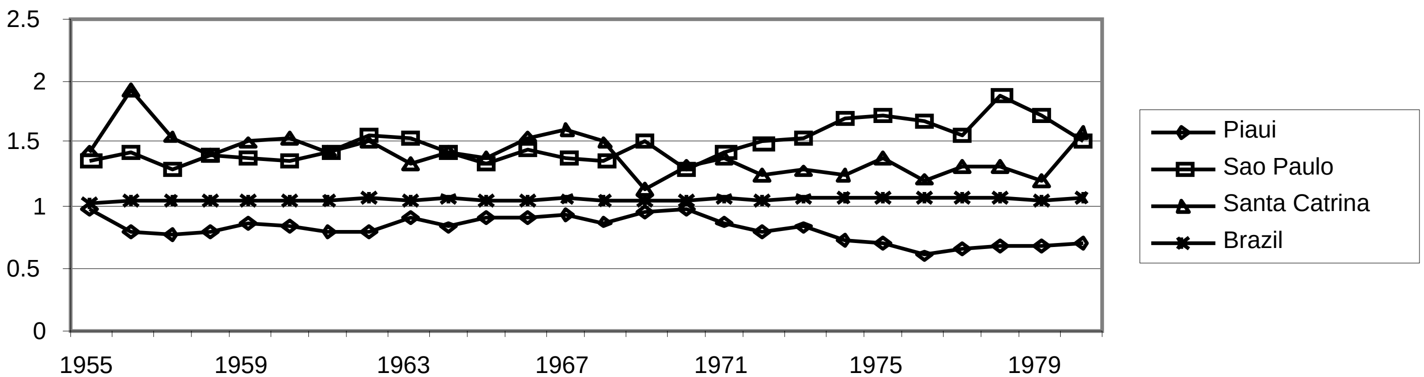


Figure 2.d: Relative Average Wage Rate of Workers with less than 5 years of schooling by year cohort was age 12): Brazil and Selected States



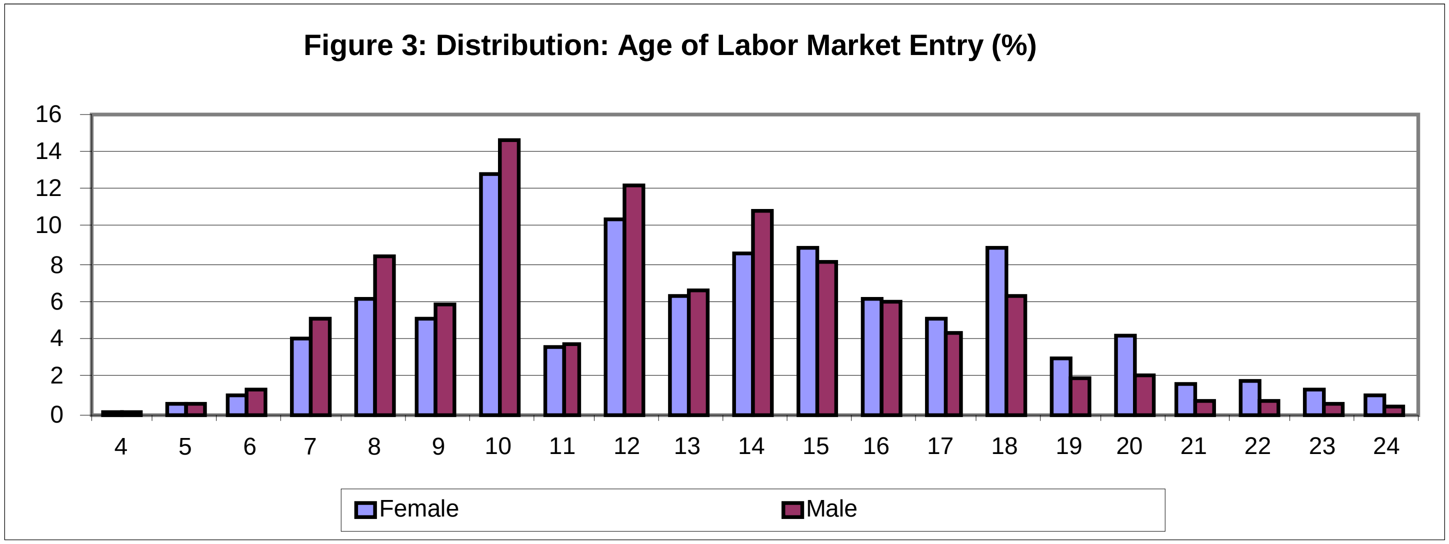


Figure 3: Distribution: Age of Labor Market Entry (%)
16
14
12
10
8
6
4
2
0
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Female
Male

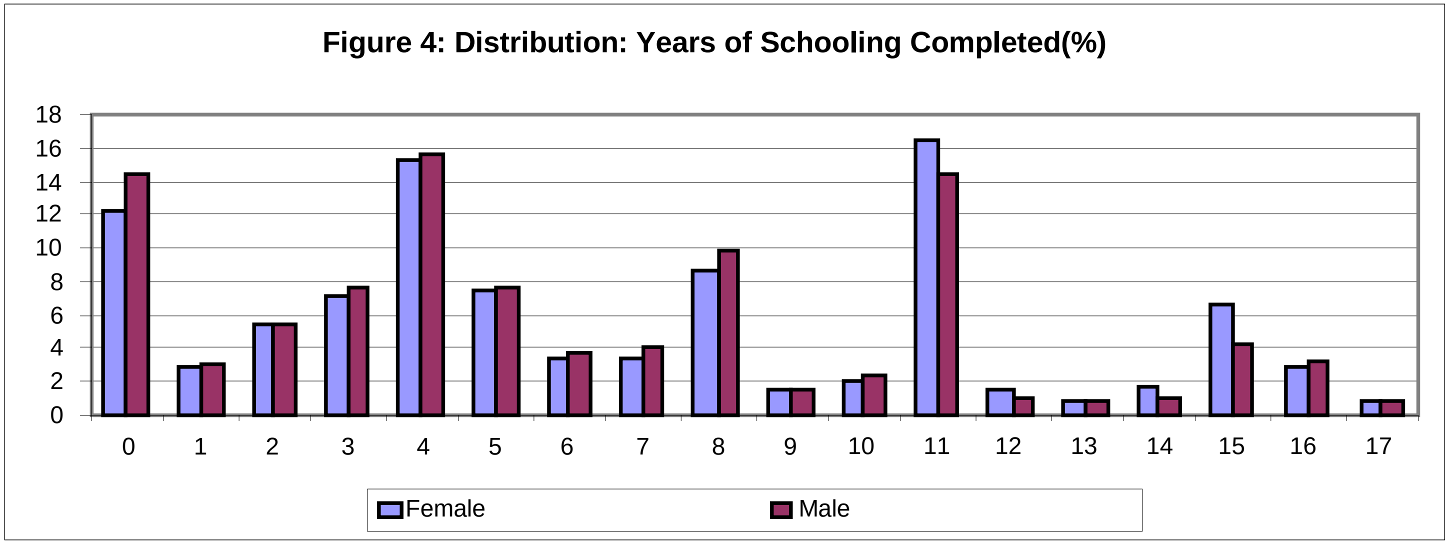


Figure 4: Distribution: Years of Schooling Completed(%)
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Female
Male

Figure 5: Averages of Years of Schooling and Age of Labor Market Entry by Year of Birth

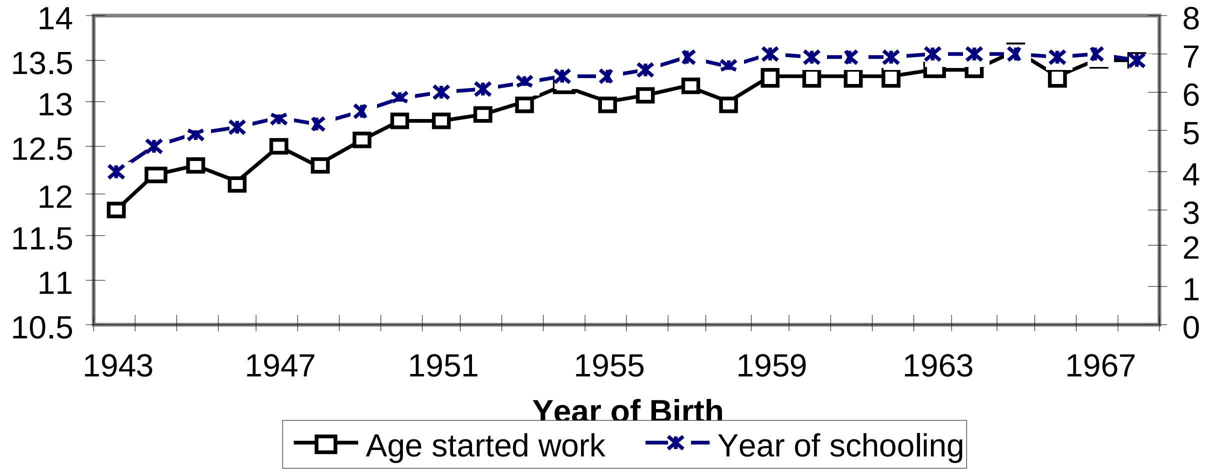


Table 1. Summary Statistics

	Pooled sample n=66839				Female n=27103		Male n=39736	
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Age started to work	13.070	3.987	4	24	13.656	4.215	12.670	3.772
Years of schooling	6.432	4.715	0	17	6.724	4.794	6.233	4.650
Male	0.595	0.491	0	1				
Age	40.702	6.968	30	55	40.455	6.878	40.871	7.023
Black	0.061	0.239	0	1	0.061	0.239	0.061	0.239
Brown	0.394	0.489	0	1	0.391	0.488	0.396	0.489
Other race	0.006	0.078	0	1	0.006	0.078	0.006	0.077
Birth north	0.043	0.202	0	1	0.047	0.212	0.040	0.196
Birth northeast	0.356	0.479	0	1	0.358	0.479	0.354	0.478
Birth south	0.207	0.405	0	1	0.211	0.408	0.205	0.404
Birth center west	0.060	0.237	0	1	0.058	0.234	0.061	0.239
Chronic Diseasse/Conditions								
Back Problems	0.297	0.457	0	1	0.328	0.470	0.275	0.447
Arthritis	0.104	0.306	0	1	0.139	0.346	0.081	0.273
Cancer	0.002	0.043	0	1	0.003	0.051	0.001	0.037
Diabetes	0.020	0.140	0	1	0.023	0.149	0.018	0.133
Asthma	0.030	0.170	0	1	0.037	0.190	0.024	0.155
Hypertension	0.150	0.357	0	1	0.184	0.388	0.126	0.332
Heart	0.040	0.196	0	1	0.051	0.221	0.033	0.177
Kidney	0.042	0.201	0	1	0.043	0.202	0.042	0.201
Depression	0.069	0.254	0	1	0.112	0.315	0.040	0.197
Tuberculosis	0.001	0.034	0	1	0.001	0.030	0.001	0.037
Tendonitis	0.031	0.173	0	1	0.046	0.209	0.021	0.143
Cirrhosis	0.002	0.048	0	1	0.001	0.033	0.003	0.056
Functional Limitations								
Raising objects	0.087	0.281	0	1	0.115	0.319	0.067	0.250
Pushing and carrying	0.017	0.130	0	1	0.026	0.161	0.011	0.104
Climbing stairs	0.041	0.198	0	1	0.063	0.243	0.026	0.158
Bending down	0.039	0.193	0	1	0.054	0.226	0.029	0.167
Walking 1km	0.029	0.168	0	1	0.042	0.201	0.020	0.139
Walking 100m	0.004	0.063	0	1	0.005	0.072	0.003	0.056
Instruments								
N.of school at age 7	5.520	1.786	0.858	11.397	5.571	1.786	5.484	1.785
N.of teacher at age 7	3.997	2.468	1.592	23.570	3.990	2.463	4.001	2.471
Lower-skilled income	1.047	0.259	0.594	18.364	1.045	0.243	1.048	0.269
GDP Per Capita(Reais)	2.570	1.937	0	11.838	2.574	1.946	2.566	1.931

Table 2. Average incidence rate of chronic diseases by people starting to work at different ages (figures are percentages within each row)

Back Problems	**Female**				**Male**			
Age \ Age started to work	5-9	10-14	15+	Total	5-9	10-14	15+	Total
30-34	35.7	25.7	19.9	24.4	26.4	21.3	16.4	20.4
35-39	35.6	31.7	23.4	28.5	32.8	24.3	19.6	24.4
40-44	42.5	36.3	28.2	34	34.8	28.2	21.6	27.6
45-49	49.3	41	34.2	40.1	40.6	34.1	25.8	33.2
50-55	53.5	45.4	40.4	45.8	44.1	37.6	27.2	36.8
Total	43.1	34.7	26.8	32.8	35.8	28	21.1	27.5
Arthritis								
Age \ Age started to work	5-9	10-14	15+	Total	5-9	10-14	15+	Total
30-34	11.8	8.1	4.2	6.8	6.1	4.2	2	3.8
35-39	15.2	11.2	6.1	9.5	8.7	5	3.4	5.2
40-44	21.4	14.8	8.6	13.3	12.5	7.6	4.2	7.6
45-49	28.4	21.8	12.6	19.6	14.7	11.1	7.6	10.9
50-55	37.8	30.9	19.1	29	21.7	17.5	10.2	16.8
Total	22.7	15.8	8.4	13.9	12.7	8.2	4.7	8.1
Hypertension								
Age \ Age started to work	5-9	10-14	15+	Total	5-9	10-14	15+	Total
30-34	13.7	9.4	6.5	8.7	6.9	6.2	5.3	6
35-39	16.9	14.2	9	12.3	10.3	8.4	7.7	8.6
40-44	22.8	22.8	16.6	20.2	14.1	13.3	12.8	13.3
45-49	32	28.6	21.1	26.4	16.4	17.9	18.6	17.7
50-55	40.4	35.1	31.6	35.3	21.8	22.8	22.1	22.4
Total	24.9	20.2	14	18.4	13.9	12.6	11.7	12.6

Table 3: Probit estimates of age started to work and other control variables on the incidence of selected chronic diseases

	Back Problems		Arthritis		Hypertension	
Variables	**A**	**B**	**A**	**B**	**A**	**B**
Years of Schooling		-.0103***		-.0065***		-.0026***
		(.0004)		(.0002)		(.0003)
Age started to work	-.0131***	-.0079***	-.0081***	-.0049***	-.0033***	-.0020***
	(.0004)	(.0005)	(.0002)	(.0003)	(.0003)	(.0003)
Age	.0085***	.0077***	.0064***	.0058***	.0095***	.0093***
	(.0002)	(.0002)	(.0001)	(.0001)	(.0001)	(.0001)
Male	-.0698***	-.0698***	-.0639***	-.0625***	-.0643***	-.0637***
	(.0036)	(.0036)	(.0023)	(.0023)	(.0028)	(.0028)
Black	-.0007	-.0226**	.0065	-.0062	.0662***	.0590***
	(.0077)	(.0075)	(.0048)	(.0043)	(.0067)	(.0066)
Brown	.0251***	.0066	-.0192***	.0078***	.0228***	.0180***
	(.0041)	(.0041)	(.0025)	(.0024)	(.0031)	(.0032)
Other race	-.0513**	-.0382	-.0101	-.0022	-.0076	-.0040
	(.0218)	(.0224)	(.0132)	(.0140)	(.0168)	(.0171)
Birth north	.0960***	.0987***	..1469***	.01491***	-.0068	-.0062
	(.0100)	(.0100)	(.0091)	(.0091)	(.0067)	(.0067)
Birth northeast	.0662***	.0525***	.0372***	.0273***	-.0055*	-.0086***
	(.0045)	(.0045)	(.0030)	(.0029)	(.0032)	(.0033)
Birth south	.0165***	.0134***	.0286***	.0267***	.0003	-.0004
	(.0052)	(.0052)	(.0036)	(.0035)	(.0038)	(.0038)
Birth center west	.0538***	.0513***	.0630***	.0604***	-.0038	-.0043
	(.0084)	(.0084)	(.0065)	(.0064)	(.0059)	(.0059)
Pseudo R2	.0353	.0418	.0964	.1091	.0595	.0605
N. Obs.	66839	66839	66839	66839	66839	66839

Note: Marginal probabilities are reported rather than probit coefficients. Robust standard errors are reported in parentheses.
*** Significant at 1% level, ** Significant 5% level, * Significant 1% level

Table 4: Partial probit estimates of the health consequences of age started to work and years of schooling

	Cancer		Diabetes		Asthma	
Variables	**A**	**B**	**A**	**B**	**A**	**B**
Years of Schooling		<.0001		<.0001		-.0001
		(<.0001)		(.0001)		(.0001)
Age started to work	<-.0001	<-.0001	<-.0001	<-.0001	-.0003*	-.0001
	(<.0001)	<.0001	(.0002)	(.0001)	(.0001)	(.0001)
Pseudo R2	.0211	(<.0001)	.0545	.0545	.0109	.0110
N. Obs.	66433	66433	66839	66839	66839	66839
	Heart		**Kidney**		**Depression**	
	A	**B**	**A**	**B**	**A**	**B**
Years of Schooling		-.0008***		-.0023***		-.0005**
		(.0001)		(.0001)		(.0002)
Age started to work	-.0010***	-.0006***	-.0033***	-.0021***	-.0029***	-.0027***
	(.0001)	(.0001)	(.0001)	(.0002)	(.0002)	(.0002)
Pseudo R2	.0466	.0476	.0257	.0323	.0471	.0473
N. Obs.	66839	66839	66839	66839	66839	66839
	Tuberculosis		**Tendonitis**		**Cirrhosis**	
	A	**B**	**A**	**B**	**A**	**B**
Years of Schooling		<-.0001***		.0013***		-.0001***
		(<.0001)		(.0001)		(<.0001)
Age started to work	<-.0001	<.0001	.0003**	-.0003**	<-.0001	<.0001
	(<.0001)	(<.0001)	(.0001)	(.0001)	(<.0001)	(<.0001)
Pseudo R2	.0224	.0320	.0307	.0349	.0297	.0349
N. Obs.	66839	66839	66839	66839	66433	66433

Note: Marginal probabilities are reported rather than probit coefficients. Robust standard errors are reported in parentheses.
All regressions included the other control variables used in Table 3.
*** Significant at 1% level, ** Significant 5% level, * Significant 1% level

Table 5: IV Estimates-First Stage Regression

Variables	Age started work	Years of schooling
Age	-.0125***	-.0493***
	(.0036)	(.0042)
Male	-.9600***	-.4508***
	(.0304)	(.0347)
Black	-.8245***	-2.5848***
	(.0645)	(.0737)
Brown	-1.0192***	-2.2789***
	(.0346)	(.0396)
Other race	.1090	1.2962***
	(.1930)	(.0220)
Birth north	1.6949***	1.2035***
	(.0872)	(.0996)
Birth northeast	.6316***	-.4962***
	(.0493)	(.0563)
Birth south	-.4359***	-.5577***
	(.0521)	(.0595)
Birth center west	-.4173***	-.1701**
	(.0720)	(.0823)
State GDP per capita at age 12	.0490**	.1560***
	(.0193)	(.0221)
Number of school per 1,000 children by state	.0375**	.0565***
	(.0149)	(.0170)
Number of teachers per school by state	.2832***	.1569***
	(.0138)	(.0158)
Average wage rate for low-skilled people by state	-.6283***	.3238***
	(.0876)	(.1001)
Intercept	13.6146***	8.3262***
	(.2604)	(.2974)
R-Squared	.0631	.1261
Test of Excluded Instruments F(4,66825)	279.52	159.08

Note: Robust standard errors were computed.

*** Significant at 1% level, ** Significant 5% level, * Significant 1% level

Table 6: IV Estimates-Second Stage Regression on incidence of selected chronic disease

	Back Problems		Arthritis		Hypertension	
Variables	**A**	**B**	**A**	**B**	**A**	**B**
Years of schooling		-.0508***		-.0321***		-.0291***
		(.0079)		(.0050)		(.0064)
Age started to work	-.0242***	.0121	-.0214***	.0006	-.0089***	.0120**
	(.0038)	(.0068)	(.0028)	(.0050)	(.0030)	(.0055)
Age	.0078***	.0051***	.0060***	.0042***	.0092***	.0077***
	(.0003)	(.0005)	(.0002)	(.0003)	(.0002)	(.0004)
Male	-.0806***	-.0681***	-.0804***	-.0723***	-.0705***	-.0628***
	(.0052)	(.0055)	(.0039)	(.0042)	(.0041)	(.0045)
Black	-.0094	-.1037***	-.0041	-.0536***	.0608***	-.0054
	(.0081)	(.0148)	(.0050)	(.0070)	(.0072)	(.0139)
Brown	.0129**	-.0679***	.0049	-.0456***	.0170***	-.0294***
	(.0057)	(.0135)	(.0039)	(.0092)	(.0044)	(.0108)
Other race	-.0499**	.0166	-.0095	.0378**	-.0071	.0343
	(.0217)	(.0268)	(.0135)	(.0214)	(.0168)	(.0225)
Birth north	.1052***	.1064***	.1710***	.1753***	-.0020	-.0011
	(.0106)	(.0106)	(.0108)	(.0110)	(.0073)	(.0073)
Birth northeast	.0641***	.0001	.0382***	-.0025	-.0061*	-.0405***
	(.0046)	(.0108)	(.0030)	(.0073)	(.0033)	(.0079)
Birth south	.0055	-.0001	.0162***	.0126***	-.0047	-.0075
	(.0063)	(.0063)	(.0044)	(.0044)	(.0046)	(.0046)
Birth center west	.0419***	.0401	.0463***	.0451***	-.0087	-.0091
	(.0091)	(.0091)	(.0071)	(.0071)	(.0064)	(.0064)
N. of Observations	66839	66839	66839	66839	66839	66839
Pseudo R2	.0257	.0262	.0783	.0791	.0579	.0582

Note: Marginal probabilities are reported rather than probit coefficients. Robust standard errors were computed.
*** Significant at 1% level, ** Significant 5% level, * Significant 1% level

Table 7: Probit estimates of age started to work and other control variables on the probability of having difficulty performing activity

	Raising object		Climbing stairs		Walking 1km	
Variables	**A**	**B**	**A**	**B**	**A**	**B**
Years of Schooling		-.0034***		-.0019***		-.0013***
		(.0002)		(.0001)		(.0001)
Age started to work	-.0055***	-.0040***	-.0026***	-.0016***	-.0018***	-.0011***
	(.0002)	(.0002)	(.0001)	(.0001)	(.0001)	(.0001)
Age	.0050***	.0046***	.0024***	.0022***	.0015***	.0014***
	(.0001)	(.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
Male	-.0536***	-.0527***	-.0372***	-.0365***	-.0229***	-.0224***
	(.0022)	(.0022)	(.0015)	(.0015)	(.0013)	(.0012)
Black	-.0049	-.0124**	.0030	-.0008	.0016	-.0011
	(.0042)	(.0039)	(.0029)	(.0026)	(.0025)	(.0023)
Brown	.0146***	.0075***	.0079***	.0046***	.0081***	.0056***
	(.0023)	(.0023)	(.0015)	(.0015)	(.0013)	(.0013)
Other race	-.0294**	-.0382**	-.0146*	-.0129	-.0173**	-.0164**
	(.0102)	(.0224)	(.0062)	(.0065)	(.0037)	(.0039)
Birth north	.0185***	.0197***	-.0024	-.0018	.0053*	.0058**
	(.0100)	(.0059)	(.0032)	(.0032)	(.0032)	(.0032)
Birth northeast	.0091***	.0037	.0055***	.0029*	.0005	-.0011
	(.0026)	(.0045)	(.0016)	(.0016)	(.0014)	(.0013)
Birth south	.0095***	.0084***	-.0032*	-.0036*	-.0012	-.0014
	(.0030)	(.0030)	(.0018)	(.0018)	(.0016)	(.0015)
Birth center west	.0219***	.0205***	.0062**	.0058**	.0097***	.0093***
	(.0052)	(.0051)	(.0032)	(.0031)	(.0030)	(.0059)
Pseudo R2	.0637	.0700	.0729	.0826	.0583	.0632
N. Obs.	66839	66839	66839	66839	66839	66839

Note: Marginal probabilities are reported rather than probit coefficients. Robust standard errors are reported in parentheses.
*** Significant at 1% level, ** Significant 5% level, * Significant 1% level

Table 8: IV Estimates-Second Stage Regression on the probability of having difficulty performing activity

	Raising object		Climbing stairs		Walking 1km	
Variables	**A**	**B**	**A**	**B**	**A**	**B**
Years of schooling		-.0252***		-.0134***		-.0117***
		(.0051)		(.0034)		(.0029)
Age started to work	-.0104***	.0077*	-.0049***	.0047	-.0003	.0080***
	(.0024)	(.0045)	(.0016)	(.0030)	(.0012)	(.0024)
Age	.0049***	.0035***	.0024***	.0017***	.0017***	.0011***
	(.0001)	(.0003)	(.0001)	(.0002)	(.0001)	(.0001)
Male	-.0603***	-.0532***	-.0413***	-.0370***	-.0222***	-.0187***
	(.0034)	(.0037)	(.0025)	(.0027)	(.0019)	(.0020)
Black	-.0090*	-.0464***	.0010	-.0197***	.0027	-.0154
	(.0045)	(.0063)	(.0031)	(.0040)	(.0029)	(.0033)
Brown	.0094**	-.0302***	.0056**	-.0153***	.0099***	-.0089*
	(.0035)	(.0083)	(.0023)	(.0055)	(.0020)	(.0048)
Other race	-.0290**	-.0009	-.0145*	-.0005	-.0177**	-.0105
	(.0105)	(.0165)	(.0064)	(.0113)	(.0038)	(.0077)
Birth north	.0249***	.0253***	-.0002	.0003	.0041	.0046
	(.0067)	(.0068)	(.0038)	(.0038)	(.0034)	(.0034)
Birth northeast	.0092***	-.0210***	.0057***	-.0102**	.0008	-.0125***
	(.0026)	(.0063)	(.0017)	(.0041)	(.0014)	(.0034)
Birth south	.0052	.0030	-.0050**	-.0059**	.0002	-.0006
	(.0038)	(.0037)	(.0022)	(.0022)	(.0020)	(.0020)
Birth center west	.0162***	.0161	.0037	.0039	.0114	.0115***
	(.0056)	(.0056)	(.0035)	(.0035)	(.0035)	(.0035)
N. of Observations	66839	66839	66839	66839	66839	66839
Pseudo R2	.0527	.0533	.0662	.0669	.0493	.0502

Note: Marginal probabilities are reported rather than probit coefficients. Robust standard errors were computed.
*** Significant at 1% level, ** Significant 5% level, * Significant 1% level

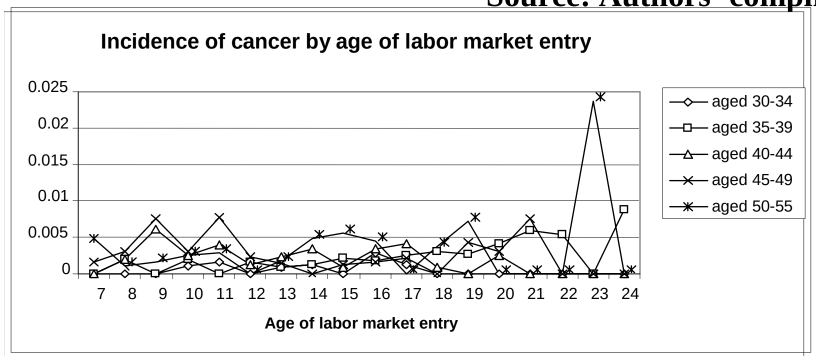
Table 9: Correlation between occupational averages of age of labor market entry, years of schooling and early adult onset of disease

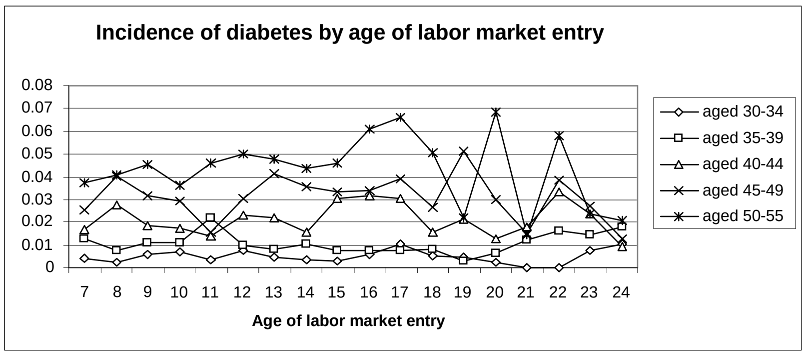
Activity	*Age started to work*	*Years of schooling*
Years of schooling	0.97	1.00
Spine Condition	-0.93	-0.92
Arthritis	-0.81	-0.78
Kidney Problems	-0.97	-0.92
Tendonitis	0.80	0.77
Difficulty.		
Raising Objects	-0.81	-0.79
Climbing stairs	-0.66	-0.68
Bending down	-0.74	-0.74
Walking 1km	-0.75	-0.78

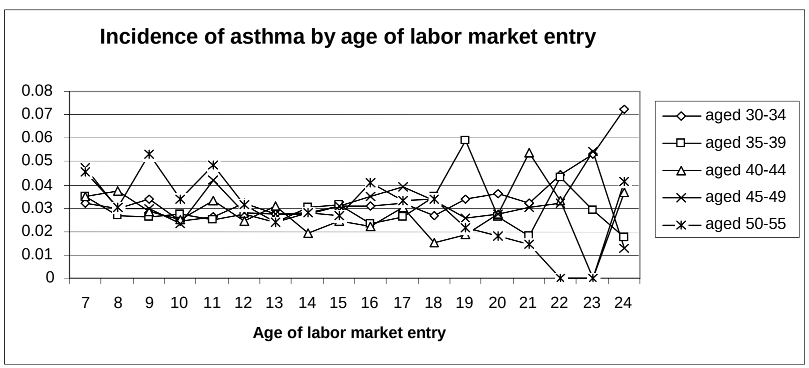
Note: Illness/condition with no significant correlation with either schooling or child labor:
Cancer , diabetes, asthma, hypertension, heart, depression, tuberculosis ,cirrhosis, pushing/carrying and walking 100m
Source: Author's computations based on the PNAD 1998

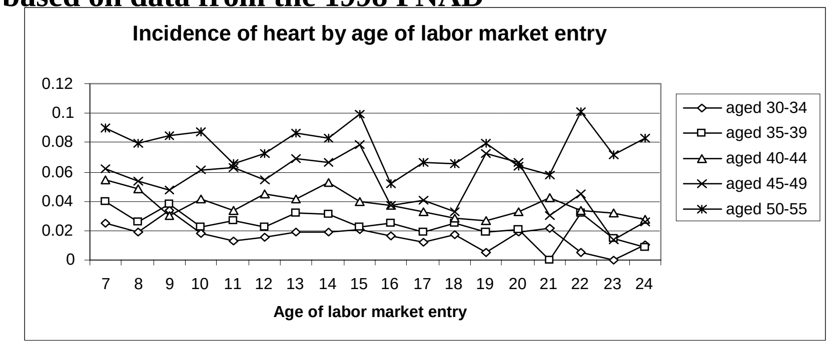
Appendix 1: Age of labor market entry and self reported adult health conditions in Brazil, by age cohort

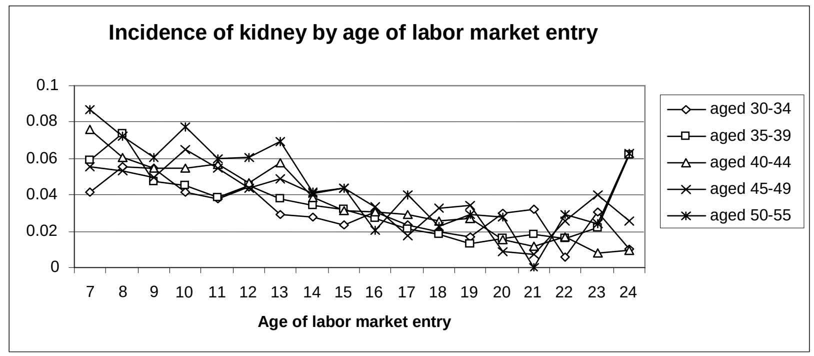
Source: Authors' compilation based on data from the 1998 PNAD

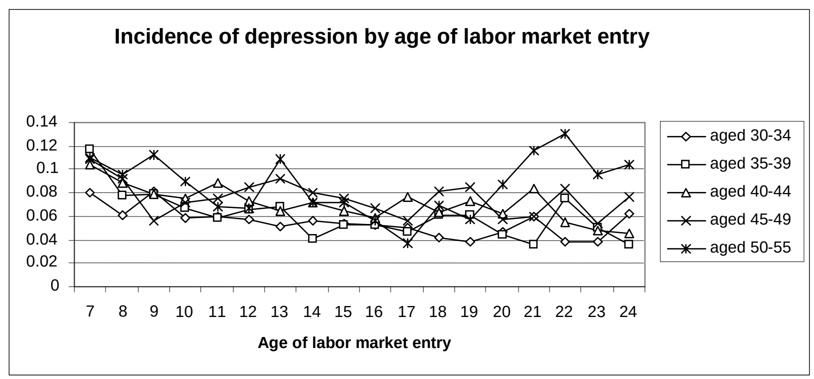




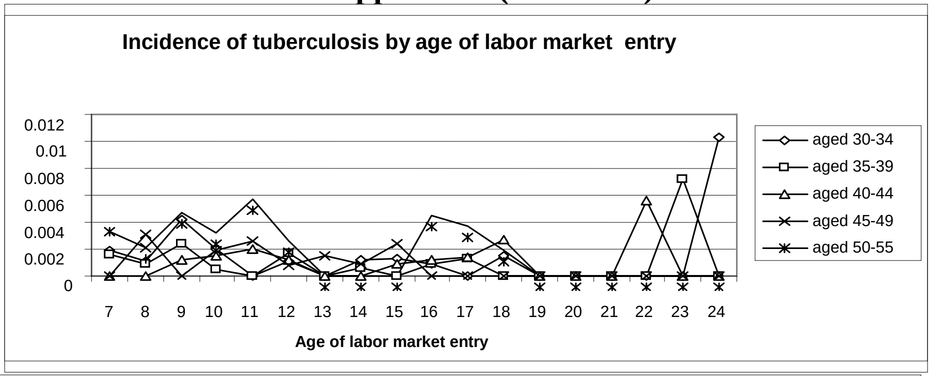


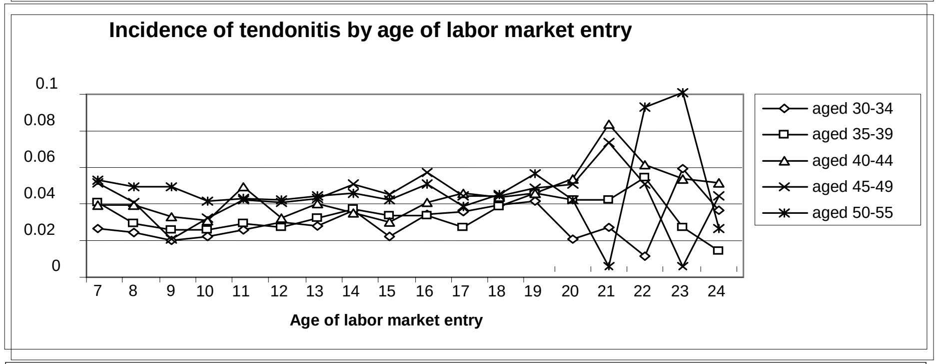


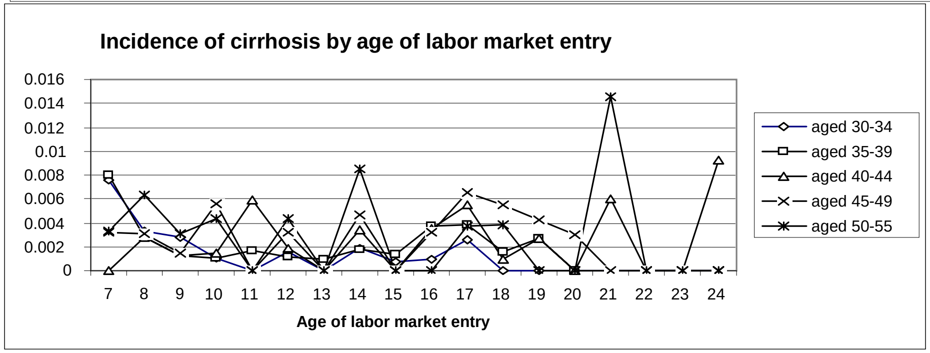




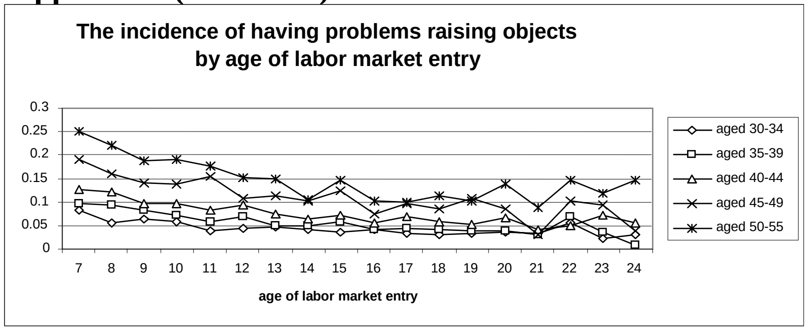
Appendix 1 (continued)

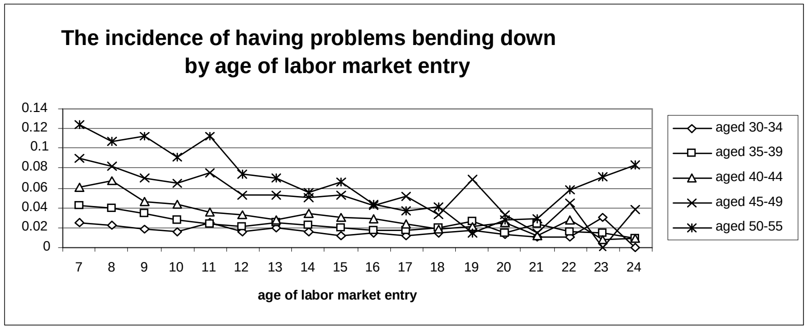


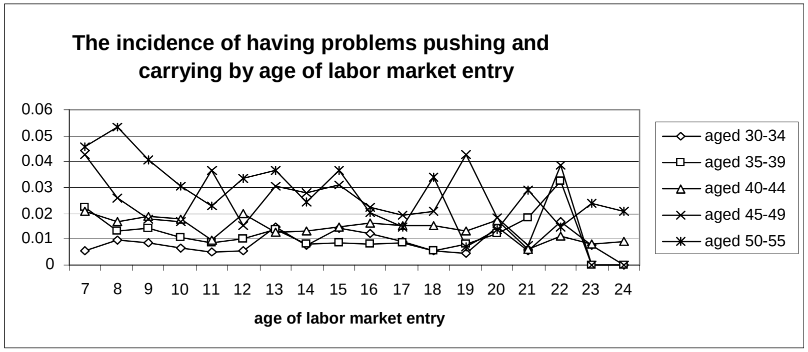


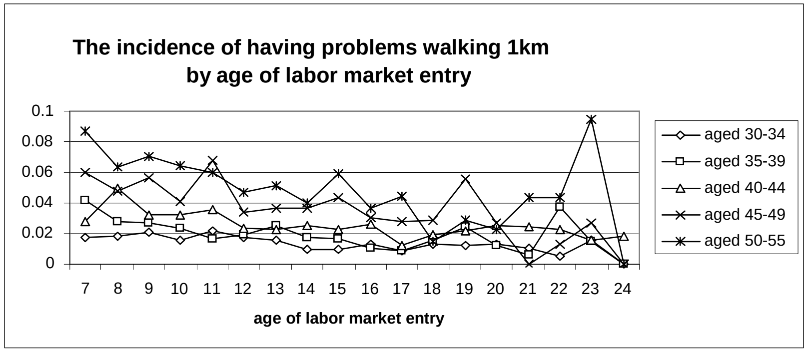


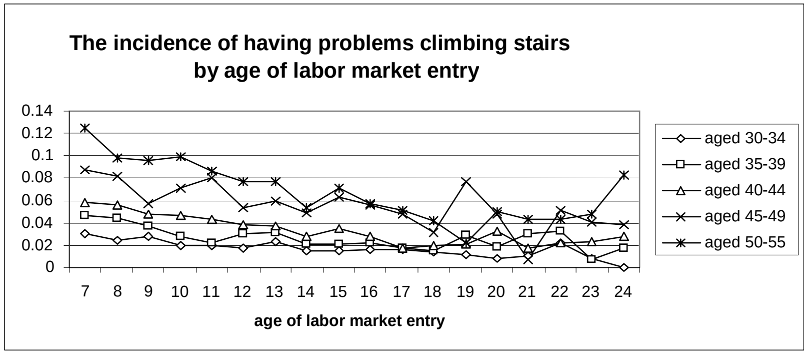
Appendix 1 (continued)

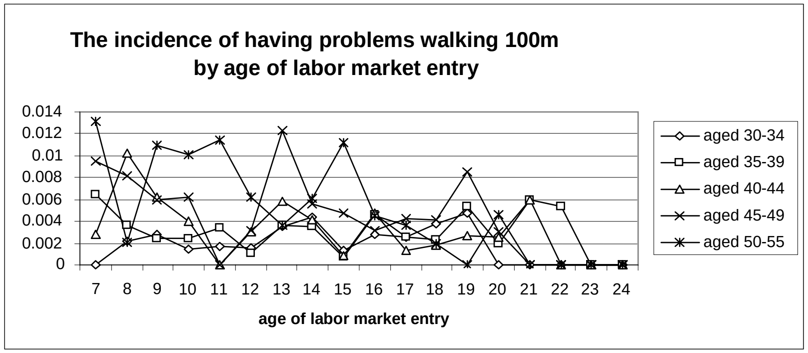












Appendix 2: Average incidence rate of chronic diseases by people starting to work at different age

Cancer	**Female**				**Male**			
Age \ Age started to work	5-9	10-14	15+	Total	5-9	10-14	15+	Total
30-34	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1
35-39	0.2	0.2	0.4	0.3	0.0	0.1	0.2	0.1
40-44	0.4	0.2	0.2	0.3	0.3	0.3	0.1	0.2
45-49	0.7	0.5	0.3	0.5	0.2	0.1	0.1	0.1
50-55	0.2	0.3	0.6	0.4	0.2	0.2	0.3	0.2
Total	0.3	0.2	0.3	0.3	0.1	0.1	0.1	0.1
Diabetes								
30-34	0.5	0.6	0.4	0.5	0.4	0.6	0.5	0.5
35-39	1.3	1.4	1.0	1.2	0.7	0.9	0.6	0.8
40-44	3.4	2.0	2.4	2.4	1.8	1.8	2.5	2.0
45-49	4.0	4.3	2.9	3.7	3.1	2.4	3.5	2.9
50-55	4.8	5.7	5.9	5.5	3.6	3.6	4.6	3.8
Total	2.8	2.4	1.9	2.3	1.9	1.7	1.9	1.8
Asthma								
30-34	5.3	3.9	3.6	3.9	2.0	2.1	2.9	2.4
35-39	3.8	3.1	3.7	3.5	2.4	2.5	2.5	2.5
40-44	4.2	3.8	2.7	3.4	2.9	1.7	2.1	2.1
45-49	5.2	3.4	4.2	4.1	2.6	2.3	2.4	2.4
50-55	4.9	3.5	3.7	3.9	3.7	3.1	2.3	3.0
Total	4.6	3.6	3.5	3.7	2.7	2.3	2.5	2.4
Heart Disease								
30-34	3.8	2.4	1.8	2.3	1.9	1.4	1.4	1.5
35-39	5.0	3.5	2.8	3.4	2.6	2.2	1.6	2.1
40-44	6.7	6.1	3.9	5.3	2.9	1.7	2.1	2.1
45-49	7.6	8.1	6.3	7.3	4.5	5.0	4.0	4.6
50-55	13.8	10.4	9.2	10.9	6.2	6.8	6.2	6.5
Total	7.2	4.8	2.5	4.3	3.6	3.4	2.8	3.3

Note: Figures are percentages within each row.

Appendix 2 (continued)

Kidney Disease	Female				Male			
Age \ Age started to work	5-9	10-14	15+	Total	5-9	10-14	15+	Total
30-34	7.2	3.9	2.4	3.6	4.3	3.6	2.4	3.3
35-39	7.6	4.1	2.7	4.0	5.3	4.1	2.1	3.7
40-44	7.1	5.6	2.4	4.5	5.6	4.6	2.8	4.2
45-49	4.7	4.8	2.4	3.9	6.2	5.4	3.5	5.0
50-55	9.1	6.5	3.2	6.1	6.3	6.4	3.1	5.5
Total	7.2	4.8	2.5	4.3	5.5	4.6	2.7	4.2
Depression								
30-34	14.2	9.4	7.2	9.0	4.0	3.4	2.7	3.2
35-39	16.9	10.2	7.7	10.1	4.8	3.5	2.9	3.6
40-44	15.7	12.5	10.1	12.1	5.4	4.2	3.1	4.1
45-49	16.9	12.1	10.5	12.5	4.8	5.6	4.2	5.0
50-55	18.5	13.9	11.4	14.3	5.9	4.9	3.6	4.9
Total	16.4	11.3	8.9	11.2	5.0	4.2	3.2	4.0
Tuberculosis								
30-34	0.4	0.0	0.1	0.1	0.1	0.2	0.1	0.1
35-39	0.0	0.0	0.1	0.1	0.2	0.1	0.0	0.1
40-44	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
45-49	0.0	0.2	0.0	0.1	0.2	0.1	0.1	0.1
50-55	0.4	0.1	0.2	0.2	0.3	0.3	0.1	0.3
Total	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1
Tendonitis								
30-34	3.0	3.4	3.4	3.3	1.2	1.6	1.9	1.6
35-39	3.9	3.4	4.3	3.9	1.7	1.9	1.7	1.8
40-44	4.4	5.0	5.2	5.0	2.6	1.6	2.5	2.1
45-49	5.4	5.4	6.0	5.6	2.2	2.3	2.8	2.4
50-55	7.1	5.7	5.9	6.1	3.3	2.6	2.7	2.8
Total	4.7	4.4	4.6	4.6	2.2	1.9	2.2	2.1
Cirrhosis								
30-34	0.6	0.1	0.0	0.1	0.3	0.1	0.1	0.2
35-39	0.1	0.0	0.2	0.1	0.6	0.2	0.2	0.3
40-44	0.2	0.0	0.1	0.1	0.2	0.3	0.3	0.3
45-49	0.2	0.1	0.1	0.1	0.4	0.5	0.5	0.5
50-55	0.0	0.1	0.0	0.1	0.6	0.6	0.3	0.5
Total	0.2	0.1	0.1	0.1	0.4	0.3	0.3	0.3

Note: Figures are percentages within each row.

Appendix 3: IV Estimates-Second Stage regression on incidence of chronic disease

	Cancer		Diabetes		Asthma	
Variables	**A**	**B**	**A**	**B**	**A**	**B**
Years of Schooling		.0010**		.0032**		-.0039
		(.0004)		(.0001)		(.0027)
Age started to work	-.0005	-.0002	-.0034***	-.0054***	.0022*	.0051**
	(.0002)	.0003	(.0011)	(.0014)	(.0011)	(.0023)
Pseudo R2	.0229	.0245	.0552	.0554	.0109	.0110
N. Obs.	66433	66433	66839	66839	66839	66839
	Heart		**Kidney**		**Depression**	
	A	**B**	**A**	**B**	**A**	**B**
Years of Schooling		-.0082**		-.0106**		-.0207***
		(.0033)		(.0045)		(.0044)
Age started to work	-.0008	.0049*	-.0101***	-.0029	-.0092***	.0058
	(.0015)	(.0029)	(.0019)	(.0041)	(.0022)	(.0040)
Pseudo R2	.0449	.0452	.0152	.0157	.0429	.0436
N. Obs.	66839	66839	66839	66839	66839	66839
	Tuberculosis		**Tendonitis**		**Cirrhosis**	
	A	**B**	**A**	**B**	**A**	**B**
Years of Schooling		-.0005		.0053**		<-.0001***
		(.0004)		(.0024)		(.0004)
Age started to work	-.0001	.0002	.0046***	.0008	-.0013	-.0013***
	(<.0002)	(.0004)	(.0012)	(.0020)	(.0004)	(.0004)
Pseudo R2	.0214	.0222	.0312	.0314	.0333	.0333
N. Obs.	66839	66839	66839	66839	66433	66433

Note: Marginal probabilities are reported rather than probit coefficients. Robust standard errors are reported in parentheses.
All regressions included the other control variables used in Table 6.
*** Significant at 1% level, ** Significant 5% level, * Significant 1% level

Appendix 4.a: Partial probit estimates of the functional disability of age started to work and years of Schooling completed

	Pushing and Carrying		Bending down		Walking 100m	
Variables	**A**	**B**	**A**	**B**	**A**	**B**
Years of Schooling		-.0003***		-.0015***		-.0001**
		(.0001)		(.0001)		(<.0001)
Age started to work	-.0007***	-.0005***	-.0027***	-.0019***	-.0002***	-.0001**
	(.0001)	(.0001)	(.0001)	(.0001)	(<.0001)	(<.0001)
Pseudo R2	.0512	.0521	.0693	.0735	.0267	.0279
N. Obs.	66839	66839	66839	66839	66433	66433

Note: Marginal probabilities are reported rather than probit coefficients. Robust standard errors are reported in parentheses.
All regressions included the other control variables used in Table 4.
*** Significant at 1% level, ** Significant 5% level, * Significant 1% level

Appendix 4.b: IV Estimates-Second Stage regression on the probability of having difficulty performing activity

	Pushing and Carrying		Bending down		Walking 100m	
Variables	**A**	**B**	**A**	**B**	**A**	**B**
Years of Schooling		-.0038*		-.0097***		.0001
		(.0021)		(.0034)		(.0009)
Age started to work	.0005	.0033*	-.0048***	.0021	.0008**	.0006
	(.0009)	(.0017)	(.0016)	(.0029)	(.0003)	(.0007)
Pseudo R2	.0472	.0475	.0576	.0579	.0241	.0241
N. Obs.	66839	66839	66839	66839	66433	66433

Note: Marginal probabilities are reported rather than probit coefficients. Robust standard errors are reported in parentheses.
All regressions included the other control variables used in Table 8.
*** Significant at 1% level, ** Significant 5% level, * Significant 1% level

Appendix 5: Mean of selected variables by current adult occupations

Variable/Occupation	Technic /Scientific area	Administive- -area	Farming area	Manufactur- -ing area	Commerce area	Transport area	Service area	Others	Total
Age started to work	16.1	14.7	10.6	12.6	13.1	13.1	12.8	13.1	13.1
Years of schooling	12.8	10.3	2.4	5.2	6.8	6.3	4.4	5.9	6.4
Chronic									
Back Problems	0.223	0.221	0.401	0.296	0.282	0.281	0.336	0.286	0.297
Arthritis	0.060	0.051	0.197	0.087	0.102	0.059	0.136	0.094	0.104
Cancer	0.003	0.001	0.002	0.001	0.002	0.001	0.002	0.002	0.002
Diabetes	0.019	0.021	0.016	0.016	0.024	0.023	0.027	0.020	0.020
Asthma	0.036	0.026	0.028	0.027	0.028	0.024	0.042	0.027	0.030
Hypertension	0.125	0.125	0.159	0.133	0.160	0.143	0.207	0.151	0.150
Heart Disease	0.030	0.034	0.039	0.038	0.047	0.033	0.058	0.041	0.040
Kidney Disease	0.023	0.029	0.066	0.043	0.041	0.041	0.045	0.039	0.042
Depression	0.067	0.054	0.067	0.059	0.088	0.039	0.110	0.067	0.069
Tuberculosis	0.001	0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.001
Tendonitis	0.045	0.040	0.024	0.027	0.027	0.024	0.037	0.026	0.031
Cirrhosis	0.001	0.002	0.002	0.004	0.001	0.003	0.001	0.003	0.002
Disability									
Raising object	0.058	0.056	0.132	0.073	0.096	0.065	0.111	0.081	0.087
Pushing & Carrying	0.016	0.013	0.020	0.013	0.023	0.010	0.024	0.018	0.017
Climbing stairs	0.027	0.024	0.062	0.031	0.050	0.024	0.063	0.036	0.041
Bending	0.027	0.023	0.058	0.035	0.045	0.025	0.053	0.034	0.039
Walking 1km	0.016	0.019	0.041	0.024	0.035	0.021	0.043	0.027	0.029
Walking 100m	0.003	0.003	0.004	0.004	0.006	0.004	0.005	0.003	0.004
N. of Observations	6567	9225	11096	12961	7935	3664	7445	7946	66839

Appendix 6.a: IV Estimates-Second Stage Regression on incidence of chronic disease by gender

	Back Problems		Arthritis		Cancer		Diabetes	
Variable	Female	Male	Female	Male	Female	Male	Female	Male
Years of schooling	-.0500***	-.0502***	-.0274***	-.0337***	.0016**	.0003	.0028	.0037*
	(.0122)	(.0119)	(.0088)	(.0072)	(.0007)	(.0006)	(.0028)	(.0019)
Age started to work	.0119	.0115	-.0107	.0070	-.0005	.0002	-.0055**	-.0055***
	(.0103)	(.0108)	(.0077)	(.0063)	(.0006)	(.0005)	(.0026)	(.0016)
N. of Observation	27103	39736	27103	39736	26935	39498	27103	39736
Pseudo R2	.0272	.0215	.0727	.0631	.0279	.0201	.0622	.0498
	Asthma†		Hypertension†		Heart Disease		Kidney Disease	
Variable	Female	Male	Female	Male	Female	Male	Female	Male
Years of schooling	-.0034	-.0042	-.0557***	-.0089	-.0155***	-.0034	-.0170***	-.0089*
	(.0044)	(.0033)	(.0099)	(.0072)	(.0054)	(.0040)	(.0053)	(.0052)
Age started to work	.0085**	.0025	.0293***	-.0030	.0077*	.0025	.0029	-.0050
	(.0036)	(.0028)	(.0085)	(.0065)	(.0046)	(.0035)	(.0048)	(.0049)
N. of Observation	27103	39736	27103	39736	27103	39736	27103	39736
Pseudo R2	.0077	.0061	.0067	.0042	.0462	.0339	.0156	.0176
	Depression		Tuberculosis		Tendonitis		Cirrhosis	
Variable	Female	Male	Female	Male	Female	Male	Female	Male
Years of schooling	-.0302***	-.0090*	-.0004	-.0005	.0129***	.0003	<.0001	<.0001
	(.0081)	(.0048)	(.0005)	(.0007)	(.0046)	(.0031)	(.0003)	(.0008)
Age started to work	.0013	.0027	-.0004	.0005	-.0009	.0025	-.0012**	-.0017***
	(.0073)	(.0042)	(.0007)	(.0005)	(.0037)	(.0027)	(.0005)	(.0006)
N. of Observation	27103	39736	24101	39736	27103	39736	25291	39498
Pseudo R2	.0087	.0057	.0286	.0197	.0175	.0113	.0159	.0262

Note: Marginal probabilities are reported rather than probit coefficients. Robust standard errors were computed.
All regressions included the other control variables used in Table 6
† There are jointly differential effects of child labor and years of schooling completed on adult health between male and female sampled group. *** Significant at 1% level, ** Significant 5% level, * Significant 1% level

Appendix 6.b: IV Estimates-Second Stage Regression on incidence of functional disability by gender

	Raising Object†		Pushing and Carrying		Climbing Stairs	
Variable	Female	Male	Female	Male	Female	Male
Years of schooling	-.0160*	-.0296***	-.0057	-.0039	-.0148*	-.0120***
	(.0080)	(.0065)	(.0039)	(.0025)	(.0059)	(.0039)
Age started to work	-.0005	.0120**	.0042	.0038*	.0052	.0036
	(.0066)	(.0057)	(.0030)	(.0022)	(.0049)	(.0036)
N. of Observation	27103	39736	27103	39736	27103	39736
Pseudo R2	.0437	.0407	.0293	.0296	.0517	.0318
	Bending down		Walking 1km		Walking 100m	
Variable	Female	Male	Female	Male	Female	Male
Years of schooling	-.0083	-.0102**	-.0165***	-.0083**	<-.0001	.0001
	(.0054)	(.0043)	(.0051)	(.0035)	(.0015)	(.0011)
Age started to work	-.0015	.0040	.0084**	.0070**	.0013	.0004
	(.0045)	(.0039)	(.0042)	(.0030)	(.0012)	(.0009)
N. of Observation	27103	39736	27103	39736	26935	39498
Pseudo R2	.0517	.0414	.0397	.0288	.0298	.0135

Note: Marginal probabilities are reported rather than probit coefficients. Robust standard errors were computed.
All regressions included the other control variables used in Table 8.
† There are jointly differential effects of child labor and years of schooling completed on adult health between male and female sampled group. *** Significant at 1% level, ** Significant 5% level, * Significant 1% level