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YLEANA PAMELA ORTIZ AREVALO

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Jeff E Biddle

Major Professor's Signature

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THREE ESSAYS ON THE ECONOMICS OF HEALTH

By

Yleana Pamela Ortiz Arevalo

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ABSTRACT

THREE ESSAYS ON THE ECONOMICS OF HEALTH

By

Yleana Pamela Ortiz Arevalo

This thesis consists of three essays that investigate issues related to the economics of health. All three studies examine the case of Mexico and draw on the first wave of the Mexican Family Life Survey (2002). The first two essays focus on school age children and the second on women.

In the first essay, I look for evidence of increasing overweight—evaluated in terms of body mass index (BMI)—and examine possible contributing factors. I find that prevalence of overweight increased for both boys and girls in recent years. To look for factors that may contribute to this increase, I propose a theoretical model of a mother's allocation of food and time, from which I obtain her reduced-form demand for weight adequacy of her child. I empirically estimate this demand measured as the probability that a child is overweight. Results indicate that contributing factors to the growth of overweight in children are: (i) increases in mother's BMI and in community median BMI of male adults; and (ii) particularly for boys, less presence of father at home and an increase in maternal labor supply.

In the second essay, I study the effects of maternal education on hemoglobin levels and possible consequences of anemia among children. Childhood anemia may impair

physical growth, weaken the ability to fight infections, affect the development of motor and learning capacities, and reduce physical performance and endurance. All of these have potential negative consequences on school functioning, accumulation of human capital, and future labor productivity. Results point out to positive effects of maternal education. I find evidence of maternal education being endogenous and possibly contaminated with measurement error. There is evidence suggesting that maternal education might be related to public health services through a substitution effect. Results also reveal that mother's labor supply is negatively associated with hemoglobin levels.

In the third essay, I examine whether sexual and reproductive behavior of Mexican women changed due to public initiatives promoting birth control and family planning launched in the 1970s. I use a variety of indicators to characterize sexual and reproductive behavior: first sexual encounter, first and second pregnancies, and utilization of contraceptive methods. To identify the effects of public programs, I make use of individual exposure to in-school sexual education and to birth control promotion in public health facilities. Results suggest that in-school sex education increased the hazard of first sexual intercourse but did not affect the hazard of first pregnancy. Both sex education in schools and exposure to campaigns in public health facilities decreased the hazard of a second pregnancy. There is also some evidence supporting positive effects of sex education on the use of contraception methods.

With my love to Jechu, Chicharito, Marifer, Lauri, Merve, and Alex.

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INTRODUCTION

The present dissertation contains three analyses of the economics of health. The first two essays focus on school age children and the third on women in their childbearing years. The dissertation links various topics in health and development. All three essays use data drawn from the first wave of the Mexican Family Life Survey collected in 2002 (MxFLS-1)[1].

Health experts agree that developing countries are currently facing health and nutrition transitions: overweight and obesity and non-communicable diseases are emerging to join traditional problems of under-nutrition and communicable diseases. For example, in Brazil, China, and Russia, 8%-11%[2] of the households have both underweight and overweight members (Doak et al., 2000). These concerns motivate the first two chapters, in which I study overweight and anemia[3] among school age children. Economically relevant aspects arise regarding the health of children. A child's ill-health may translate into low human capital accumulation and low labor productivity, and in the context of developing countries, these could become serious constrains to development and attempts to reduce inequality. When treating child health both economic and non-economic studies tend to emphasize the analysis of parental characteristics since it is generally believed that children, especially younger ones, play no role or at most a minimum role in making decisions related to their lives (Haveman and Wolfe, 1995;

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[1] For details see Appendix 4.
[2] 11% in Brazil and 8% in China and Russia.
[3] Anemia is the deficiency of hemoglobin in blood, the protein in charge of transporting oxygen through the body. Anemia may be caused by deficiency of micronutrients, such as iron, folic acid, Vitamin B12, or Vitamin A, but one of its main causes is iron deficiency. It may also be caused by non-nutritional factors such as infections, e.g. worms.

Strauss and Thomas, 1995; Paxson and Waldfogel, 1999; and, Burton, Phipps and Curtis, 2002).

In the first chapter, I develop a theoretical model that provides some insights into the relationships between maternal nutritional choices, in terms of monitoring time and food, and child's weight. I empirically test the model's implications with particular attention on the effects of maternal labor supply and time allocation. This analysis reveals no evidence of maternal labor supply being correlated with the likelihood of children being overweight. However, evidence suggest that other factors, such as child's age, mother's BMI and education, and number of siblings at home, have effects on the probability of overweight. Finally, results point to effects of community-level variables on the likelihood of boys being overweight.

In the second chapter, I empirically estimate the effects of maternal education on child health as measured by hemoglobin concentrations in blood. Since maternal education could affect child's health directly or indirectly through other factors, I analyze how it interacts with household and community infrastructure and access to information. Results suggest significant positive but small effects of maternal education on children hemoglobin levels and that maternal education might be operating with public health services (clinic/hospital) through a substitution effect.

The third chapter is motivated by the public initiatives promoting birth control and family planning launched in the 1970s by the Mexican government in education and health sectors. As in other countries, these public policies were introduced in order to reduce the pressure of population growth and were effective in doing so. In the last three decades, the average population growth rate dropped from 3.4%, in the period 1960-70, to 1.0%, in the period 2000-05, while fertility rate fell from 5.7 in 1976 to 2.2 in 2006[4]. I examine how sexual and reproductive behavior of Mexican women changed due to the exposure to sex education in schools and family planning in public health facilities. I find that public initiatives had several effects on the behavior of Mexican women. I find that not only exposure to such initiatives influenced changes on sexual and reproductive behavior, but also that private schooling, completed education, and birth cohort play important roles on changing behavior of Mexican women.

[4] National Institute of Geography, Statistics, and Informatics (INEGI).

CHAPTER 1

OVERWEIGHT IN MEXICAN CHILDREN

1.1. Introduction

Obesity is today regarded as a "pandemic" phenomenon: "[It] has reached epidemic proportions globally…is a major contributor to the global burden of chronic disease and disability…is a complex condition, with serious social and psychological dimensions, affecting virtually all ages and socioeconomic groups." [5] Overweight and obesity are concerns in both developed and developing countries, particularly because of their association with non-communicable chronic diseases (NCCDs). In developing countries, these add up to join the traditional public health problems: malnutrition, under-nutrition, and communicable diseases. Weight problems have also become a concern in the case of younger population groups, e.g. in the United States, prevalence of child overweight and obesity—starting in the 1980s—has been rising.

Recently evidence has been presented of a rise in the prevalence of overweight and obesity in Mexico, particularly among women and preschool-age children. However, this trend has not yet been documented rigorously nor approached from an economic perspective, and the purpose of this paper is to do so. The trend is relevant for economists due to its potential negative consequences—current and future—on labor productivity, earnings capacity, and health systems and/or budgets. Public policies, such as food assistance programs or available diets in schools, may also be affected. This paper addresses the question of whether childhood overweight and obesity have really increased in Mexico by examining body mass index (BMI) distributions at two points in

[5] World Health Organization (WHO, 2003).

time, and looks for possible clues to the factors contributing to the increase by analyzing cross section variation in current childhood obesity.

Child overweight and obesity, like other child outcomes, has been analyzed under the assumption that decisions are made by the parents, not directly by the child[6]. Both economic and non-economic studies tend to emphasize the role of parental, household and other environmental characteristics when exploring factors associated with child overweight and obesity. Some ideas that have been proposed to explain trends of children overweight and obesity in the US are that children follow eating and exercising patterns of their parents, they watch more television, and are monitored less than before since parents work more in the labor market (Philipson and Posner, 1999).

First, I propose a simple theoretical model to derive the mother's behavior when allocating food and time. This provides some insights into the relationships between maternal nutritional choices, in terms of monitoring time and food, and child's weight. The mother is assumed to derive utility from food consumption, non-food consumption, and the closeness of her child's weight to what she considers the child's "ideal" weight. Her optimization is constrained by a budget constraint containing non-labor and labor income, and a technology for the "closeness to ideal weight" as a function of food and monitoring time. Two basic predictions are derived from this model: weight increases with mother's wages or labor market opportunities and is decreasing in food prices.

[6] Note that Burton, Phipps and Curtis (2002) argue that the causality is usually taken as going from parents to children, that the focus has been more on "production inputs" than on "production process". As they state, "More praise may encourage a child to do well, but parents may also praise more when a child does well." According to their theoretical model, parental behavior should not be taken as exogenous and the empirical evidence they present supports this idea. Their results suggest that socioeconomic factors and parenting style play a very important role in determining child behavior, and that parenting behavior is, in turn, influenced by stresses in parents' lives and by children's behavior.

The empirical strategy gives particular attention to analyzing the relationship between mother characteristics—such as education, labor supply, and time allocation—and child weight. The underlying idea follows from the arguable[7] assumption that children do not make nutrition choices by themselves, at least not for the most part. In Mexico, children are mostly cared for by their mothers or other family members; a market for childcare is virtually non-existent. A first analysis focuses on mother characteristics without taking into account whether the child is supervised by someone else. Additionally, I address the question of how own, parental, household, community characteristics, and food prices affect a school child's weight, and how these characteristics contribute to the risk of a child to becoming overweight or obese.

I next examine evidence of increasing overweight and obesity prevalence in Mexican children. Unfortunately, large representative surveys have focused on collecting information on preschool children. Nutrition and health surveys have been carried out in Mexico since the 1970s but only in a few cases were school children considered[8], thus it is difficult to even establish the existence of a trend for this age group. But it is most likely that, like women and preschool children, school children experienced an increase in their weight.

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[7] Variyam et al. (1999) provide evidence on maternal health and nutrition knowledge improving overall dietary quality of preschoolers more than that of older children. This perhaps in part because the older the child the more choices she or he makes on her/his own, like intake of food not supervised by the mother.
[8] Only the Urban Nutrition Survey (Ávila. et al., 2003), the ENN (1999), the National Health Survey (ENSA, 2000), and the National Health and Nutrition Survey (ENSANUT, 2006) contain information on nutritional status of school-age children.

The main cross-sectional analysis makes use of the first wave of the Mexican Family Life Survey (MxFLS-1)[9], which contains extensive information on socioeconomic, demographic, and health characteristics at individual and household levels. The analysis reveals evidence of mother's working hours being correlated with the likelihood of being overweight of boys; however, this correlation is small and weakly significant. Other factors, such as child's age, mother's BMI and education, number of siblings at home, and some community variables, are found to have important effects on the probability of overweight. Number of siblings is negatively correlated with overweight, somehow reflecting an overall effect of resource availability. Mother's BMI has a positive effect that might be representing both genetic and behavioral components. Mother's education is also positively correlated with child's probability of being overweight. The presence of father at home is positively and largely correlated with overweight, but not significant for girls. This may be supporting evidence to the idea of fathers "favoring" their sons comparatively to their daughters (e.g. see Thomas, 1994); however, it is difficult to disregard the possibility that this result follows from a "role model" effect. The effect of household income is statistically insignificant.

At the community level, effects are found for boys: median community BMI of 25-50 year-old men and median education (in years) of mothers are positive; while median education of fathers is negative. This suggests that school boys are heavier, and more likely overweight, the heavier adult males are in their community and the better educated their mothers are. The opposite occurs if boys live in communities where fathers are better educated—boys weigh less and are less likely to be overweight.

[9] The MxFLS-1 is a multi-topic survey that follows the design of the Indonesian Family Life Survey (IFLS). It is representative at all national, regional, and urban-rural levels.

The chapter is organized as follows. Section 1.2 portrays some background on the definition, measurement, and various current concerns about overweight and obesity. Section 1.3 provides a brief appraisal of works on the role of maternal characteristics in the production of child health outcomes and review of the economic literature on childhood overweight and obesity. Section 1.4 presents the theoretical model. The empirical strategy and results are described in section 1.5 and Section 1.6 concludes.

1.2. Background

1.2.1. International dimension

Overweight and obesity have become important concerns both in developed and developing countries due to their increasing prevalence and their association with as important risk factors of non-communicable diseases. WHO sums up various facts about obesity in the world: (i) more than 1 billion overweight adults—at least 300 million obese; (ii) obesity and overweight represent a major risk for NCCDs—type 2 diabetes, cardiovascular disease, hypertension and stroke, and certain forms of cancer; and, (iii) that these are mostly consequences of an increase in the consumption of energy-dense foods—high contents of saturated fats and sugars—and a decrease of physical activity[10]. In the case of children, overweight and obesity have also been related to chronic health problems, such as type II diabetes, high blood lipids, hypertension, sleep apnea, orthopedic problems, early malnutrition, and a higher risk of becoming overweight or obese when adult (Anderson, Butcher and Levine, 2003).

[10] WHO (2003).

In the United States, using the National Health and Nutrition Examination Surveys (NHANES) to estimate overweight and obesity prevalence rates, the Centers for Control Disease and Prevention (CDC)[11] report that, between 1976 and 2002, combined overweight and obesity prevalence increased by 38% (from 47% to 65%) and obesity doubled (from 15% to 31%). In the case of children, evidence from the NHANES reveals that between the 1960s and 1980 rates of overweight children (6-11 years old) and adolescents (12-19 years old) remained relatively stable. But, an important rise has been observed since the early 80s. Overweight was 7% for children and 5% for adolescents, in 1976-80; 11% for both groups, in 1988-94; and 16% for both groups, in 1999-02. Recent estimates indicate that Europeans[12] have a high average BMI (26.5). Prevalence of obesity ranges from 5% to 20% in men and up to 30% in women among European countries. Even countries that traditionally had low rates of overweight—such as France, Norway, and Netherlands—have experienced rises in adult obesity during the last decade. Evidence also suggests that 10–30% of the European children (aged 7–11 years) and 8–25% of adolescents (14–17 years) are overweight.

Experts maintain that developing countries are currently facing health and nutrition transitions: under-nutrition coexisting with overweight and obesity, and the association of the latter with a rise in NCCDs, i.e. that overweight, obesity, and NCCDs are emerging to join and combine with the traditional health problems of developing countries[13]. Doak et al. (2000) use data from large national surveys in Brazil, China, and Russia. They find

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[11] Centers for Disease Control and Prevention: Prevalence of Overweight among Adults. http://www.cdc.gov/nchs/products/pubs/pubd/hestats/obese/obse99.htm. and Prevalence of Overweight among Children and Adolescents. http://www.cdc.gov/nchs/products/pubs/pubd/hestats/overwght99.htm (accessed April 18, 2006).
[12] WHO (2005).
[13] Zambrano and Guzmán (2002); Popkin, Richards and Monteiro (1996); and, Hoffman (2001).

that the proportions of households with both underweight and overweight members were 11% in Brazil and 8% in China and Russia; and, that these households account for 45%, 23% and 58% respectively, of all households with an underweight member. Rivera and Sepúlveda (2003) present results from Mexico revealing that between 1988 and 1999 for women 18-49 years old overweight prevalence increased by 46%, (from 24% to 35%) and obesity in this group increased by 160% (from 9% to 24%). They also find that prevalence of obesity in preschool children (under 5 years old) grew by 26%.

Commonly, nutritional and health transitions observed in most countries in Asia, Latin America, Northern Africa, Middle East and urban areas of sub-Saharan Africa, have been related to changes in the population's lifestyles, particularly changes in diet and physical activity: increased consumption of fat, added sugar, and animal products, i.e. high fat/high carbohydrate energy-dense foods, in contrast to lower total intakes of cereal, fiber, fruits and vegetables (Uauy, Albala and Kain, 2001 and Popkin, 2001); and reduced physical activity as a consequence of more sedentary work and leisure—driven by technological changes (Rivera et al., 2004). Despite the fact that such changes in lifestyles have also been observed in developed countries[14], according to WHO (2004), developing countries are those currently more and increasingly affected by this problem in terms of mortality, morbidity, and disability—where 66% of deaths relate to non-communicable diseases and on average involve relatively younger people than in developed countries.

[14] See below for an exposition of studies on the causes of obesity trends in the US.

1.2.2. Definition and measurement

Obesity is defined as a condition of abnormal or excessive fat accumulation in adipose tissue or as a disease in which excess body fat has accumulated to such an extent that health may be adversely affected or impaired (WHO, 2000). The most widespread technique to evaluate weight adequacy is the body mass index (BMI)[15]. The BMI is defined as weight (in kilograms) divided by height squared (in meters). A simple classification for adults is the following: overweight if BMI $\geq$ 25; preobese if 25 < BMI$\geq$ 29.99, with an increased risk of comorbidities; obese class I if 30 $\leq$ BMI $\geq$ 34.99, with a moderate risk of comorbidities; obese class II if 35 $\leq$ BMI $\geq$ 39.99, with a severe risk of comorbidities; and, obese class III if BMI $\geq$ 40, with a very severe risk of comorbidities[16]. The BMI has been usually used for adult populations, but it has been adopted for children populations as well (Rolland-Cachera et al., 1991).

BMI was not adopted until recently to evaluate weight adequacy of children populations. Unlike case of adults, there is not broad agreement for defining overweight and obesity cut-offs. In part, this is because BMI changes considerably with age. However, researchers in different countries have proposed some reference options. In the United States the 85th and 95th centiles of age and sex based BMI distributions are used as reference points (Must, Dallal and Dietz, 1991). In France, values of cut-offs are identified by using Z-scores (Rolland-Cachera et al., 1991). Cole et al. (2000) established an age and sex based standard definition for child overweight and obesity using

[15] Note that BMI does not really measure body fatness, but body mass or weight adequacy to height.
[16] Notice that this classification is age and gender-independent and that WHO acknowledges that "...the relationship between BMI and body fat content varies according to body build and proportion, and...a given BMI may not correspond to the same degree of fatness across populations".

nationally representative cross sectional growth studies from Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the US, which makes it comparable internationally, and can be used to identify changes over time.

1.2.3. Non-economic studies

Both economic and non-economic studies tend to emphasize the role of parental, household and other environmental characteristics when exploring factors associated with child overweight and obesity. For instance, Hernández et al. (2003) find that risks of overweight and obesity in Mexican school children were positively associated with mother's education and socioeconomic status. Additionally, they find that risk is also positively associated with age and that prevalence is higher for girls, but found no significant differences between regions or urban and rural areas. Padrón (2002) argues that considering environmental, social, and genetic factors separately cannot explain the trends observed in the last decades. She points to an excess of sedentary activities, such as watching television, videogame and computer use, and to a reduction in relative prices of low nutritious-quality food. She also suggests that children should not be rewarded (by parents) with food and that healthy food should not be substituted with snacks. A study among children in Mexico City by Hernández et al. (1999), using a random sample of schools from two communities (*delegaciones*), reveals that risk (odds ratio) of obesity was higher by 12% for each additional hour per day of watching television, 10% lower for each hour per day of moderate or vigorous physical activity, and 20% lower considering only vigorous activity. Brewis (2003) investigates obesity among middle-class children from a school in the city of Xalapa, finding that children from households with fewer children, those with more permissive, less authoritarian parents, and boys were more likely to be obese. She argues that food treats are a cultural index of parental caring, and as a consequence can result in indulgent feeding especially for sons in smaller middle-class families.

1.3. Economic studies

1.3.1. The role of maternal characteristics: education and labor supply

There is a large literature on the effects of parental/household characteristics on child health outcomes. Here I concentrate on some works that analyze maternal labor supply and education. Thomas et al. (1991) and Glewwe (1999) study possible mechanisms through which mother's education affects child's health in terms of height. Thomas et al. (1991), in Brazil, find evidence of access to information being such a mechanism; while Glewwe, in Morocco, finds that it is health knowledge acquired through literacy and numeracy skills learned in school. Kassouf and Senauer (1996) analyze parental education direct and indirect effects via wages and full income on three anthropometric measures for Brazilian children and, using regression results, they simulate effects by education levels. In particular, they find positive direct effects of the role of mother's education, negative small indirect wage effects, and large positive indirect full income effects on weight for age and weight for health. Total effects are positive and larger as education increases. Variyam et al. (1999) study the effect of maternal nutrition and health knowledge on dietary intakes of children 2-17 years of age in the US. They find that maternal knowledge influences children's diet especially for preschool children, but that this effect becomes weaker for older children (> 5 years old). They also include mother's labor participation status (not, part, and full employed), finding that total and saturated fat intakes decrease if mother is not employed or part-time employed as compared to being full-employed, only for school-age children. Effects of employment status for preschoolers seemingly occur through maternal nutrition and health knowledge. Blau, Guilkey and Popkin (1996) examine the relationship between mother's labor supply, infant feeding, and infant health. They find that after accounting for possible endogeneity there is little evidence of direct causal effects of mother's labor supply on weight and height of infants in the Philippines. They also find that mothers with higher wages have healthier children and that mothers who face higher food (infant formula and corn) prices have less healthy children. Glick and Sahn (1998) investigate the effect of mother's labor supply and income in preschool children of Guinea, as Blau et al. (1996), accounting for possible labor supply endogeneity. They find that on average positive effects of labor income on children height are offset by large negative effects of labor supply.

1.3.2. Economic studies of child overweight and obesity

Works studying adult obesity in the US have focused on distinguishing the effects of different factors on the trends of adult obesity including technological change (TCH) and its impact on food prices and more sedentary home and market work (Philipson and Posner, 1999 and Lakdawalla and Philipson, 2002); change in lifestyle and its association with changes in value of time, especially for women; increased real cost of cigarette smoking; more availability of fast food—which reduce costs of search and travel and relative cost of fast food meals (Chou, Grossman and Saffer, 2002; Rashad, Grossman and Chou, 2005); and, decrease in time cost of food—due to a rise in mass preparation of food, permitting the production of food in one location and its consumption in another—with an effect on the frequency of food consumption of greater variety (Cutler, Glaeser and Shapiro, 2003).

Economic literature on children, as in the case of adults, mainly addresses the question of possible causes of the rise in overweight and obesity prevalence. In the United States, existing works are few and recent; the list would include Anderson et al. (2002); Anderson et al. (2003); Ruhm (2004); Anderson and Butcher (2005); and, Anderson and Butcher (2006). Table 1.1 presents a brief synopsis of these works.

Anderson et al. (2002; 2003) study whether the rise in the prevalence of working mothers observed during the last decades has had a causal effect on the prevalence of overweight children. In particular, they find a positive relationship between the average hours per week worked over a child's lifetime and his/her probability of being overweight—e.g. changing from a part (20 hours per week) to a full-time (40 hours per week) employment would cause an increase by 1 to 2 percentage points on such probability.

Table 1.1. Previous studies analyzing the child obesity.

Author	Sample/Data	Theoretical/Empirical Results	Comments
Anderson et al. (2002)	National Longitudinal Survey of Youth (NLSY, 1986-1996). Supplemented by the National Health and Nutrition Examination Survey (NHANES III, 1988-1994) and the Continuing Survey of Food Intakes by Individuals (CSFII 1994-96, 1998)	Positive, and possibly causal, relationship between mother employment (average hours per week) and overweight. Only a small part of the observed growth in prevalence of overweight children can be explained by mothers working more intensively between 1975 and 1999 (0.4 – 0.7 percentage points).	No theoretical model. Econometric modeling derives from a conceptual economic and "physiological" framework. Three econometric techniques are applied: probit, sibling differences, and instrumental variables. Time-definitions of employment: current, during first 3 years of child's life, and over child's lifetime. Pattern-definition: weeks per year and hours per week or intensity.
Ruhm (2004)	NLSY (1986-2000)	Derived from a maximization procedure, child outcomes are modeled as a production function of working hours, individual or family background characteristics, and a disturbance term to capturing shocks. Negative consequences of mother market work are found among more advantaged children. Results are rarely statistically significant.	Maximization of a dynamic child outcomes-production function with respect to time and income constraints; from which a reduced-form demand function of prices and production shocks is obtained. For analysis, due to data restrictions, an approach of "hybrid" equations is used. Econometric techniques: Ordinary least squares and probit. Employment definitions are average hours per week at different child ages, including before pregnancy and after ages 10-11 (post-assessment). The inclusion of a post-assessment variable is meant to control for possible endogeneity problems.

Table 1.1. (cont'd).

Author	Sample/Data	Theoretical/Empirical Results	Comments
Anderson et al. (2003)	NHANES (1971-74; 1976-80; 1988-94; and 1999-2000) NLSY (1986-1996) Current Population Survey (CPS-March, 1976 and 1995) School Health Policies and Programs Study (SHPPS, 1994 and 2000)	BMI distribution almost equal in 1971-74 and 1976-80. Obesity began to increase in 1980. Not all children (2-19 years) were affected in the same way: while the median BMI increased by 4.5%, the BMI at the 95th percentile increased by 15.7%.Argue that more availability of unhealthy food at schools may also be contributing to epidemic.	This paper covers insights about child obesity from an economic approach. It provides a summary of several issues: the public character of obesity, a review of its trends in the US, and the role of mothers working more hours and the role of schools. No theoretical model is derived. Presents empirical evidence on BMI trends by comparing distributions, econometric results from 2002 paper (see above).
Anderson and Butcher (2005)	NLSY (1997) SHPPS (1994 and 2000) National Center for Education Statistics for Education Statistics (NCES) Common Core data	Find positive average effect of access to junk food at school on obesity (1%), but this is driven by adolescents with a genetic predisposition for obesity (whose effect is 2.2%). These are equivalent to 1.5 and 3.3 extra pounds respectively. Junk foods in schools are found to account for 20% of the increase in adolescents' average obesity.	Implement two-step approach similar to that of two-sample IV for empirical estimation. Essentially this procedure is done due to data constraints, but it helps to deal with potential endogeneity of food policy variables. No theoretical model is derived, but empirical strategy follows from the idea of school food policies contributing to obesity.

Table 1.1. (cont'd).

Author	Sample/Data	Theoretical/Empirical Results	Comments
Anderson and Butcher (2006)	Data on prevalence of obesity (WHO, 1998). NHANES (1971-74; 1976-80; 1988-94; and 1999-2000). US soft drink consumption data. Labor force participation rates from Statistical Abstract of the US. Nielsen Media's Report on Television.	Descriptive analysis of obesity trends internationally and in the US. Examination of potential causes of trends observed in the US.	Provide extent reviews on: (i) Obesity definition/measuring and trends. (ii) Energy balance studies (intake, expenditure, and additional correlates as breastfeeding). (iii) Changes in built environment, school and child care, and the role of parents.

However, the magnitude of the estimated effects of maternal employment only account for 6 to 11 percent of the observed growth in the prevalence of overweight children. Additionally, using their estimates the increase in adult women overweight and obesity can "explain" 11 percent of the phenomenon.[17] Anderson et al. (2003) analyze child obesity from a broader economic perspective, though they devote specific attention to the role of working mothers. They discuss several caveats regarding the particularities of the child overweight and obesity issue, from the pertinence of using a standard economic model, to the role of parental supervision, schools, fast food and television, to the public policy implications due to social health costs and externalities.

Maternal employment is also analyzed by Ruhm (2004), who assesses the question of how maternal employment relates to various developmental outcomes of 10 and 11 year-old children—cognitive development, obesity, and potential risky behaviors. He finds that 20 additional hours per week are associated with a 22 to 27 percent rise in obesity and a 19 to 20 percent increase in the risk of being overweight. Anderson and Butcher (2005) study the role of schools, arguing that schools facing financial pressures fund themselves through permitting more access to "junk" foods. They look at the likelihood of schools under financial difficulties implementing "potentially unhealthful food policies". They find a positive effect of access to junk food at school on obesity: if the proportion of schools allowing junk food in a county increases by 10 percentage points, BMI increases by 1% on average—equivalent to 1.5 extra pounds. But they notice that this is driven by adolescents with a genetic predisposition for obesity—an effect of 2.2% or 3.3 extra pounds. Using these figures, they estimate that junk foods in schools are

[17] Notice that even if taken together, these aspects fail to explain the largest part of the observed trend observed in the US.

found to account for 20% of the observed increase in adolescents' average obesity. Anderson and Butcher (2006) provide a descriptive analysis of childhood obesity trends and potential causes in the US. They assess the definition of obesity and emphasize the validity of using the BMI for measuring children obesity. They review the energy balance literature (intake, expenditure, and additional correlates as breastfeeding) to address possible causes of childhood obesity and look at the consistency between the time patterns of obesity and its "causes". They present evidence pointing out to, on the side of energy intake, increased availability of (calorie dense) convenience foods and soft drinks and increased demand for away-from-home or pre-prepared foods, due to more time devoted to market work by parents. On the side of expenditure and also related to less available monitoring time by parents, they identify a more sedentary children's lifestyle—i.e. lighter physical activity practices.

Authors use a variety of techniques to overcome biases that may arise because of unobservables being correlated with maternal employment. Although they try to control for as many factors as possible, problems such as heterogeneity or endogeneity are always a concern. Anderson et al. (2002; 2003) use sibling difference models to reduce the bias due to unobserved heterogeneity. They compare siblings in two ways: the different ages, using same survey year; and, at same age, using different survey years. To correct potential bias as a consequence of other unobserved variables, they apply an instrumental variable procedure for maternal employment. Ruhm (2004) includes a variable of maternal employment measured at a period following that under study, i.e. maternal employment after children are 10-11 year-old, to account for possible reverse causation that might bias his estimates. The interpretation for doing so is that if coefficients of post-assessment employment are different from zero, then not only do maternal labor decisions affect children development—e.g. their risk of being overweight—but also that mothers decide whether to work or not, and how many hours, depending on their children's situation.

1.4. Theoretical model

To grasp how a child's weight is influenced by the decisions of his or her mother, I propose to model her behavior when allocating food and time. She allocates food and time by maximizing a utility function that depends on food consumption (F), non-food consumption (X), and the difference between her child's actual weight and what she considers an "ideal" weight for her child (ΔB). The mother is assumed to be her children's only caregiver and that she successfully manages her children into consuming nutritious food, i.e. maternal monitoring time is effective for improving her child's food intake.[18]

Her optimization is constrained by a time and money-budget constraint and by a technology or production function determining the "closeness to ideal weight". Also, I assume that children enjoy food but they are not concerned with nutrition or health issues. Thus, children must be monitored for them to eat a more nutritious and healthy

[18] The model and its assumptions are largely compatible with some results on eating behavior found by psychologists and child development experts. For example, there is evidence indicating that parental monitoring and even the threat of it influences food selection of children (4-7 years old): reducing choices of non-nutritious foods and the caloric intake of the meal (Klesges et al., 1991). Another piece of evidence on 5 years-old girls supports that "parenting practices are shaped and influenced by the child... [Specifically] that child-feeding practices are influenced by the weight status of the child: mother's child-feeding practices and perceptions of their daughters' risk of overweight are found to have effects on her daughters' eating and relative weight—effects that comparable to those of maternal weight (Birch and Fisher, 2000).

diet. Price of the non-food good is assumed to be one. The mother has a utility function given by:

$$\max \quad U(X,F,\Delta B) = u[X,F] + v[\Delta B]$$

$$\text{s.t.} \quad Y + w(T-t) - pF - X = 0 \tag{1.1}$$

$$\Delta B = |BMI - BMI^*| = f(t,F) = \beta F\left(1 - \frac{t}{T}\right)$$

where Y is non-labor income, w is the market wage, T is total time, t is monitoring time, p is food price, and price of X is 1. *BMI* is child's actual body mass index, and *BMI** is mother's ideal body mass index standard. Assumptions about functional form of the mother's utility are the following: $u_X > 0, u_F > 0, u_{XX} < 0, u_{FF} < 0$ and $u_{XF} = u_{FX} > 0$. The mother experiences disutility if their child's weight differs from her ideal standard, so v'<0, v''>0. Mother's technology of weight adequacy—with respect to her ideal standard |*BMI-BMI**|—is assumed to be linear in all arguments, increasing in F and decreasing in t. I assume standard *BMI** is fixed and determined by mother's preferences, so it may or may not coincide with experts' recommendations. For simplicity, this function is defined only for the case of *BMI* >*BMI**, i.e. for the case in which mothers consider their children to be overweight. In other words, more food in the household would contribute to increase actual child's *BMI* ($f_F > 0$)—moving away from *BMI**—and more time devoted to monitoring would decrease it ($f_t < 0$)—approaching towards *BMI**.[19]

To solve (1.1), the mother allocates *t*, consumes *X*, and allocates and consume *F*. The first-order conditions are:

$$v' f_t - \lambda w = 0$$

$$u_F + v' f_F - \lambda p = 0 \tag{1.2}$$

$$u_X - \lambda = 0$$

$$Y + w(T - t) - pF - X = 0$$

where λ is the Lagrangean multiplier. To identify effects of wage, food price, and income on child's weight, I totally differentiate expressions in (1.2) and constraint Δ*B* (see Appendix 1). Then I use the results to assess: (i) how higher wages and thus market opportunities affect children's weight and (ii) what effect a change in food price has on weight.

Formally, these are $\frac{d\Delta B}{dw}$ and $\frac{d\Delta B}{dp}$, and it can be shown that (see Appendix 1):

[19] Note that if the child is underweight more of both food and monitoring time would increase BMI, making it approach towards BMI*.

$$\frac{d\Delta B}{dw} = \left[f_t \varphi_{tt} + f_F \varphi_{Ft}\right] + (T-t)\left[f_t \omega_t + f_F \omega_F\right]$$

$$\frac{d\Delta B}{dp} = \left[f_t \varphi_{tF} + f_F \varphi_{FF}\right] - F\left[f_t \omega_t + f_F \omega_F\right] \tag{1.3}$$

$$\frac{d\Delta B}{dY} = f_t \omega_t + f_F \omega_F$$

where φ_{tt}, φ_{FF}, and $\varphi_{tF} = \varphi_{Ft}$ are own- and cross-compensated price effects (substitution effects), ω_t and ω_F are income effects, and f_t and f_F are the partial derivatives of ΔB with respect to monitoring time and food. Own-compensated effects are negative and as stated above $f_t < 0$ and $f_F > 0$. If it is assumed that $U_{tF} > 0$ and "small enough", together with the other functional assumptions of U, then $\varphi_{tF}, \varphi_{Ft} > 0$ (see Appendix 1). F is assumed to be a normal good, so $\omega_F > 0$; and, as long as ΔB is a normal good, t is also "normal", so $\omega_t > 0$.

Under these conditions, signs of expressions in (1.3) cannot be identified accurately unless further assumptions about "total income" effect, $\frac{d\Delta B}{dY} = f_t \omega_t + f_F \omega_F$, are stated. Let $\frac{d\Delta B}{dY}$ be either positive or negative but assume $(T-t)[f_t \omega_t + f_F \omega_F]$

and $-F[f_t \omega_t + f_F \omega_F]$ are relatively small with respect to price effects, so that it can be shown that[20]

$$\frac{d\Delta B}{dw} > 0 \text{ and } \frac{d\Delta B}{dp} < 0 \tag{1.3'}$$

According to these predictions, the model suggests that an increase in wages for women, which may be interpreted as increasing market opportunities for mothers and higher labor force participation, have a positive effect on children's weight (ΔB). It also suggests a negative relationship between food prices and weight, implying that a decrease in food prices that may translate into reduced price of calories would contribute to increasing children's weight.

1.5. Empirical model, data, and results

1.5.1. Empirical model and data

Ideally the empirical strategy would aim to answer whether an increasing trend in overweight and obesity exist in Mexico and what its causes are. Repeated cross sections or panel data would be needed for accomplishing these tasks. However, such data are not available, so I instead focus on looking at possible factors that might be contributing to the alleged rise in obesity in school-age children by analyzing cross-section variation.

Evidence supports the idea of the existence of an increasing trend. Prevalence of obesity in preschool children increased from 4.2% in 1988 to 5.3% in 1999; combined

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[20] Note that the same results are obtained if the total income effect is assumed to be positive, which would imply that $|f_t \omega_t| < f_F \omega_F$ is assumed.

prevalence of overweight and obesity of women (18-49 years old) was 33.4% in 1988 and 59.6% in 1999, and prevalence of obesity increased from 9% to 24%[21]. Data on school age children are not available for 1988. Using data from the National Survey of Food Consumption and Nutrition in Rural Areas 1996 (ENAL, 1996)[22], from Rivera et al. (2001), and from the rural sub-sample of the MxFLS-1, I calculate the combined prevalence of overweight and obesity of school age children: 15.5%, in 1996; 19.7%, in 1999; and, 18.5% in 2002[23]. Finally, at a national level, prevalence of overweight school-aged children was 19.5%, in 1999, and 23.2%, in 2002[24]. Overall, these estimates suggest that there has been an increase in the prevalence of overweight and obesity in Mexico for both female adults and children.

Comparisons between school children BMI distributions provide additional supporting evidence. I analyze BMI distributions in rural areas (Figures 1.1-1.3) and national BMI distributions (Figures 1.4-1.6).[25] Rural data are drawn from the ENAL (1996) and national level data are drawn from the National Nutrition Survey (ENN, 1999)[26] and from data from the MxFLS-1. The vertical line (approximately) indicates the minimum age-sex reference threshold above which a child may be considered overweight: BMI=17.15 for girls and BMI=17.42 for boys (Cole et al., 2000).One can

[21] Rivera et al. (2004) using National Nutrition Surveys (ENN, 1988 and ENN, 1999).
[22] *Encuesta Nacional de Alimentación y Nutrición en el Medio Rural* collected by the *Instituto Nacional de la Nutrición Salvador Zubirán*. For details on this survey see Ávila et al. (1997).
[23] Estimate for 1999 was calculated using US population as standard reference (Rivera et al., 2001). For 1996 and 2002 estimates, I used Cole et al. (2000) as standard reference. Thus, comparisons should then be taken with caution.
[24] Both estimates were calculated using Cole et al. (2002) standard references. 1999 figure was taken from Hernández et al. (2003).
[25] Rural baseline is drawn from the ENAL (1996). National baseline is drawn from ENN (1999). Data of 2002 are drawn from MxFLS-1. The vertical line (approximately) indicates the minimum age-sex reference threshold above which a child may be considered overweight: BMI=17.15 for girls and BMI=17.42 for boys (Cole et al., 2000).
[26] *Encuesta Nacional de Nutrición* collected by the *Instituto Nacional de Salud Pública*. For details on this survey see Rivera et al. (2001).

observe that the rise in prevalence discussed above derives from a shift of the distributions to the right. In the case of rural areas, this shift is particularly important at the left tail and the center part of the distribution, suggesting that prevalence in overweight and obesity are rising not because the density of the right tail is increasing but that lower and medium levels of BMI are increasing.

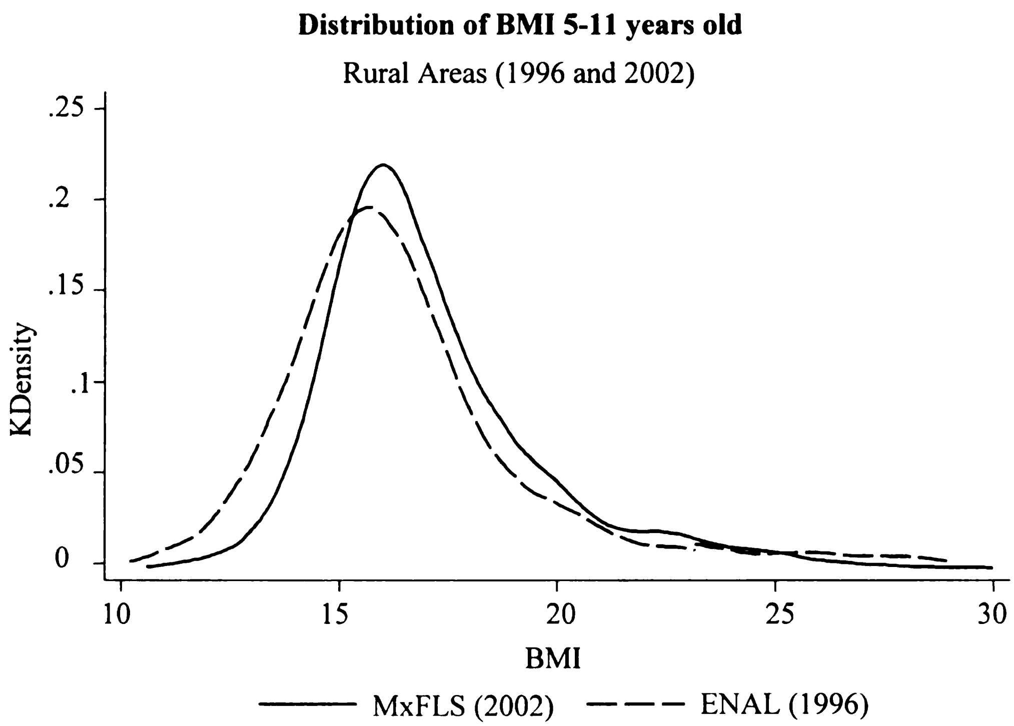

Figure 1.1. Distribution of BMI in rural areas (school age children). Kernel density estimation using data drawn from the National Survey of Food Consumption and Nutrition in Rural Areas 1996 (ENAL, 1996) and the Mexican Family Life Survey (MxFLS-1, 2002).

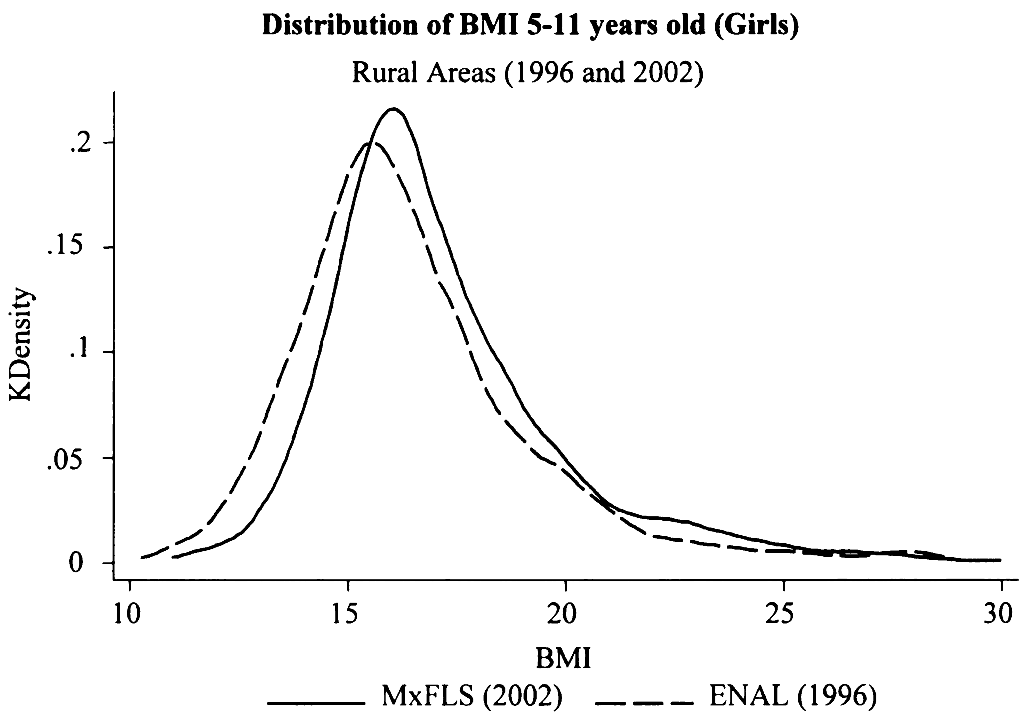

Figure 1.2. Distribution of BMI in rural areas (school age girls). Kernel density estimation using data drawn from the National Survey of Food Consumption and Nutrition in Rural Areas 1996 (ENAL, 1996) and the Mexican Family Life Survey (MxFLS-1, 2002).

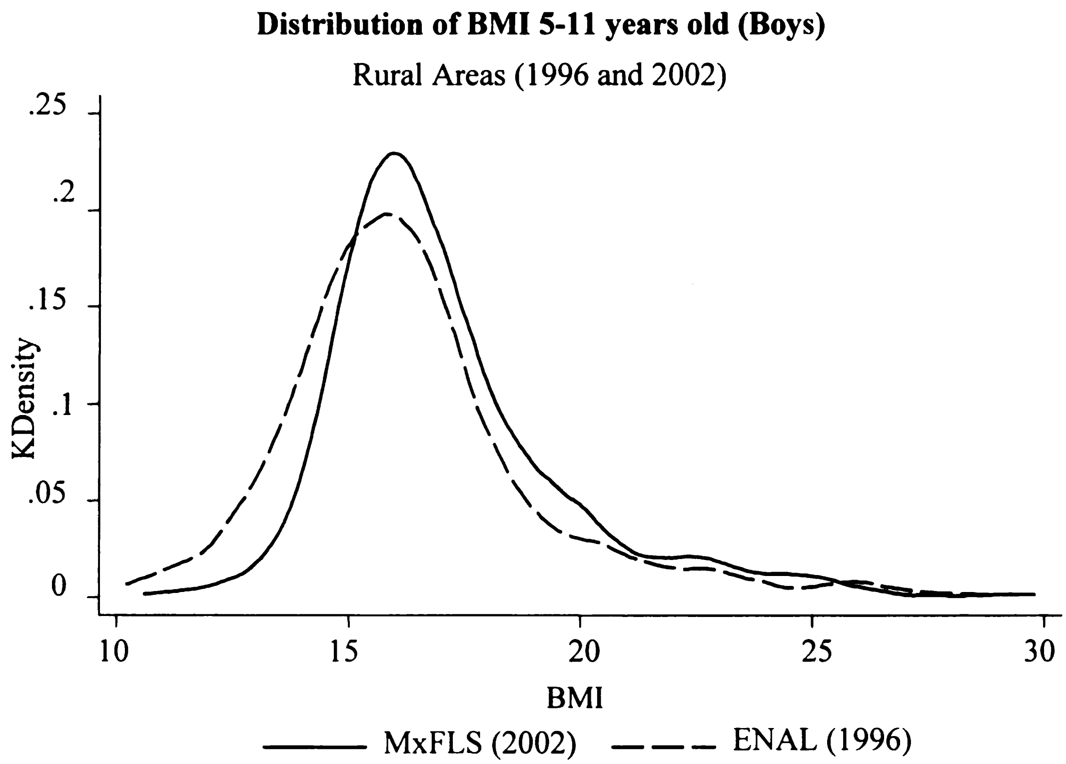

Figure 1.3. Distribution of BMI in rural areas (school age boys). Kernel density estimation using data drawn from the National Survey of Food Consumption and Nutrition in Rural Areas 1996 (ENAL, 1996) and the Mexican Family Life Survey (MxFLS-1, 2002).

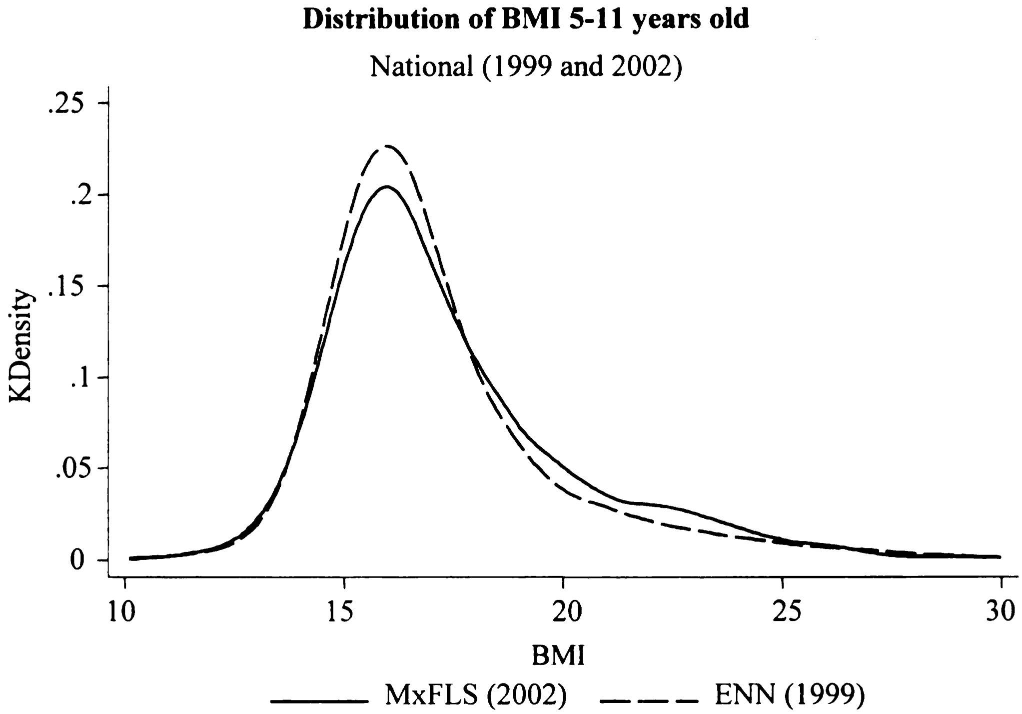

Figure 1.4. Distribution of BMI national (school age children). Kernel density estimation using data drawn from the National Nutrition Survey (ENN, 1999) and the Mexican Family Life Survey (MxFLS-1, 2002).

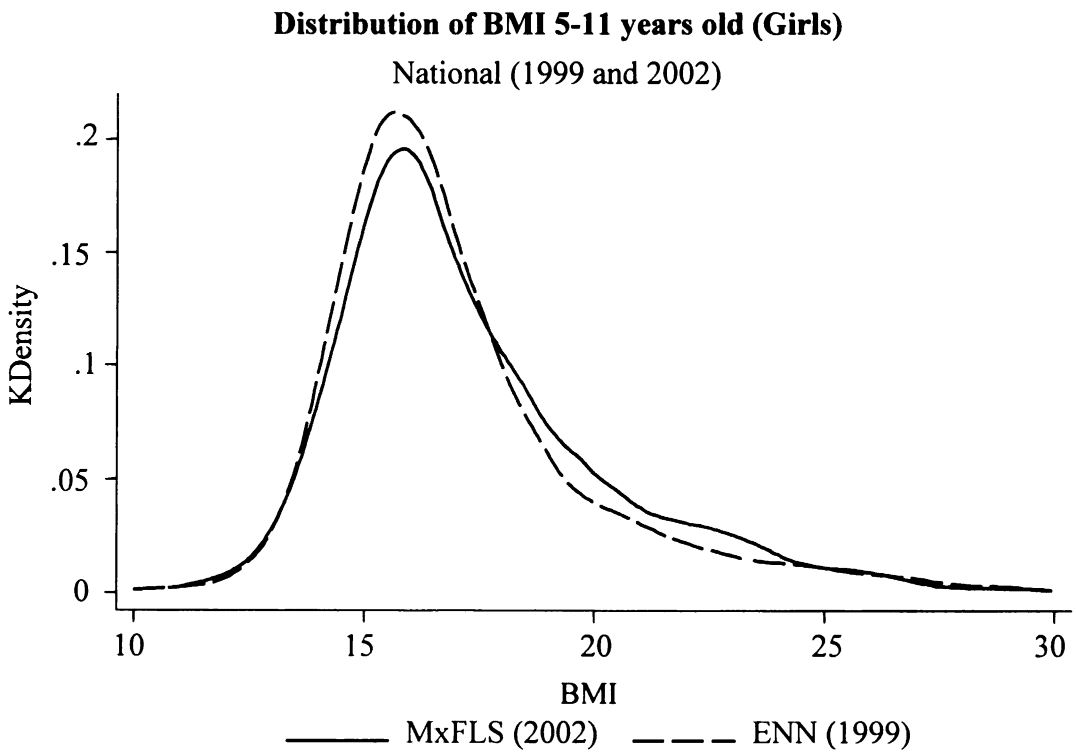

Figure 1.5. Distribution of BMI national (school age girls). Kernel density estimation using data drawn from the National Nutrition Survey (ENN, 1999) and the Mexican Family Life Survey (MxFLS-1, 2002).

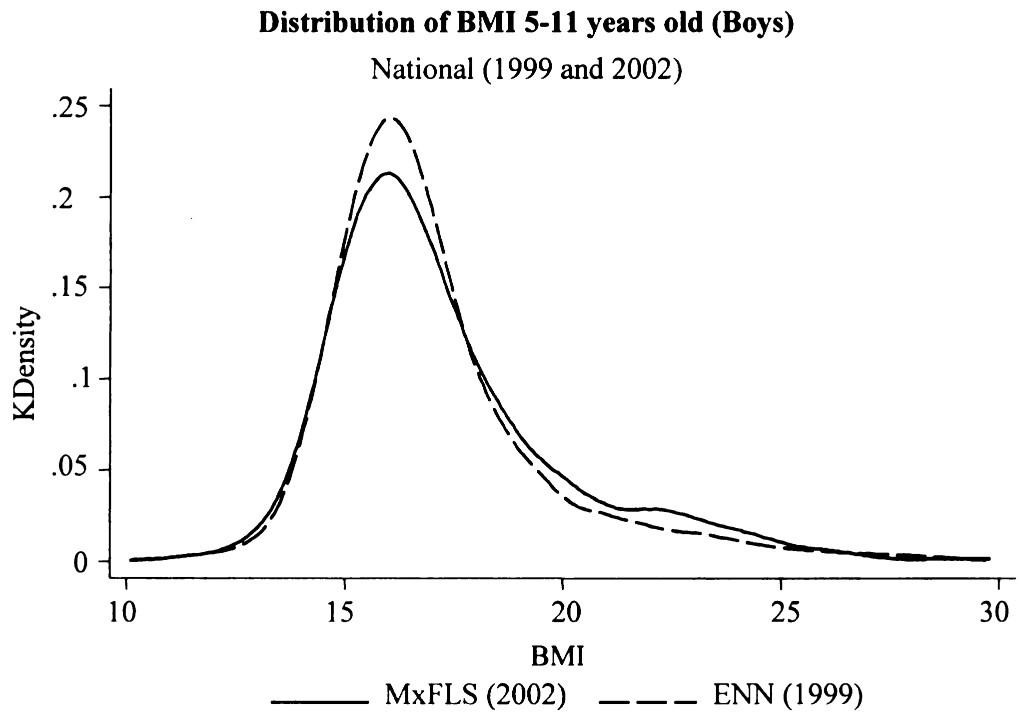

Figure 1.6. Distribution of BMI national (school age boys). Kernel density estimation using data drawn from the National Nutrition Survey (ENN, 1999) and the Mexican Family Life Survey (MxFLS-1, 2002).

At the national level, the shift is mainly observed at the right tails and only for girls can one observe some increases at the center-left of the distribution. Another interesting aspect of the national distributions is that they all become relatively flatter around the center. Overall, at the national level, it appears that average BMI is raising because of more overweight; however, at the rural level, BMI seems to be increasing at all levels.

To some extent, these pieces of evidence sustain the idea of nutrition facing a transition in developing countries, as children are becoming less undernourished in terms of weight, but also more overweight. Other pieces of evidence reveal changes in dietary patterns of Mexicans. The contribution of fat intake to energy increased between 1988 and 1999. The percentage of total energy from fat increased from 23.5% to 30.3% in this period. Between 1984 and 1998, mean purchases of different food types also changed: fruit and vegetables decreased by 29.3%, milk and derivatives decreased by 26.7%, meats decreased by 18.75; while refined carbohydrates increased by 6.3% and soft drinks (soda) increased by 37.2%.[27]

The static model of mother's behavior in section 4 provides some guidance as to the expected roles of mother's labor market opportunities and food prices. It is possible to identify a demand for the weight (BMI) adequacy of each child that is a function of prices, wages, and non-labor income:

$$\Delta B_i = g_i(p, w, Y) \tag{1.4}$$

Note that wages are only observable for those women participating in the market. Thus, to account for labor market opportunities and decisions, I instead use labor supply. And, consistently with the unitary household model, I assume that all income sources affect the child outcome similarly, so I combine mother's wages and all other sources of income within the household into a total income measurement[28]. For the empirical estimation, I allow for possible differences in BMI* across mothers using covariates such

[27] Rivera et al. (2004).

[28] In the cases where individual labor income is missing but should be observed, I input it by matching individuals with a probability score procedure estimated from socio-demographic characteristics and information availability at an individual level. While this improves observable data on income, it does not alter main estimation results on the effects of household income on the probability of overweight.

as mother's education and community-level adult BMI. I estimate a linear approximation of (1.4) in terms of the probability of a child being overweight:

$$P(BMI_i > BMI^* | \mathbf{X}, \mathbf{e}) = \beta_0 + \beta_i X_i + \beta_m X_m + \beta_h X_h + \beta_c X_c + e \quad (1.5)$$

for all i=1,....n school-age children, where $\boldsymbol{X_i}$, $\boldsymbol{X_m}$, $\boldsymbol{X_h}$, and $\boldsymbol{X_c}$ are vectors containing own, mother's, household, and community variables. $\boldsymbol{X_i}$ includes only child's age and its square to account for possible non-linearities. I exclude children time allocation due to potential endogeneity led by reverse causality—it is not only that a more sedentary child might gain weight, but also that an overweight child might become more sendentary. $\boldsymbol{X_m}$ contains mother's BMI and a dummy variable if pregnant or breastfeeding interacted with BMI; mother's education, labor hours, and hours devoted to other non-sedentary and sedentary activities. To account for omission of unobservable skills, I include scores from the Raven Test[29] for adults as a proxy. Household characteristics included in $\boldsymbol{X_h}$ are number of siblings, a dummy variable if father is present in the home, a dummy variable indicating if occupation of household head is agriculture, and total income. Community level variables in $\boldsymbol{X_c}$ are median BMI of adults, median years of schooling of mothers and fathers, median family income, proportion of agricultural households, median % of expenditure in different types of food, dummy variables for region and population size.

Mother's education serves as both an indicator of maternal nutrition and health knowledge and as a proxy of socioeconomic status even for non-working mothers. In its

[29] The Raven Test consists of progressive matrices, for which an individual is asked to complete a pattern by selecting a piece that fits a missing part. It provides results on a person's abilities of observation, problem solution, and learning.

former interpretation, education acts through direct channels if nutrition and health knowledge are in fact acquired at school and through indirect channels by providing skills that women use when investing in their children's health. Cognitive ability in terms of Raven Scores serves as a control for unobservable skills likely correlated with both education attainment and dietary decisions by mother affecting, in turn, the probability of her child to be overweight. Labor supply provides an inverse proxy for monitoring time (Glick and Sahn, 1998). Time devoted to "active" and "passive" activities may be regarded as reflecting other aspects of mother's "life-style". Maternal BMI serves as an indicator of current nutrition/health status, as well as of genetics; the interaction term that indicates if pregnant or breastfeeding is designed to account for possible temporary increased weight.

Number of siblings may affect availability of nutrition resources and therefore child's BMI. Less than 80% of children in the sample live with their fathers, so instead of including father's characteristics, I include a dummy variable indicating if father is at home. Results of nutrition surveys emphasize that children in rural areas tend to be less overweight. Between 20 and 26% of the sampled children live in households with the head working in agricultural activities, so I include a dummy variable to account for a potential correlation.

Community variables are incorporated as proxies for current health, social and economic environment (adult BMI, schooling, income medians and proportion of agricultural households) and possibly for diet-cultural[30] differences (household % of

[30] Mexican regions are characterized to some extent by different diets, for example northern states tend to consume more meat than southern and wheat tortillas instead of corn tortillas.

expenditures on different foods respect to household food expenditure). Dummies for regions and population size are included to account for additional potential effects.

Table 1.2 presents summary statistics of relevant variables for the sub-sample of school children (ages 5-11 years) who live in households where only mother or both mother and father are present[31]. Overweight and not overweight children differ in many dimensions[32]. Compared to not overweight children, overweight children tend to be older, a higher proportion of overweight children attend school, and, in the case of overweight girls, a smaller proportion attends public schools. Overweight children sleep fewer hours and spend more time watching TV. All girls devote more time to household work and taking care of others, but play less than boys; those girls who are overweight spend more time on household work and less time playing and taking care of others than those not overweight, for boys time allocated to these activities is not statistically different.

Mothers of overweight children are older—the difference is weakly significant for girls. They also have a higher average BMI, are more educated, and obtained higher Raven scores. Mothers of overweight boys participate more in the labor market than mothers of not overweight group—a difference of 23%. Mothers of overweight girls are not more likely to participate in the labor market. Overall, maternal labor participation seems to be more important for boys than for girls. However, there are no statistical differences in terms of maternal labor supply for any gender. Mothers may be role models more for girls than for boys; overweight girls have less "active" mothers who

[31] I use data drawn from the Mexican Family Life Survey (MxFLS-1), described in the introduction section. I exclude children with no parents at home and children living with fathers only, because data on their mothers is not available.

[32] This sub-sample consists of children both parents or only mother present at home. Statistical significance not presented but checked.

dedicate more time to sedentary activities and less time to non-sedentary activities, but for boys there is no evidence of this.

If father is at home, his characteristics also seem to be associated with children being overweight. Overweight children have heavier fathers and who are more educated. Paternal labor decisions do not differ between overweight and not overweight children. Overweight children also have fathers who devote more time to sedentary activities. Only in the case of girls, those overweight also have more “active” fathers spending more time on non-sedentary activities. That fathers are “active” interestingly does not make a difference for boys, but it does if fathers are more sedentary, which may also contribute to the transmission of models and habits.

Additionally, evidence suggests that overweight children have fewer siblings, live in non-agricultural households—supporting the idea that prevalence in obesity is higher in urban communities—and belong to wealthier families. They live in households where food expenditure is higher; and, where larger percentages of food expenditure are devoted to animal origin food and soft drinks—evidence on soft drinks is weak for boys—, but smaller percentages are spent on fruit, vegetables, and legumes. A striking piece of evidence is that households of overweight children spend relatively less in cereals, bread, and tortillas than do those of not overweight children; while the same is observed for snacks and sugar the differences are not statistically significant. These results may be indicating some endogeneity of food consumption, as when mothers concerned about their children’s weight purchase less high-caloric content food.

Table 1.2. Summary statistics.

	Girls				Boys			
	Not Overweight		Overweight		Not Overweight		Overweight	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Child								
Age	7.96	2.00	8.51	1.94	7.93	1.99	8.49	1.84
Go to school	0.93	0.26	0.98	0.15	0.93	0.25	0.97	0.17
Public School	0.96	0.2	0.92	0.27	0.96	0.2	0.95	0.23
Work	0.02	0.13	0.02	0.15	0.04	0.2	0.04	0.18
Time Allocation:								
Sleep	9.2	1.44	9.05	1.34	9.17	1.31	8.96	1.46
Activities out home	0.71	2.48	0.79	2.62	1.13	3.04	1.36	3.27
Lessons	0.19	1.51	0.31	1.93	0.22	1.61	0.17	1.3
TV	12.3	9.91	14.8	10.53	12.54	10.05	14.97	10.95
Household work	3.1	4.52	3.52	4.87	1.82	3.93	1.78	3.54
Play	16.4	13.4	14.7	11.93	18.15	13.33	17.32	12.92
Take care of others	2.05	5.9	1.58	4.64	1.33	4.96	1.52	5.44
Mother								
Age	34.56	6.89	35.07	6.68	34.35	6.87	35.05	6.8
BMI	27.34	4.92	29.81	5.18	27.48	4.91	29.03	5.24
Overweight	0.66	0.47	0.81	0.39	0.65	0.48	0.78	0.41
Education	5.96	3.86	7.11	4.06	6.39	3.91	7.62	3.93
Cognitive ability	5.06	2.88	5.88	2.83	5.16	2.94	5.87	2.82
Labor market participation	0.4	0.49	0.43	0.5	0.39	0.49	0.48	0.5
Working hours (if market labor)	34.94	19.31	36	20.6	34.86	19.88	36.08	18.3
Non-sedentary activities	54.12	32.41	50.29	32.21	54.03	32.05	51.97	32.32
Sedentary activities	15.46	12.64	17.89	12.88	16.74	13.8	17.64	12.1

Table 1.2. (Cont'd).

	Girls				Boys			
	Not Overweight		Overweight		Not Overweight		Overweight	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Father								
Age	36.3	12.7	35.37	12.65	35.95	12.32	35.47	13.07
BMI	26.45	4.03	28.6	4.1	26.59	3.72	28.54	4.19
Overweight	0.63	0.48	0.78	0.41	0.66	0.47	0.81	0.39
Education	6.55	4.34	8.05	4.43	6.98	4.21	8.12	4.42
Cognitive ability	5.67	2.97	6.5	2.83	5.76	2.91	6.18	2.92
Labor market participation	0.98	0.13	0.98	0.13	0.98	0.13	0.98	0.13
Working hours (if market labor)	50.05	18.05	51.24	16.97	49.64	17.32	50.91	18.25
Non-sedentary activities	14.01	21.41	11.74	18.58	11.58	18.09	11.86	18.43
Sedentary activities	12.32	10.82	14.01	11.04	13.44	12.58	15.54	11.88
Household								
Siblings	1.96	0.89	1.7	0.79	1.94	0.91	1.75	0.83
Father at home	0.8	0.4	0.82	0.39	0.8	0.4	0.83	0.38
Agricultural	0.25	0.43	0.15	0.35	0.24	0.43	0.18	0.39
Total income (Annual, 2002 Mx pesos)	52,181	55,971	65,564	62,053	52,872	57,964	63,468	61,282
Food Expenditure (% of total)								
Fruit, vegetables, and legumes	26.21	12.83	23.62	11.36	25.02	12.33	23.06	10.49
Cereals, bread and tortillas	19.68	12.35	17.61	10.25	19.88	11.67	17.64	10.13
Animal origin	36.16	15	39.46	13.89	37.17	14.69	39.57	13.42
Snacks and sugar	3.83	3.7	3.7	3.32	3.88	3.7	3.7	4.01
Soft drinks	4.99	6.74	5.6	6.17	4.74	5.89	5.27	6.55
Total expenditure (2002 Mx pesos)	449.85	268.1	526.05	278	453.05	264.51	536.2	295.94

Table 1.2. (Cont'd).

	Girls				Boys			
	Not Overweight		Overweight		Not Overweight		Overweight	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Community								
Median BMI of males	26.62	1.52	27.08	1.24	26.77	1.42	27.14	1.33
Median BMI of females	27.74	1.91	28.07	1.52	27.88	1.77	28.15	1.54
Median education of mothers	6.16	2.75	7.12	2.56	6.5	2.66	7.36	2.49
Median education of fathers	6.67	2.78	7.53	2.61	6.9	2.72	7.59	2.56
Median snacks and sugar	2.86	1.03	2.71	1.03	2.83	1.07	2.72	0.96
Median animal origin	36.84	6.64	38.63	5.27	37.26	6.38	38.77	5.2
Median soft drinks	3.22	2.23	3.4	2.22	3.21	2.25	3.19	2.08
Sample size:	1,677 (75%)		557 (25%)		1,696 (79%)		443 (21%)	

[1] Children (5-11 years old) living with mother and father or mother only and with data on height and weight.

Finally, in terms of community characteristics, overweight children tend to belong to communities where adults are heavier; parents are more educated; and where the median household spends more in animal origin food, but less on snacks and sugar. There is less evidence on overweight children living in communities where median expenditure on soft drinks is larger—a weak difference among girls and none among boys.

1.5.2. Results

I estimate equation (1.5) using a linear probability model. Tables 1.3 and 1.4 present results for girls and boys, respectively: columns (1) contain ordinary least squares estimates of a basic specification, which excludes cognitive ability and time allocation of the mother; columns (2) incorporate cognitive ability; columns (3) add labor hours and time devoted to sedentary and non-sedentary activities; and, columns (4) contain two stage least squares (2SLS) to account for potential endogeneity of maternal labor supply, using same specification as (3) but excluding regional dummies to avoid collinearity with state-level identifying instruments. Identifying instruments for maternal labor supply are mother's age[33], median community working hours and labor participation of men and women, and state dummy variables.

[33] Mother's age does not seem to belong into the overweight equation, in none of the specifications was found to be economically or statistically significant when directly introduced—results not presented.

Table 1.3. OLS and two-stage least squares results for girls.

Dependent variable: OVERWEIGHT	(1)	(2) OLS	(3)	(4) IV [7]
Child:				
Age	0.012	0.020	0.028	0.029
	(0.042)	(0.042)	(0.044)	(0.044)
Age squared	0.001	0.000	-0.000	-0.000
	(0.003)	(0.003)	(0.003)	(0.003)
Mother:				
BMI	0.017	0.017	0.016	0.016
	(0.002)***	(0.002)***	(0.002)***	(0.002)***
BMI*Dummy if pregnant or breastfeeding	-0.001	-0.001	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Education	0.009	0.008	0.007	0.008
	(0.003)***	(0.003)**	(0.004)**	(0.004)**
Cognitive ability		0.009	0.009	0.009
		(0.004)**	(0.004)**	(0.004)**
Labor Hours			-0.000	-0.003
			(0.001)	(0.002)
Non-sedentary (Activities in hours)			-0.000	-0.000
			(0.000)	(0.000)
Sedentary (Activities in hours)			0.000	-0.000
			(0.001)	(0.001)
Household:				
Siblings	-0.042	-0.041	-0.045	-0.042
	(0.011)***	(0.011)***	(0.011)***	(0.011)***
Father at home	0.006	0.006	0.005	-0.026
	(0.023)	(0.024)	(0.025)	(0.037)
Agricultural [1]	-0.032	-0.029	-0.029	-0.031
	(0.024)	(0.025)	(0.026)	(0.026)
Total Income	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Community:				
Median BMI of males [2]	0.021	0.021	0.019	0.017
	(0.009)**	(0.009)**	(0.009)**	(0.009)*
Median BMI of females [2]	-0.015	-0.016	-0.012	-0.013
	(0.007)**	(0.007)**	(0.008)	(0.008)*
Median years of schooling (mothers)	0.008	0.008	0.004	0.004
	(0.007)	(0.007)	(0.008)	(0.008)
Median years of schooling (fathers)	-0.002	-0.002	0.001	0.001
	(0.007)	(0.007)	(0.008)	(0.007)
Median family income [3]	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)

Table 1.3. (cont'd).

Dependent variable: OVERWEIGHT	(1)	(2) OLS	(3)	(4) IV [7]
Proportion of agricultural households	0.012	-0.005	0.018	-0.011
	(0.081)	(0.081)	(0.086)	(0.085)
Median snacks and sugar [4]	0.005	0.006	0.006	0.007
	(0.012)	(0.012)	(0.012)	(0.011)
Median animal origin [4]	0.001	0.001	0.000	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Median soft drinks [4]	0.006	0.005	0.006	0.003
	(0.005)	(0.005)	(0.005)	(0.005)
Region and population size [5,6]:				
Northwest region	-0.040	-0.042	-0.048	
	(0.036)	(0.036)	(0.037)	
Northeast region	-0.003	-0.008	0.002	
	(0.038)	(0.038)	(0.039)	
Central-west region	0.009	0.011	0.012	
	(0.032)	(0.032)	(0.033)	
Central region	0.022	0.020	0.024	
	(0.031)	(0.031)	(0.032)	
Population > 100,000	-0.003	-0.014	-0.013	0.004
	(0.040)	(0.040)	(0.041)	(0.041)
Population 15,000 - 100,000	0.046	0.039	0.028	0.041
	(0.046)	(0.046)	(0.049)	(0.049)
Population 2,500 - 15,000	0.020	0.022	0.030	0.051
	(0.037)	(0.038)	(0.040)	(0.039)
Constant	-0.611	-0.642	-0.674	-0.513
	(0.253)**	(0.255)**	(0.263)**	(0.267)*
R-squared	0.10	0.10	0.10	0.09
Observations	2,051	2,017	1,887	1,887

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

[1] Dummy indicating if occupation of household head (or other member) is agriculture.

[2] Calculated at the community level considering only adults 25 to 50 years old, by sex.

[3] Median household total income at the community level.

[4] Median % of expenditure on each food type.

[5] Dummy variables with baseline: South region.

[6] Dummy variables with baseline: Community with population < 2,500 (officially considered as rural).

[7] Identifying instruments for maternal labor supply: mother's age, labor characteristics in community (median working hours at community level for men and women, labor participation at community level for men and women), state dummy variables.

Table 1.4. OLS and two-stage least squares results for boys.

Dependent variable: OVERWEIGHT	(1)	(2) OLS	(3)	(4) IV [7]
Child:				
Age	0.088	0.090	0.083	0.079
	(0.041)**	(0.041)**	(0.043)*	(0.043)*
Age squared	-0.004	-0.004	-0.004	-0.004
	(0.003)	(0.003)*	(0.003)	(0.003)
Mother:				
BMI	0.009	0.009	0.009	0.009
	(0.002)***	(0.002)***	(0.002)***	(0.002)***
BMI*Dummy if pregnant or breastfeeding	-0.004	-0.004	-0.003	-0.003
	(0.001)***	(0.001)***	(0.001)***	(0.001)**
Education	0.009	0.007	0.007	0.006
	(0.003)***	(0.003)**	(0.003)**	(0.003)*
Cognitive ability		0.004	0.005	0.005
		(0.003)	(0.004)	(0.004)
Labor Hours			0.001	0.003
			(0.000)	(0.002)*
Non-sedentary (Activities in hours)			-0.000	-0.000
			(0.000)	(0.000)
Sedentary (Activities in hours)			-0.001	-0.000
			(0.001)	(0.001)
Household:				
Siblings	-0.028	-0.027	-0.030	-0.033
	(0.010)***	(0.010)***	(0.010)***	(0.011)***
Father at home	0.044	0.042	0.061	0.091
	(0.023)*	(0.023)*	(0.024)**	(0.032)***
Agricultural [1]	-0.014	-0.013	-0.009	-0.014
	(0.025)	(0.025)	(0.026)	(0.026)
Total Income	0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Community:				
Median BMI of males [2]	0.018	0.019	0.023	0.026
	(0.009)*	(0.009)**	(0.010)**	(0.009)***
Median BMI of females [2]	-0.007	-0.008	-0.009	-0.011
	(0.007)	(0.007)	(0.008)	(0.007)
Median years of schooling (mothers)	0.016	0.016	0.019	0.017
	(0.007)**	(0.007)**	(0.007)**	(0.007)**
Median years of schooling (fathers)	-0.009	-0.007	-0.013	-0.013
	(0.007)	(0.007)	(0.007)*	(0.007)*
Median family income [3]	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)

Table 1.4 (cont'd).

Dependent variable: OVERWEIGHT	(1)	(2)	(3)	(4)
		OLS		IV [7]
Proportion of agricultural households	0.119	0.123	0.104	0.112
	(0.082)	(0.082)	(0.084)	(0.080)
Median snacks and sugar [4]	0.003	0.003	0.005	0.008
	(0.011)	(0.011)	(0.012)	(0.011)
Median animal origin [4]	-0.000	-0.001	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Median soft drinks [4]	-0.006	-0.005	-0.004	-0.004
	(0.005)	(0.005)	(0.005)	(0.004)
Region [5] and population size [5,6]:				
Northwest region	0.000	0.000	-0.010	
	(0.038)	(0.038)	(0.039)	
Northeast region	-0.037	-0.042	-0.051	
	(0.035)	(0.035)	(0.036)	
Central-west region	-0.008	-0.004	-0.018	
	(0.031)	(0.032)	(0.033)	
Central region	-0.020	-0.016	-0.021	
	(0.032)	(0.032)	(0.033)	
Population > 100,000	0.038	0.034	0.038	0.036
	(0.037)	(0.037)	(0.038)	(0.039)
Population 15,000 – 100,000	0.005	0.011	0.011	-0.003
	(0.040)	(0.040)	(0.042)	(0.042)
Population 2,500 - 15,000	0.032	0.036	0.036	0.034
	(0.037)	(0.037)	(0.039)	(0.039)
Constant	-0.875	-0.888	-0.862	-0.927
	(0.263)***	(0.264)***	(0.275)***	(0.272)***
R-squared	0.06	0.06	0.06	0.05
Observations	1,947	1,917	1,796	1,796

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
[1] Dummy indicating if occupation of household head (or other member) is agriculture.
[2] Calculated at the community level considering only adults 25 to 50 years old, by sex.
[3] Median household total income at the community level.
[4] Median % of expenditure on each food type.
[5] Dummy variables with baseline: South region.
[6] Dummy variables with baseline: Community with population < 2,500 (officially considered as rural).
[7] Identifying instruments for maternal labor supply: mother's age, labor characteristics in community (median working hours at community level for men and women, labor participation at community level for men and women), state dummy variables.

Variables affecting the probability of being overweight are almost the same for girls and boys, but some distinctive features are observed. Own age has a positive effect only for boys (approximately, 0.08-0.09), i.e. older boys are more likely to be overweight, but such effect becomes weakly significant as mother's time allocation variables are included and labor hours are treated as endogenous; additionally, there is no much evidence of non-linearity of age.

Mother's BMI has positive effects for both girls and boys that are robust and strongly significant across specifications: the probability of being overweight increase by 0.09 and 0.05, for girls and boys, respectively, if mother's BMI rises by 5 points. In the case of boys, if mother is pregnant or breastfeeding the effect of maternal BMI decreases a little—the effect is 0.03. The effect of mother's education is positive and similar for girls and boys (between 0.021-0.027 for every three additional years of schooling), but it becomes slightly smaller and weakly significant for boys when labor supply is considered as endogenous. Maternal cognitive ability is important only for girls, when included, it practically does not affect education estimated coefficient; moreover, its sign and magnitude is comparable to that of education. Neither labor supply nor time allocation to other activities have effects on girls. In the case of boys, there is only weak evidence of a positive effect of labor hours, which is found when maternal labor supply is treated as endogenous: a ten hour/week rise in the supply of mother's labor increases by 0.03 the probability for a boy of being overweight.

Among the household characteristics that may influence the likelihood of overweight, number of siblings is important for both girls and boys; it remains robust, slightly increases for boys, significant across specifications, and a little larger for girls than for boys—the presence of an additional child at home reduces the probability of being overweight by 0.04 for girls and 0.03 for boys. The presence of father at home affects boys but not girls; this effect grows and becomes more significant across specifications, the presence of his father increases the probability of a boy being overweight by 0.09. This result may well be associated with the "preference" of fathers for their sons and/or the "transmission" of habits and lifestyle from fathers to sons. Interestingly, there is no evidence suggesting that household income is important either economically or statistically. The household being agricultural has the expected negative sign; however, this is not statistically significant in any case.

At the community level median BMI of adult males has positive effects for both girls and boys (0.10 and 0.10-0.15, respectively, for every 5-point increase in median BMI), which become weakly significant for girls but more significant and larger for boys. However, median BMI of adult females is negatively correlated only with girls' probability of being overweight, becoming not or weakly significant and smaller across specifications (from -0.10 to -0.05, for every 5-point increase in median BMI). Education of parents at the community level has ambiguous effects only for boys, the effect of median years of schooling of mothers is robust and positive across specifications (about 0.06 for 3 additional years of schooling); however, this is not the case of median years of schooling of fathers, which is negatively and weakly correlated with the probability of boys being overweight (approximately -0.04 for 3 additional years of schooling). There is no evidence of dietary-cultural habits being important, as none of the community-level food expenditures (median proportion spent in each food type relative to total food expenditure) is found to be significant. No effects of income or agricultural-type are obtained at the community level, just as in the case of the household. Finally, neither the regional variables nor the size of the community are found to have a significant influence on children's probability of being overweight.

First stage results are in Table 1.5, providing a fairly good support for identifying instruments. Mother's age and state dummies are weakly significant at the 10% level in the first stage for boys and only men labor participation is significant in the case of girls. Taken altogether instruments seem to be doing well especially in the absence of prices, which in principle would provide a much better set of identifying instruments.

Table 1.5. Identifying instruments first stage results.
Dependent variable is mother's labor hours.

	(1) Boys	(2) Girls
Mother's age	-0.113	-0.030
	(0.073)	(0.074)
Community labor characteristics		
Median labor hours of women	0.164	0.001
	(0.071)**	(0.063)
Women labor participation	38.057	36.066
	(5.285)***	(5.055)***
Median labor hours of men	0.036	0.132
	(0.158)	(0.137)
Men labor participation	9.604	17.811
	(8.973)	(8.752)**
F Test	17.30	18.19
	[0.000]	[0.000]
State dummies (F Test)	1.65	1.85
	[0.056]	[0.024]
All variables F Test	6.33	6.10
	[0.000]	[0.000]
R-squared	0.19	0.24
Observations	1,796	1,887

Robust standard errors in parentheses. P-values in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%

1.6. Conclusions

This paper examines overweight in Mexican school children. The motivation arises from: (i) the increase in prevalence of overweight that has been observed in recent years among Mexican population; and, (ii) the little attention that school age children have been given—relative to preschoolers and infants—by nutrition and health national surveys in Mexico[34]. Evidence I present here supports the growth in the prevalence of overweight among school children; moreover, evidence suggests that Mexican children are heavier than before as observed by the right-shifts of the BMI distributions.

I develop a simple theoretical model to portray the mother's behavior when allocating food and time and to provide insights into the relationships between maternal nutritional choices, in terms of monitoring time and food, and child's weight. Basic predictions suggest that an increase in wages for women, which may be interpreted as increasing market opportunities for mothers and higher labor force participation/supply, have a positive effect on children's weight. It also suggests a negative relationship between food prices and weight, implying that a decrease in food prices that may translate into reduced price of calories would contribute to increasing children's weight. Using this model, I obtain a demand for weight adequacy of the child and estimate a linear approximation of its reduced form.

Risk of overweight in Mexican children has been positively associated with, among other factors, maternal education, socioeconomic status, and fewer siblings. Economic studies identify the growth of mother labor supply as being a plausible cause of increasing overweight in American children and adolescents. My results tend to confirm

[34] This group has been incorporated into nationally representative surveys of nutrition and health since 1999.

these findings and provide evidence of maternal BMI and BMI of adults at the community level influencing the probability of school children being overweight, effects that are difficult to disentangle between genetic and environmental factors, although the negative sign of median BMI of females in the girls' estimation may be pointing to some environmental effects. In sum, I obtain some clues into what might be possible contributing factors to the growth in prevalence of overweight among school children: (i) increase mother's BMI, specially for girls; (ii) an increase of maternal labor supply in the case of boys; (iii) increasing adult males BMI at a community level; and (iv) possibly an increase in father's BMI or sedentary habits. Future research should investigate the channels through which community level characteristics affect the behaviors of individual children with respect to diet and activity levels.

CHAPTER 2

THE EFFECTS OF MATERNAL SCHOOLING ON CHILD HEALTH: THE CASE OF ANEMIA.

2.1. Introduction

Parental characteristics and behavior are essential inputs into the child health production function, since decisions regarding most aspects of a child's life are believed to be made by her/his parents (see Haveman and Wolfe, 1995; Strauss and Thomas, 1995; Paxson and Waldfogel, 1999; and, Burton, Phipps and Curtis, 2002). Special attention has been placed on characteristics and behavior of the mother due to her role as a caregiver (for example, Thomas et al., 1991; Blau et al., 1996; Glewwe, 1999; and, Handa, 1999). In particular, empirical studies have shown evidence of important effects of maternal education on child health, as well as possible ways or mechanisms through which maternal education affects child health relate (see review by Handa, 1999). Much of this research has used mortality, morbidity, anthropometric, and/or dietary intakes as indicators of child health, with an emphasis on infants and younger children, given the vulnerability of these age groups. In this paper, I examine the effect of maternal education on child health using a biochemical health indicator and concentrating on relatively older children. In particular, I analyze the effects of maternal education on hemoglobin concentrations in blood among school age children.

Hemoglobin is the protein in the red cells that carries oxygen to tissues and organs. The deficiency of hemoglobin in blood is known as anemia. Anemia may be caused by both nutritional and non-nutritional factors. Iron deficiency is the most common of its nutritional causes. The World Health Organization (WHO) estimates that anemia affects 2 billion people around the world and that about 50% of all anemia can be attributed to iron deficiency—iron deficiency anemia or IDA (WHO/UNICEF, 2004).[35].

Prevalence of anemia varies widely among regions and countries. For example, prevalences of anemia and IDA are, respectively, 53% and 39% in Southeast Asia but 9% and 7% in Europe. The prevalence of iron deficiency in Mexico is high compared to the US[36]. According to a recent nationwide nutrition survey (ENN, 1999) prevalence was estimated between 20% and 27% among children (12 or younger). The ENN99 results[37] suggest that prevalence of anemia was 21.1% in women, 27.2% in 6-59 months-old children, and 19.5% in 5-11 years old children. The most vulnerable groups were pregnant, women with a prevalence of 27.8%— jointly with their unborn babies—and 1 to 2 years old children among whom prevalence was 48.9%. Using three different procedures to specifically evaluate iron adequacy[38]—one for recent iron ingestion and two for body reserves—estimated prevalence of iron deficiency associated with anemia were 17.8% (recent ingestion), and 29.7% or 41.4% when measured as body reserves for all children in sample (0-11 years old). Overall, the combined prevalence of "severe" (associated with anemia) and "less severe" (associated with a deficient production of blood cells) iron deficiencies were estimated to be 43% and 55% or 60%, respective to each procedure.

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[35] It is worth noting some delicate distinctions: "In the absence of international agreement on how to assess the iron status of populations, the prevalence of iron deficiency has often been derived from the prevalence of anaemia using measurements of blood haemoglobin concentration. However not all anaemic people are iron deficient and iron deficiency may occur without anaemia." (WHO/CDC, 2005)

[36] Estimates of prevalences of IDA in the US (third National Health and Nutrition Examination Survey, 1988-94) are: (i) 3% in 1-2 years old; (ii) <1% in 3-5 years old; (iii) <1% in 6-11 years old; (iv) 2-5% among non-pregnant females (aged 12 and older); and, (v) <1-2% among adult males (aged 12 and older).

[37] Villalpando et al. (2003) and Shamah-Levy et al. (2003).

[38] Rivera et al. (2001).

For years evidence has revealed that child health and parental education are positively correlated. An extensive appraisal of the literature on market and non-market returns to education by Wolfe and Haveman (2001 and 2002) shows that parental education, mainly maternal, improves child health—as measured by infant mortality rates, birth weight, and vaccination rates. The intergenerational connection between parental inputs and child outcomes that works through parental education has two components[39]: (i) direct, "improvements in the choices and investments made by parents"; and, (ii) indirect, "quality of the human/social capital of the neighbourhoods in which children grow up". Or as Case et al. (2005) assert: "cohort members born into poorer families experienced poorer childhood health, lower investments in human capital and poorer health in early adulthood, all of which are associated with lower earnings in middle age—the years in which they themselves become parents."

The present research contributes to the existing literatures in health, human capital, and developing countries by providing insights into the non-market returns to education and the role mothers play in the etiology of anemia in Mexico. First, my results complement knowledge of the function of mother characteristics as inputs into child nutrition and health production. Maternal education may affect child's health directly or it may interact in different ways with other factors—income, labor supply, access to information, health services, community infrastructure, and/or family background. Second, my estimates also provide information on the full returns to schooling of women. Since in Mexico labor market participation of adult women is relatively low, 49.5% for

[39] Wolfe and Haveman (2001).

25-54 year old women[40], market returns to schooling fail to fully capture the impact of educating Mexican women. Thus, estimates of non-market returns to schooling, e.g. in terms of child health, are needed to correctly assess the potential impact of women's education.

The paper is organized as follows. Section 2.2 presents the conceptual framework, consisting mainly of a review of the literature on two aspects: hemoglobin levels as an indicator of health and nutrition status and the role of maternal education in the production of child health outcomes. The empirical strategy is described in section 2.3. Section 2.4 presents the results. And, Section 2.5 concludes.

2.2. Conceptual framework

2.2.1. Hemoglobin levels as an indicator of nutrition and health

Among the reasons for anemia, iron deficiency is the most common, contributing to 50% of cases worldwide[41-42]. Iron is essential to body functioning because it is necessary for multiple metabolic processes—such as oxygen transport, oxidative metabolism, and cellular growth. Low hemoglobin levels showing anemia due to iron deficiency indicate absence of iron stores, inadequate supply of iron to the bone marrow and other tissues,

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[40] INEGI (Mexican National Institute of Statistics, Geography, and Informatics). Figure is of 2004, may be found in http://www.inegi.gob.mx/est/contenidos/espanol/rutinas/ept.asp?t=mtra06&c=3655.
[41] WHO/UNICEF (2004).
[42] Deficiencies of other micronutrient—vitamin A, riboflavin, folic acid, and vitamin B_{12}—may also contribute to the presence of anemia. Iron deficiency is frequently associated with other deficiencies: "Diets that are low in animal products are low in absorbable iron as well as retinol, riboflavin, folic acid, vitamin B_{12}, and other micronutrients...Intestinal parasites can cause the simultaneous malabsorption of iron, retinol [vitamin A], folic acid, and vitamin B_{12}, as can blood loses due to hookworm infestation." However, most prevalence of anemia in the world is related with iron deficiency (Allen and Casterline-Sabel, 2001). Anemia may have other non-nutritional causes like exposure to infections (e.g. hookworm, schistosomiasis), genetic disorders (e.g. thalassemias) or even lead poisoning (e.g. lead may be found in paint, toys, furniture, plumbing, and soil, among others).

and impaired oxygen delivery.[43] The presence of anemia mostly indicates "both functionally significant tissue iron deficiency and impaired oxygen delivery" (Lynch and Green, 2001). Even if anemia is present without iron deficiency, it might still be related to deficiencies of other micronutrients and indicative of potential or actual ill-health[44].

Anemia may produce symptoms such as fatigue, weakness, decreased appetite, headache, and shortness of breath, among others.[45] In the case of school-age children[46], anemia may impair physical growth, ability to fight infections, and development of motor and learning capacities, and may also reduce physical performance.[47] Moderate forms of anemia may reduce endurance—i.e. increase time a person takes to complete a task—and even mild iron deficiency without anemia may decrease work capacity and immune response (Passi and Vir, 2001). As a result school functioning declines, with potential negative effects on future accumulation of human capital and productivity. For example, Horton and Ross (2003) provide an extensive review of the evidence on effects of iron deficiency and anemia on children's cognitive development and adult productivity, as well as calculations of annual losses in physical productivity due to iron deficiency using data from ten developing countries.

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[43] "The earliest evidence of iron deficiency is the absence of iron stores...[with] no functional consequences, but there are not iron reserves to meet physiological or pathological requirements...[Early functional iron deficiency consists of] a suboptimal rate of iron delivery to the bone marrow and other tissues although there is no detectable anemia...[The] final stage is characterized by a decrease in functional iron with an onset of anemia and its associated clinical symptoms (iron deficiency anemia)." (Lynch and Green, 2001)

[44] However, "[unlike] deficiencies of vitamin A, folic acid, and vitamin B_{12} ..., functionally significant tissue iron deficiency does not appear to occur in the absence of anemia." (Lynch and Green, 2001)

[45] But symptoms may not show if anemia is mild (see Medline Plus http://www.nlm.nih.gov/medlineplus/ency/article/000584.htm).

[46] Thomas (2001) provides a useful and comprehensive discussion about the relationship among labor productivity and hemoglobin concentrations and iron stores.

[47] WHO/UNICEF (2004) and Passi and Vir (2001).

Indicators typically used to estimate the effects of different inputs into the production of child health are height for age, weight for height, body mass index, birthweight, parental reports of child health status and mortality. Hemoglobin levels have been mainly used for evaluation of health interventions that provide micronutrient supplementation and/or deworming drugs. For example, Thomas et al. (2004) present evidence from an experimental setting in Indonesia, finding that males treated with iron supplements improved their physical, psycho-social health, and productivity; for those self-employed, earnings rose significantly. Bobonis et al. (2004) find that weight and school participation increased substantially among 2-6 year old children supplemented with iron and deworming drugs in India. Using results from health interventions carried out in Indonesia, Thailand, Egypt, and Guatemala, Pollitt (1997) finds evidence that suggest that IDA constitutes a risk factor for poor educational performance of school age children. To my knowledge there are few works that analyze socioeconomic factors associated with anemia and hemoglobin concentrations—Bhattacharya et al. (2002 and 2004) using US data and Villalpando et al. (2003) using Mexican data.

Health indicators are likely correlated.[48] Height is closely associated with hemoglobin concentrations due to its importance for child growth, as iron deficiency anemia contributes to growth retardation. Hemoglobin and weight relate intimately through nutrition and diet quality.[49] Stunting, wasting, and anemia are all essential indicators of different types of malnutrition. While wasting and anemia occur due to energy-protein

[48] "Children suffer from anemia, either as a result of low iron intakes or poor absorption, or as a result of illness. Severe protein-energy malnutrition and vitamin B12/folate deficiency can also lead to anemia." (Alderman et al., 2003).

[49] It is worth noting that anemia may be caused by lead poisoning and genetic disorders. But as pointed out above iron deficiency is its most common cause.

and/or micronutrient malnutrition, stunting may be the result from a cumulative effect of either or both types of malnutrition. Such correlations are not perfect (e.g. an individual may be anemic but show no signs of nutritional problems in terms of height/weight; or an individual may be stunted/wasted due to other causes than anemia) and, given data availability, a more complete assessment should probably analyze them together (e.g. Ghuman et al., 2005).

The most recent nationwide nutrition survey in Mexico (ENN, 1999) reveals the existence of high rates of anemia among children; prevalence was estimated to be between 20 and 27%. Estimates of micronutrient ingestion from ENN-99 24-hour recall data reveal that iron ingestion by Mexican children (0-11 years old) is 32% to 58% of adequacy recommendations; 61% to 80.8% in the case of the school age group (5-11 years old); and for preschoolers (12-59 months old) median iron adequacy is between 23% and 56.5%.[50]. Authors of this survey suggest that at least part of the explanation is diet: consumed foods mainly either supply non-heme iron (found in vegetables, legumes, and cereals), which is more difficult to absorb than heme iron (found in meat), or, particularly in rural areas, contain substances that inhibit iron absorption. Since for children dietary decisions take place mostly at home and for Mexican children, in particular, such decisions are made mainly by mothers, a most pertinent matter seems to be the role of a mother in the production of hemoglobin level of her child. Given that anemia of school age children has received little attention relative to preschoolers and

[50] Children aggregate figures by Rivera et al. (2001) and age-group figures by Villalpando et al. (2003).

women of fertile age[51], and due to the importance of an adequate level of hemoglobin both in the physical and cognitive development of children aged 5 to 11—not only infants and younger ones.

Using data from the ENN-99, Villalpando et al. (2003), surprisingly find that more educated mothers have children with smaller concentrations of hemoglobin. After controlling for anthropometric indicators (height for age or weight for height), sex, socioeconomic levels, whether household is indigenous, intake of dietary supplements, beneficiary of food assistance programs, and altitude, they obtain a negative effect of maternal education (one additional year has a 7% decrease on hemoglobin levels) for 2-years or older children, but not for younger children (<2 years old). This result is intriguing because one would expect ceteris paribus that more educated mothers have healthier children, unless they work more and monitor their child's diet less. Several drawbacks may be causing such a result, including the omission of maternal labor; the possible bias that arise from a simultaneity or/and ambiguous causality on the production of hemoglobin levels and other nutrition outcomes as height and weight; and, "overcontrolling", i.e. the analysis controls for dietary supplements, food assistance benefits, and anthropometric indicators, all of which are avenues through which maternal education effects might operate. Considering these and other concerns discussed below, I obtain new results about the effects of maternal education on hemoglobin levels and anemia using data drawn from Mexican Family Life Survey (MxFLS).

[51] Passi and Vir (2001). Note that, given that most attention—by nutritionists, psychologists, and even economists—has focused on younger children and infants, the works of Horton and Ross (2003) and Pollit (1997) (see above) are particularly relevant.

2.2.2. The role of maternal education in the production of child health outcomes

It is typically believed that children have a minor role when making decisions on allocation of household resources. It is parental behavior and characteristics that are pointed out as major (causal) factors determining health, among other, outcomes of children. In a recent work by Currie and Moretti (2005) evidence suggests the importance of intergenerational transmission of health and income—parent's income would affect child's health, which would in turn affect her/his future income. Researchers have also commonly looked for the paths and mechanisms through which education affects child health, introducing covariates that may be correlated or interacting with education—particularly mother's education—, such as income, household and community characteristics, and parental background and endowments. Literature examining effects of maternal education on child outcomes is very rich; here I review only a small set of this research done since the 1990s.

Table 2.1 contains a summary of these works with information on samples and empirical approaches used by the authors. Strauss (1990) finds positive and jointly significant effects of mother's and father's education on weight for height and only a positive maternal education effect on height. He finds that community characteristics are important as measured by health environment and quality of health infrastructure. Thomas et al. (1991), in Brazil, find evidence that access to information (newspapers, television, and radio) explains most of the effect of maternal education on child height. In urban areas, semi literate status of the mother accounts for some of the education effect.

Table 2.1. Selected studies on the effects of maternal education since the 1990s.

Author	Sample	Indicator	Results	Empirical Strategy
Strauss (1990)	The Côte d'Ivoire Living Standards Survey Under 6 yrs	Height for age and weight for height	Positive and jointly significant effects of m. education and f. education on weight for height; positive m. education effect on height. Community characteristics are important: health environment and quality of health infrastructure. Evidence of strong effects of intra-household distribution.	Household and mother FE. Household RE. Interaction with community variables: distance to services. Predictions of indicators for representative household effects of exchanging parental and hh characteristics with child age/sex constant. Mother's height used directly and father's for a smaller sample.
Thomas et al. (1991)	Pesquisa Nacional de Saude Materno-Infantil e Planejamento Familiar. (Brazil: 1986). 6 months-5 yrs	Height for age	Indicators of access to information (newspapers, television, and radio) explain most of the effect of maternal education. In urban areas, semi literate status of the mother accounts for some of the education effect. Substitutability between m. education and community services.	(1) OLS with and without income; (2) 2SLS procedures to instrument for income and indicators of access to information; and, (3) OLS to estimate effects community covariates: direct inclusion and with/without interactions with m. education.
Kassouf and Senauer (1996)	Brazilian National Health and Nutrition Survey (1989) 2-5 yrs	Height, weight for height, and weight for age	Parental education direct and indirect effects via wages and full income. Only education of 4-8 years has a significant direct effect; higher levels have larger but indirect effects. Negative effect of wages (parents' value of time), while positive and predominant effect of full income.	OLS: use parental heights as proxies for genetic and background; education categories instead of years; other covariates as comm. characteristics and regions. Produced policy simulations of direct and indirect effects of education.

Table 2.1. (Cont'd).

Author	Sample	Indicator/Age	Results	Empirical Strategy
Desai and Alva (1998)	Demographic and Health Surveys (22 countries) 12-36 months and 12-60 months	Infant mortality, height for age immunization	Maternal education has a significant positive effect on all indicators, but its effect is reduced on height and mortality when accounting for socioeconomic and community characteristics.	OLS, logit and community FE. Other independent variables: child's age, urban residence, father's education, mother w/o partner, and water and toilet (not present in FE).
Glewwe (1999)	Enquête Nationale sur le Niveau de Vie des Menages (Moroco: 1990-91) Under 5 yrs	Height for age	Skills: math, languages, and health knowledge absorb all the effect of formal education. Health knowledge shows as the most important skill acquired indirectly (through literacy and numeracy) obtained in school.	(1) OLS and community FE; (2) 2SLSFE, endogenous: income and skills (math, languages, and health knowledge); (3) Decomposition of the effect of m. education on child health. Education used both directly in estimation and as an instrument. Direct use of parental height to account for unobserved endowments.
Variyam et al. (1999)	Continuing Survey of Food Intakes by Individuals and Diet and Health Knowledge Survey (USA: 1989-91) 2-17 yrs	Dietary intakes	Maternal education influences children diet through health and nutrition knowledge; but this effect decreases as children age. Support the idea that education improves efficiency of health input allocation.	Latent variable estimation for health and nutrition knowledge. Introduction of mother's labor participation status: not, part, full employed.

Table 2.1. (Cont'd).

Author	Sample	Indicator/Age	Results	Empirical Strategy
Reed et al. (1996)	Cross-sectoral survey of the District of Ouidah (Benin: 1990) 13-36 months	Weight for age	Effects of low maternal education (< 5 years) differ across socioeconomic levels: low, flat non-significant; intermediate, positive significant; high, weakly positive. For higher m. education, a negative effect on child health.	One-way ANOVA tests to compare child and mother characteristics among socioeconomic groups. OLS with interactions between education level and socioeconomic group (univariate).
Handa (1999)	Jamaican Survey of Living Conditions (1989) Under 5 yrs	Height for age	Maternal education independent of income. Evidence of interactions between m. education and access to television and private doctors, and of substitutability with sanitation services at home. It is correlated with unobserved heterogeneity, presence of father and position of mother in hh.	OLS: with and without income to account for possible income effect. IV: income treated as endogenous. FE: account for unobserved heterogeneity. Controls for effects of house facilities: directly and through interactions; intrahousehold effects: education of other woman at home; and, bargaining: presence and position of mother in hh.
Rubalcava and Teruel (2004)	Mexican Family Life Survey (2002) 0–17 yrs	Height for age	Maternal cognitive ability has a positive effect on child health, which diminishes when controlling for mother's height. Returns to education decrease when controlling for mother's observable childhood endowments.	OLS, 2SLS, and mother and community FE. Identifying instruments: mother's background variables. Use total expenditure instead of hh income. Include mother's height directly into regression.

They also find evidence of substitutability between maternal education and community services. Glewwe (1999) studies possible mechanisms of influence in Morocco, finding that skills—math, languages, and health knowledge—absorb all the effect of formal education. Particularly, it is health knowledge which shows as the most important skill acquired indirectly, through literacy and numeracy, in school. Using Jamaican data, Handa (1999) provides a rich analysis of possible mechanisms through which maternal education affects child height: income effects, interactions with household and community characteristics, information processing, unobserved household heterogeneity, and bargaining power. He finds evidence of mother's education having an effect independent of income, of complementarities between maternal education and access to television and private doctors, and of substitutability with respect to house sanitation services. He also finds maternal education is correlated with unobserved heterogeneity, and that intrahousehold effects and bargaining are important in the form of presence of father and position of mother in household.

Kassouf and Senauer (1996) analyze the direct effect of parental education and its indirect effects via wages and full income on three anthropometric measures—height, weight for height, and weight for age—for Brazilian children. They find positive direct effects, negative small indirect wage effects, and large positive indirect full income effects on weight for age and weight for health. Total effects are positive and larger as education increases. Variyam et al. (1999) study the effect of maternal nutrition and health knowledge on dietary intakes of children 2-17 years of age in the US. They find that maternal knowledge influences children's diet especially for preschool children. However, this effect becomes weaker for older children (> 5 years old). Rubalcava and

Teruel (2004) examine the effect of different sources of maternal human capital—schooling, cognitive ability and childhood background—on child health measured in terms of height using data drawn from MxFLS1. Thus, their work provides a reference for the analysis I present here. They find that maternal cognitive ability has a positive effect on child health, which diminishes when controlling for mother's height. They also provide evidence of returns to education decreasing when controlling for mother's observable childhood endowments.

A further concern is that child characteristics may influence how resources are in fact allocated within the household[52]—e.g. if a child is sick, a working mother could decide to stop working or work fewer hours to take care of him/her, or else start working or work more hours to be able to pay for the expenses of her sick child. Reed et al. (1996) finds that the effects of maternal education (less than 4 years of formal schooling) are non-linear across "socio-environmental status"—which, besides socioeconomic status of a household, includes economic, ecologic and infrastructural characteristics at a village level—in rural Benin. At higher levels of education this relationship becomes negative, suggesting a possible association between higher education and labor market participation, according to the authors. Variyam et al. include mother's labor participation status (not, part, and full employed), finding that total and saturated fat intakes decrease if mother is not employed or part-time employed as compared to being full-employed, but only for school-age children. Effects of employment status for preschoolers seemingly occur through maternal nutrition and health knowledge, while school children are more affected directly by time allocation of mother.

[52] Burton et al, (2002) also discuss how parental behavior may be affected by their children's behavior.

While some researchers have recognized and accounted for the endogeneity of mother's labor participation and supply[53], maternal education has been mostly treated as exogenous. However, Desai and Alva (1998) argue that education acts as a proxy for socioeconomic status of a family and area of residence. They examine data from the Demographic and Health Surveys for 22 developing countries and find that a causal relationship between mother's education and child health has not really been established because as other household and community-level characteristics are introduced the effects of maternal education mostly become statistically insignificant. This provides evidence indicating that mother's education may be correlated with other factors that could influence her decisions and behavior towards her child's health. Thus, even after controlling for household and community characteristics, there could be unobservables correlated with both maternal education and child health, such as mother's genetics and/or early life constraints that may also have affected her educational attainment. The next section contains the empirical strategy I follow to account for these issues.

2.3. Empirical strategy

2.3.1. Model

The estimation follows from an application of the household production function by Berhman and Deolalikar (1988) to the case of child health and nutrition. Household

[53] Blau et al. (1996) examine the relationship between mother's labor supply, infant feeding, and infant health. They find that after accounting for possible endogeneity there is little evidence of direct causal effects of mother's labor supply on weight and height of infants in the Philippines, but that mothers with higher wages have healthier children. Glick and Sahn (1998) investigate the effect of mother's labor supply and income in preschool children of Guinea. After accounting for possible labor supply endogeneity, they find that in average positive effects of labor income on children height are offset by large negative effects of labor supply.

(parental) optimization, under normal conditions, leads to a reduced form demand for health of child i:

$$H^{\bullet}_{i} = H(p, w, Y; \mu_{i}, \mu_{h}, \mu_{P}, \mu_{C}) \tag{2.1}$$

where p is the price of a market composite-good C, w is the wage rate and Y is the household non-labor income; μ_i, μ_P, μ_h, and μ_C: are observed and unobserved technology parameters determined by characteristics of member/child, parents, household, and community, e.g. sex, age, endowments, background. For empirical estimation some points should be considered:

(i) Prices are not directly observed, but to account for price variation across communities, I use expenditures on five food items as percentages of total food expenditures. I expect that these variables in part reflect price differentials across local food markets rather than wealth effects, since I also control for household income and community level infrastructure. I calculate expenditure variables at a household level and then use the community-level median as price proxies in the empirical estimation.

(ii) Parental labor income not only translates into more household resources but also may translate into less time available to spend in non-labor activities, e.g. child monitoring and care. Ideally mother's wages would capture market vs. non-market decisions, however, wages are not observed for mothers not participating in the labor market—approximately 60% of mothers of school-age children in sample. Therefore, I use labor supply to account for the effect of maternal labor decisions. Concerns of possible endogeneity naturally rise, for example, a mother may choose to work, stop working, or work less in the market due to her child's health condition. I discuss this issue below and explicitly deal with it in my empirical procedure.

(iii) Labor and non-labor incomes are collapsed into total household income.

(iv) Since μ_i, μ_P, μ_h, and μ_C are not fully observed I include observable characteristics, such as age and sex of child, mother's education, presence of father, and community characteristics.

Let vector X contain all observable characteristics—individual, parental, household, and community—and $\mathbf{\upsilon}$ include all unobservables, so the determinants of μ_i, μ_P,μ_h, and μ_C may be reclassified into two categories: observed and unobserved. Then, using these criteria, I rewrite equation (2.1):

$$H^*_i = H(\boldsymbol{X};\boldsymbol{\upsilon}) \tag{2.2}$$

where X contains child, parental, household, and community (observable) characteristics, and $\boldsymbol{\upsilon}$ stands for all unobservable heterogeneity that may be thought of as being captured by a random error term. Now, consider a linear approximation of (2.2):

$$H = \beta_0 + \beta_i \mathbf{X}_i + \beta_m \mathbf{X}_m + \beta_h \mathbf{X}_h + \beta_c \mathbf{X}_c + \boldsymbol{\upsilon} \tag{2.3}$$

where $\boldsymbol{X_i}$, $\boldsymbol{X_m}$, $\boldsymbol{X_h}$, and $\boldsymbol{X_c}$ are vectors containing child's, parent's, household, and community variables, respectively. $\boldsymbol{X_i}$ consists of age and sex; $\boldsymbol{X_m}$ includes maternal education, cognitive ability (CA), and labor supply. Mother's education serves as both an indicator of maternal nutrition and health knowledge and as a proxy of socioeconomic status even for non-working mothers—more educated mothers are likely to belong to relatively wealthier households. In its former interpretation, education may act through direct channels if nutrition and health knowledge are in fact acquired at school and through indirect channels by providing skills that women use when investing in their children's health. Unobserved skills are believed to bias returns to schooling; one of its forms, CA, may be considered as an innate or an acquired ability or both[54], affecting educational performance and attainment. To overcome this omitted variable problem, I use Raven Test Scores as a proxy for CA. Labor supply provides both an inverse proxy for available time devoted to activities that promote child's health (Glick and Sahn, 1998) and an indicator of labor market opportunities.

Household-level variables in $\boldsymbol{X_h}$ include number of siblings, total income, and whether main labor activity of head of household is agriculture. Number of siblings may affect availability of nutrition resources *per* child and therefore her/his health. Instead of including father's characteristics I include a dummy variable indicating whether father is at home, since about 20% of children in the sample do not live with their fathers. I include a dummy variable indicating whether the child lives in a household where the head works in agricultural activities—22% of sampled children—which also serves as an indicator of rural households. $\boldsymbol{X_c}$ includes community median food expenditure (%) on different types of food to account for dietary/cultural differences between communities. It also includes community infrastructure and services—sanitary services, health services,

[54] "It is not clear that innate ability can be measured: any test that claims to do so (in the sense of measuring a genetic endowment) almost always reflects environmental factors (American Psychological Association, 1995)" in Glewwe and Kremer (2005).

and access to information. Since the higher the altitude the less oxygen pressure and the higher the hemoglobin level of an individual, a control for the altitude is necessary. Unfortunately, due to data availability I do not observe community-level altitude, so I have to use the average altitude at the municipality level—the average altitude across communities in a municipality[55]. State and population size dummy variables capture other effects.

I apply two procedures to estimate (2.3): an ordinary least square (OLS) and a two stage least square (2SLS) to deal with potential endogeneity of education and labor supply. As identifying instruments in the 2SLS estimation, I propose to use mother's background characteristics and current labor environment variables. I use mother's height as a proxy of her genetic endowment and past nutrition constraints, since health investments during childhood are closely associated with investments in education and eventually with schooling attainment. Child health and/or nutrition have been considered and found to be correlated with education outcomes for a long time (Alderman et al., 2001). For example, Strauss and Thomas (1998) review evidence revealing that taller men tend to be better educated and participate more in the labor market; Alderman et al. (2001) find large effects of preschoolers' nutrition on school enrollments in rural Pakistan; and, Miguel and Kremer (2004) find that improvements in current health status, in terms of deworming, reduce school absenteeism in Kenyan children. Mother's family background is proxied by using her birth order with respect to her siblings, which is likely to be related to her school attendance, affecting education attainment, and her current labor participation/supply, through past or lifetime labor decisions. To control for

[55] INEGI: Catalog of States Municipalities, and Localities. Downloaded from http://mapserver.inegi.gob.mx/mgn2k/?c=646.

current labor environment, I use median labor hours of female and women labor force participation at the community level. Additionally, to account for potential cohort and education policy effects, I draw data on the proportion of women who graduated from elementary, secondary and high school in the mother's age cohort and state she lived in at 12 years of age from the 2000 Mexican Population Census (INEGI[56]).

Child health has been usually measured by anthropometric indicators; in particular, height (see section 2.2.2), which is a long-run marker of general health and lifetime nutrition. On the one hand, given that hemoglobin concentrations are calculated by using an electronic device that counts hemoglobin from a drop of blood, hemoglobin is less prone to measurement error than it is height, which is obtained by using a height measuring scale. In this sense, measured hemoglobin is a less noisy indicator of true hemoglobin and, thus, of anemia, than measured height is for true height and thus, of general health. On the other hand, it is important to understand better the value of hemoglobin as an alternative way of assessing how maternal education relates to child health, so I compare maternal education estimated effects by using hemoglobin with estimates using height. The idea is to examine how the effects of maternal education on health compare between these two approaches of measuring health. I replicate the estimation of the econometric model using height; I apply the same identifying instruments as in the case of hemoglobin, except mother's height, which enters directly into the regression.

[56] Downloaded from http://www.inegi.gob.mx/est/contenidos/espanol/proyectos/censos/cpv2000/bd/pv2000/pf12.asp?c=5620.

2.3.2. Data

Table 2.2 presents summary statistics of all variables for the sub-sample of school children (ages 5-11 years) who live in households where only mother or both mother and father are present[57]. Average hemoglobin level is 13.2 g/dl with a standard deviation of 1.5. Using critical values proposed by the WHO of 11.0 g/dl for 5-year old and 12.0 for 6-11 year-old children[58], I estimate that 14.5% of girls and 16.4% of boys are anemic. Taken together this is 15.5% of school children in my sample. Considering the sample average and standard deviation of hemoglobin together with critical values of anemia diagnosis, the average child would be anemic if his hemoglobin levels drop by one-standard deviation (i.e. 1.5 g/dl). These children are 8 years old on average and the sample is balanced across genders. On average, mothers are 35 years old, they attained 6.5 years of schooling—slightly more than only elementary school, and obtained 44% of total points in the Raven Test. Forty percent of them participate in the labor market, working a mean of 35.4 hours/week.

On average, there are around 2 children in a household, 80% of the children live with their fathers and 20% live in agricultural households. The largest part of food expenditures goes to that of animal origin (37.5%)—meat, poultry, pork, eggs, and dairy—followed by fruit, vegetables and legumes (23.9%); and cereals, bread and tortillas (17%); and the smallest proportions go to soft drinks and snacks and sugar (3.3 and 2.8%, respectively).

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[57] I use data drawn from the Mexican Family Life Survey (MxFLS-1), described in the introduction section. I exclude children with no parents at home and children living with fathers only, because data on their mothers is not available.

[58] Rivera et al. (2001). Notice that these criteria are for individuals living at the sea level and my estimates are rough, since I do not adjust for altitude.

Table 2.2. Summary statistics

Variable	Mean	Std. Dev.
Child		
Hemoglobin level (g/dl)	13.2	1.5
Girls	0.5	0.5
Age (years)	8.1	2.0
Mother		
Age (years)	34.6	6.8
Education (years)	6.5	4.0
Labor participation	0.4	0.5
Labor hours (weekly hours, if participating)	35.4	19.7
Cognitive ability (point-score Raven Test)	5.3	2.9
Household		
Siblings at home	1.9	0.9
Father at home	0.8	0.4
Total Income (Annual 2002 Mx pesos)	55,723	59,395
Agricultural household	0.2	0.4
Community		
Food (% of total food expenditure)		
Animal origin	37.5	6.3
Fruit, vegetables and legumes	23.9	5.1
Soft drinks	3.3	2.2
Snacks and sugar	2.8	1.0
Cereals, bread and tortillas	17.0	4.6
Infrastructure		
Access to piped water (% of houses)	84	26
Access to drainage (% of houses)	54	41
Access to electricity (% of houses)	92	15
Sanitary services		
Private toilet with drainage	0.56	0.5
Private toilet with moat	0.36	0.5
Toilet shared with neighbors	0.01	0.1
Lake/river	0.01	0.1
Yard/field	0.01	0.1
Other	0.05	0.2
Garbage disposal		
Basket/picked up	0.69	0.5
Burned in house land	0.15	0.3
Burned outside house land	0.07	0.3
River	0.01	0.1
Buried	0.01	0.1
Other	0.06	0.2

Table 2.2. (Cont'd).

Variable	Mean	Std. Dev.
State and population size:		
Baja California Sur	0.03	0.2
Coahuila	0.06	0.2
Mexico DF	0.02	0.1
Durango	0.06	0.2
Guanajuato	0.07	0.3
Jalisco	0.05	0.2
Mexico	0.09	0.3
Michoacan	0.10	0.3
Morelos	0.04	0.2
Nuevo Leon	0.07	0.3
Oaxaca	0.06	0.2
Puebla	0.06	0.2
Sinaloa	0.08	0.3
Sonora	0.07	0.3
Veracruz	0.09	0.3
Yucatan	0.05	0.2
Population > 100,000	0.35	0.5
Population 15,000 - 100,000	0.09	0.3
Population 2,500 - 15,000	0.11	0.3
Population < 2,500	0.46	0.5
Sample size[1]:	4,410	

[1] Children (5-11 years old) living with mother and father or mother only and with data on hemoglobin level.

Access to services in the average community is of 84% piped water, 54% drainage, and 92% electricity; sanitary services are basically private toilet with either drainage (56%) or moat (36%) and garbage is mainly removed in baskets to be picked up (69%)—though in 15% of communities people burn it within their land. Sample distribution among states and community categorized by sized is shown in the second part of table 2; 46% of the children live in rural areas where population size is less than 2,500, 35% live in large cities with more than 100,000 inhabitants; and 20% live in "mid-size" cities (2,500-100,000).

2.4. Results

2.4.1. OLS

Table 2.3 presents OLS estimates of equation (3) using pooled sub-samples of girls and boys. Chow tests in the bottom panel provide support for the pooling assumption. Column (1) reports the basic specification containing mother's characteristics, child's own characteristics, household variables, state and population size dummies—it excludes all community level variables. I incorporate municipality-average altitude in Column 2. In column (3), I include community diet-cultural characteristics. Following the common practice by authors[59], I examine possible mechanisms through which maternal education may work to improve child health, so in columns (4) thru (6), I add community infrastructure—sanitary services and health services—and access to information—time allocation to watching TV—respectively. The OLS results may be summarized as follows:

(i) Maternal education has a positive but small effect on hemoglobin levels (*H*); three additional years of education have an effect of 0.02 standard deviations, and such effect is weak (significant at 10%). When altitude is included the influence of maternal education falls by 27% and becomes statistically insignificant. However, this effect remains stable across specifications; it does not change as variables of food expenditure, infrastructure, or access to information are added.

(ii) Maternal labor supply becomes statistically significant (at 10%) when attitude is included and remains equal throughout columns (2) – (6). This effect is negative and

[59] I partly base on Handa's (1999) approach. In this section, I analyze direct effects of infrastructure and information, below I show results of how education interacts with these variables.

small; a ten-hour increase in weekly labor supply would make hemoglobin level diminish by 0.01 standard deviations.

(iii) Other important results:

- Mother's cognitive ability has an unexpected negative effect, but it is not statistically significant; and, there is weak evidence of older mothers having healthier children.
- There is evidence of older children being healthier than younger ones, which confirms previous findings of prevalence of anemia decreasing with children's age (see Appendix 2, Figure A2.1).
- Effects of number of children in household are weak and negative; an additional child at home would decrease *H* by 0.02-0.03 standard deviations. The presence of father at home becomes negatively associated with better health (in terms of *H*), though statistically insignificant, when controlling for altitude.
- Relative to other ("non-rural") children, those in agricultural households have lower hemoglobin levels, the effect is of 0.15 g/dl less *H*, which is equivalent to one-tenth of a standard deviation; however, this effect disappears when controlling for altitude.
- Wealthier households have healthier children. This effect of income is stable across specifications but small—a one-thousand pesos increase in monthly income leads to an increase of about 0.006 hemoglobin standard deviations. I suspect attenuation bias due to classical measurement error[60].

[60] Note that about 3% of the households in the children sample have a calculated total income of zero even after imputing labor income for those working household members with no information of labor income. Effects of expenditure—results not presented—are smaller (estimates is around 0.006) than those of income (0.009), goodness of fit of specifications using income is slightly better than when using expenditure, so I prefer the former to account for material resources available to household.

Table 2.3. OLS Results. Dependent variable: hemoglobin levels.

	(1)	(2)	(3)	(4)	(5)	(6)
Mother:						
Education	0.011	0.008	0.008	0.008	0.008	0.008
	(0.006)*	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
Labor hours	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.001)	(0.001)*	(0.001)*	(0.001)*	(0.001)*	(0.001)*
Cognitive ability	-0.011	-0.010	-0.010	-0.010	-0.010	-0.010
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Age	0.005	0.006	0.006	0.006	0.006	0.006
	(0.003)	(0.003)*	(0.003)*	(0.003)*	(0.003)*	(0.003)*
Child:						
Sex	0.028	0.032	0.031	0.031	0.033	0.030
	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
Age:[1]						
6 years	0.118	0.129	0.130	0.130	0.135	0.129
	(0.078)	(0.077)*	(0.077)*	(0.077)*	(0.077)*	(0.077)*
7 years	0.233	0.246	0.238	0.237	0.238	0.237
	(0.079)***	(0.078)***	(0.078)***	(0.078)***	(0.078)***	(0.078)***
8 years	0.450	0.461	0.461	0.461	0.462	0.460
	(0.079)***	(0.077)***	(0.077)***	(0.077)***	(0.077)***	(0.077)***
9 years	0.533	0.541	0.538	0.538	0.537	0.538
	(0.078)***	(0.077)***	(0.077)***	(0.077)***	(0.077)***	(0.077)***
10 years	0.594	0.597	0.588	0.588	0.589	0.587
	(0.080)***	(0.079)***	(0.079)***	(0.079)***	(0.079)***	(0.079)***
11 years	0.785	0.784	0.784	0.784	0.787	0.785
	(0.079)***	(0.077)***	(0.077)***	(0.077)***	(0.078)***	(0.078)***
Household:						
Siblings	-0.036	-0.039	-0.041	-0.040	-0.039	-0.041
	(0.024)	(0.023)*	(0.023)*	(0.024)*	(0.023)*	(0.024)*
Father at home	0.019	-0.016	-0.013	-0.012	-0.013	-0.012
	(0.057)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
Total Income[2]	0.009	0.009	0.009	0.009	0.009	0.009
	(0.005)*	(0.004)**	(0.005)**	(0.005)**	(0.005)**	(0.005)**
Agricultural household	-0.151	-0.064	-0.071	-0.072	-0.078	-0.075
	(0.057)***	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)
Community:						
Altitude[3]		0.051	0.048	0.048	0.048	0.049
		(0.005)***	(0.005)***	(0.005)***	(0.005)***	(0.005)***
Food[4]						
Animal origin			0.008	0.008	0.008	0.008
			(0.006)	(0.006)	(0.007)	(0.006)
Cereals[5]			0.000	0.000	0.002	-0.000
			(0.007)	(0.007)	(0.008)	(0.008)
Fruit and vegetables[6]			0.017	0.018	0.019	0.017
			(0.007)**	(0.007)**	(0.007)***	(0.007)**

Table 2.3. (Cont'd).

	(1)	(2)	(3)	(4)	(5)	(6)
Soft drinks			-0.004	-0.003	-0.002	-0.003
			(0.013)	(0.013)	(0.013)	(0.013)
Snacks and sugar			0.087	0.087	0.074	0.083
			(0.029)***	(0.029)***	(0.029)**	(0.029)***
Sanitary services						
Private toilet				-0.042		
with moat				(0.071)		
Shared/outdoors/other[7]				-0.073		
				(0.109)		
Health services[8]						
Public clinic/hospital						
Kms. < 0.2					0.002	
					(0.068)	
Kms. ≥ 0.2 or DK					0.068	
					(0.068)	
Private clinic/hospital						
Kms. < 0.2					-0.185	
					(0.094)**	
Kms. ≥ 0.2 or DK					0.016	
					(0.072)	
Traditional healer or midwife						
Kms. < 0.2					0.022	
					(0.062)	
Kms. ≥ 0.2 or DK					-0.040	
					(0.055)	
Access to information						
TV[9]						-0.005
						(0.006)
State and population size[10,11]						
Baja California Sur	-2.297	-1.180	-1.222	-1.218	-1.190	-1.217
	(0.205)***	(0.226)***	(0.226)***	(0.226)***	(0.230)***	(0.226)***
Coahuila	-1.278	-0.577	-0.598	-0.593	-0.563	-0.577
	(0.180)***	(0.188)***	(0.197)***	(0.197)***	(0.200)***	(0.197)***
Durango	-1.421	-1.065	-1.017	-1.016	-0.986	-1.004
	(0.173)***	(0.176)***	(0.183)***	(0.183)***	(0.188)***	(0.183)***
Guanajuato	-0.931	-0.679	-0.741	-0.741	-0.621	-0.721
	(0.177)***	(0.179)***	(0.182)***	(0.182)***	(0.195)***	(0.183)***
Jalisco	-0.824	-0.256	-0.211	-0.216	-0.174	-0.204
	(0.178)***	(0.183)	(0.184)	(0.185)	(0.192)	(0.184)
Mexico	-0.067	-0.062	-0.100	-0.085	-0.048	-0.104
	(0.169)	(0.171)	(0.172)	(0.172)	(0.181)	(0.173)
Michoacan	-1.067	-0.708	-0.709	-0.684	-0.657	-0.714
	(0.172)***	(0.175)***	(0.178)***	(0.179)***	(0.185)***	(0.178)***

Table 2.3. (Cont'd).

	(1)	(2)	(3)	(4)	(5)	(6)
Morelos	-0.716	-0.150	-0.161	-0.165	-0.097	-0.147
	(0.185)***	(0.190)	(0.195)	(0.195)	(0.203)	(0.195)
Nuevo Leon	-1.562	-0.640	-0.665	-0.665	-0.604	-0.646
	(0.174)***	(0.189)***	(0.203)***	(0.203)***	(0.211)***	(0.203)***
Oaxaca	-1.108	-0.601	-0.565	-0.561	-0.525	-0.577
	(0.173)***	(0.178)***	(0.185)***	(0.185)***	(0.192)***	(0.186)***
Puebla	-1.362	-0.976	-1.046	-1.031	-0.972	-1.050
	(0.175)***	(0.177)***	(0.179)***	(0.180)***	(0.188)***	(0.179)***
Sinaloa	-2.103	-0.911	-0.893	-0.897	-0.777	-0.874
	(0.171)***	(0.198)***	(0.204)***	(0.204)***	(0.214)***	(0.205)***
Sonora	-1.728	-0.591	-0.691	-0.691	-0.626	-0.683
	(0.172)***	(0.196)***	(0.203)***	(0.203)***	(0.214)***	(0.203)***
Veracruz	-1.467	-0.534	-0.692	-0.677	-0.622	-0.689
	(0.168)***	(0.184)***	(0.193)***	(0.194)***	(0.198)***	(0.193)***
Yucatan	-1.933	-0.730	-0.669	-0.630	-0.646	-0.660
	(0.179)***	(0.206)***	(0.216)***	(0.221)***	(0.222)***	(0.216)***
Pop. > 100,000	-0.021	0.008	0.127	0.103	0.134	0.127
	(0.057)	(0.057)	(0.071)*	(0.082)	(0.083)	(0.071)*
Pop. 15,000 - 100,000	-0.249	-0.144	-0.015	-0.045	-0.031	-0.011
	(0.079)***	(0.079)*	(0.089)	(0.103)	(0.097)	(0.089)
Pop. 2,500 - 15,000	-0.185	-0.100	-0.014	-0.040	0.009	-0.011
	(0.069)***	(0.069)	(0.074)	(0.085)	(0.079)	(0.074)
Constant	13.940	12.689	11.756	11.755	11.604	11.795
	(0.217)***	(0.241)***	(0.499)***	(0.500)***	(0.508)***	(0.502)***
R-squared	0.19	0.21	0.22	0.22	0.22	0.22
Observations	4,150	4,150	4,150	4,150	4,150	4,150
Chow test[12]	0.96	0.99	1.11	1.19	1.22	1.12
p-value	[0.464]	[0.509]	[0.707]	[0.807]	[0.837]	[0.724]

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Column (1): basic independent variables.
Column (2): (1) plus mean altitude at municipality level.
Column (3): (2) plus diet variables at community level; median % food expenditure at community level.
Columns (4)-(6): (3) plus sanitary services, health services and access to information, respectively.
[1] Baseline of child's age: 5 years.
[2] Monthly, 2002 Mx pesos.
[3] Average at municipality-level.
[4] % of total food expenditure, median at the community-level.
[5] Includes tortillas and bread.
[6] Includes legumes.
[7] Baseline of sanitary services: Private toilet with drainage. Outdoors may be lake/river or yard/field.
[8] Distance dummy variables, baseline is service not present in community. DK if don't know distance.
[9] Median-community weekly hours that mothers' watch TV.
[10] Dummy variables with baseline: Mexico DF (excludes metropolitan area).
[11] Dummy variables with baseline: Community with population < 2,500 (officially considered as rural).
[12] Tests the pooling assumption. Ho: Each coefficient and constant term is the same for girls than for boys.

- Altitude is positively related to hemoglobin levels as expected and its effect is statistically significant (at 5%), a one-hundred meters increase in average municipality altitude will have an effect of 0.03 standard deviations on hemoglobin level.
- There is some evidence of community dietary habits affecting hemoglobin levels, higher consumption of animal origin food, fruits, vegetables and legumes, and (surprisingly) snacks and sugar, increase *H*.
- At the community level there is no evidence of sanitary services having any statistically significant effect on *H,* however the signs of the estimates show that compared to children in communities where the most used service is private toilet with drainage, children in communities with other types of services would have less hemoglobin levels.
- Among the effects of health services, only relative closer presence of private clinic/hospitals has a statically significant effect on *H*: hemoglobin levels decrease by almost one-eight of a standard deviation in communities with a private clinic/hospital within 0.2 kilometers from the community center.
- Access to information, in terms of community median weekly hours that mothers watch TV, has a negative but small and statistically not significant effect.
- Children living in other states than Mexico DF have considerable lower hemoglobin levels, with estimated effects that range between of one-third and 1.5 standard deviations—-the only exceptions, with not significant effects, are the state of Mexico whose larger municipalities conform the metropolitan area of Mexico City together with Mexico DF—confirming previous observations showing lower prevalence of

anemia in children living in Mexico City (metropolitan area) relative to other regions (see Appendix 2 Figure A2.2). Possible explanations to these could be differences in access and/or quality of health services available in Mexico City and/or the altitude of Mexico City. Actually, once average altitude is controlled for, the effects of state variables fall by half and the effects of other two states, Jalisco and Morelos, disappear (statistically); in addition, when health services are accounted for, state coefficient estimates are the smallest (in absolute terms) of all specifications, particularly those of the states of Mexico, Jalisco, and Morelos have the lowest (not significant) effects. Finally, note that effects of community sizes are ambiguous and significant only in few cases.

2.4.2. 2SLS

As discussed above, unobserved endowments or maternal background correlated with mother's schooling may affect mother's current behavior towards her child, as pointed out by Rubalcava and Teruel. Also, child health may influence maternal work decisions. This is less likely in the case of anemia, which is difficult for mothers to detect. Both of these considerations represent endogeneity problems. Table 2.4 presents results of endogeneity and overidentification tests. The left panel presents results of testing that both education and labor supply are exogenous, and central and right panels contain results of testing that education only and labor supply only, respectively, are exogenous. Evidence suggests that education is endogenous but not labor supply—I cannot reject exogeneity assumption in any case. To some extent this is not surprising, in that maternal labor decisions are more likely to be affected by their children's health problems or diseases that are relatively more evident to mothers, and low hemoglobin levels are not obvious, except maybe when anemia symptoms become a concern to the mother or until the child is medically diagnosed with anemia. In what follows, I relax the assumption that maternal education is exogenous, but keep it for maternal labor supply.

I run overidentification tests in order to verify that the identifying instruments are uncorrelated with the error. Results of these tests are valid under the assumption that at least one of the instrumental variables is exogenous. Within my instrument set this requirement most plausibly holds for graduates in mother's cohort, a variable that measures the proportion of women in mother's birth cohort and state where she lived at 12 years that graduated from each school level—although, of course, I expect that all my instruments are in fact exogenous. Results of overidentification tests indicate that identifying instruments perform better when relaxing only the assumption of education being exogenous. First-stage results are in Table 2.5; columns (1) thru (4) contain four specifications corresponding to columns (3) thru (6) in table 3. Evidence of instruments identifying education is consistent across specifications.

Some instruments are strongly correlated with education, in particular, mother's height that serve as proxy for genetics and mother's past nutrition and mother's birth order, a proxy for family background. Evidence is slightly weaker in the case of mother's cohort graduates at each level (see estimates of elementary and high school graduates) but overall these seem to be good instruments.

Table 2.4. Endogeneity and Overidentification Tests.

Endogenous: :	Education and labor supply				Education only				Labor only			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	IV2	IV31	IV32	IV33	IV2	IV31	IV32	IV33	IV2	IV31	IV32	IV33
Endogeneity test [1]												
"By hand" F and t-tests*	1.2	0.9	1.1	1.1	-2.0	-2.0	-2.0	-2.0	0.11	0.07	0.33	-0.07
	[0.308]	[0.391]	[0.335]	[0.338]	[0.045]	[0.046]	[0.044]	[0.045]	[0.914]	[0.940]	[0.745]	[0.943]
Wu-Hausman F-test	1.1	0.9	1.0	1.0	3.7	3.7	3.7	3.7	0.01	0.01	0.11	0.0
	[0.338]	[0.421]	[0.373]	[0.361]	[0.054]	[0.055]	[0.055]	[0.054]	[0.916]	[0.941]	[0.744]	[0.945]
Durbin-Wu-Hausman X^2-test	2.2	1.8	2.0	2.1	3.8	3.7	3.7	3.7	0.01	0.01	0.11	0
	[0.334]	[0.417]	[0.369]	[0.357]	[0.053]	[0.054]	[0.054]	[0.053]	[0.915]	[0.941]	[0.743]	[0.944]
Overidentification test [2]												
X^2-test ("By hand")*	14.3	15.1	14.7	15.1	10.7	11.1	10.7	10.7	16.7	17.1	16.7	17.5
	[0.046]	[0.035]	[0.040]	[0.035]	[0.098]	[0.085]	[0.098]	[0.098]	[0.034]	[0.029]	[0.034]	[0.026]
Sargan test [3]	14.2	15.3	14.6	15.0	10.8	11.0	10.7	10.8	16.63	17.24	16.71	17.32
	[0.048]	[0.033]	[0.041]	[0.036]	[0.094]	[0.090]	[0.097]	[0.094]	[0.034]	[0.028]	[0.033]	[0.027]

p-values in brackets

*Following Woodridge (2002 and 2003).

F tests joint significance for both education and labor and t tests significance of education only.

[1] Ho: Regressor (s) is (are) exogenous

[2] Ho: All IV's are uncorrelated with the error. Cov $(z,u) = 0$.

Table 2.5. Identifying instruments first-stage results. Dependent variable is education.

	(1)	(2)	(3)	(4)
Mother's genetics and past nutrition				
Mother's height	58.13	56.59	56.95	58.71
	(20.346)***	(20.345)***	(20.341)***	(20.331)***
Mother's height square	-17.38	-16.93	-16.96	-17.57
	(6.632)***	(6.630)**	(6.629)**	(6.627)***
F Test	21.30	19.64	21.35	21.30
	[0.000]	[0.000]	[0.000]	[0.000]
Mother's family background[1]				
Mother is not oldest	-1.32	-1.32	-1,32	-1.33
	(0.265)***	(0.265)***	(0.266)***	(0.265)***
Mother does not know siblings ages	-0.30	-0.31	-0.29	-0.30
	(0.132)**	(0.132)**	(0.132)**	(0.131)**
F Test	12.5	12.4	12.3	12.6
	[0.000]	[0.000]	[0.000]	[0.000]
Graduates in mother's cohort[2]				
Elementary graduates	3.04	3.07	3.14	3.02
	(1.582)*	(1.584)*	(1.581)**	(1.583)*
Secondary graduates	5.61	5.63	5.87	5.60
	(2.444)**	(2.448)**	(2.445)**	(2.443)**
High school graduates	-0.84	-0.91	-1.34	-0.83
	(2.653)	(2.654)	(2.666)	(2.651)
F Test	27.87	27.93	27.40	27.77
	[0.000]	[0.000]	[0.000]	[0.000]
All variables F Test	25.83	25.28	25.81	25.84
	[0.000]	[0.000]	[0.000]	[0.000]
R-squared	0.43	0.43	0.43	0.43
Observations	3,968	3,968	3,968	3,968

Robust standard errors in parentheses; P-values in brackets,
* significant at 10%; ** significant at 5%; *** significant at 1%.
Column (1): Basic specification + altitude + median % food-types expenditure.
Column (2): (1) + Sanitary Services.
Column (3): (2) + Health services
Column (4): (3) + Access to information (Median weekly hours devoted to TV watching by mothers)
[1] Family composition: mother's birth order. Baseline indicates mother is oldest sibling.
[2] Proportion of women, in mother's cohort and state she lived in at 12 years, that graduated from each school level (proportion accumulates).

Estimates of 2SLS procedure are shown in Table 2.6. Columns (1)-(5) correspond to columns (2)-(6) of the OLS estimation in table 3. I summarize results as follows:

(i) Effects of education remain positive but become significant and larger, increasing by approximately 7-10 times relative to their OLS counterparts. This reflects that the 2SLS procedure may well be also correcting measurement error, which could have produced a downward biased estimate before. Estimated effects of 3 additional years of maternal schooling on child's hemoglobin levels range between 0.22 and 0.23, equivalent to 0.15 of a standard deviation. This is a small effect that may be reinterpreted as follows: it takes 6.8 additional years of maternal education for a child, say with a hemoglobin concentration of 11 g/dl, to be no longer anemic, i.e. to reach a level of 11.5 g/dl.

(ii) Estimates of labor supply effects become more statistically significant than, but still as small as, their OLS counterparts in table 3. A 10-hour increase in weekly labor hours decreases child's hemoglobin level by 0.03, which is equivalent to 0.02 standard deviations. This is effect is small, for example, for a child with the average hemoglobin level it would not represent a threat of becoming anemic, since it would require a mother to work 600 additional weekly hours!

Table 2.6. 2SLS Results. Dependent variable: hemoglobin levels.

	(1)	(2)	(3)	(4)	(5)
Mother:					
Education	0.073	0.074	0.075	0.074	0.074
	(0.031)**	(0.033)**	(0.034)**	(0.033)**	(0.033)**
Labor hours	-0.002	-0.003	-0.003	-0.003	-0.003
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
Cognitive ability	-0.038	-0.038	-0.038	-0.038	-0.038
	(0.016)**	(0.016)**	(0.016)**	(0.016)**	(0.016)**
Age	0.013	0.013	0.013	0.013	0.013
	(0.005)***	(0.005)***	(0.005)***	(0.005)***	(0.005)***
Child:					
Sex	0.064	0.062	0.061	0.063	0.061
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Age:[1]					
6 years	0.112	0.115	0.114	0.121	0.115
	(0.081)	(0.081)	(0.081)	(0.081)	(0.081)
7 years	0.260	0.251	0.249	0.251	0.250
	(0.081)***	(0.081)***	(0.081)***	(0.081)***	(0.081)***
8 years	0.449	0.448	0.447	0.451	0.447
	(0.080)***	(0.080)***	(0.080)***	(0.080)***	(0.080)***
9 years	0.540	0.542	0.540	0.539	0.542
	(0.079)***	(0.079)***	(0.079)***	(0.079)***	(0.079)***
10 years	0.618	0.611	0.611	0.611	0.610
	(0.081)***	(0.081)***	(0.081)***	(0.081)***	(0.081)***
11 years	0.816	0.816	0.816	0.818	0.816
	(0.080)***	(0.080)***	(0.080)***	(0.080)***	(0.080)***
Household:					
Siblings	-0.036	-0.044	-0.043	-0.042	-0.044
	(0.025)	(0.025)*	(0.025)*	(0.025)*	(0.025)*
Father at home	0.019	0.027	0.026	0.026	0.028
	(0.059)	(0.058)	(0.059)	(0.058)	(0.058)
Total Income[2]	-0.000	0.000	0.000	0.000	0.001
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Agricultural household	-0.013	-0.023	-0.025	-0.030	-0.026
	(0.063)	(0.063)	(0.063)	(0.063)	(0.063)
Community:					
Altitude[3]	0.047	0.042	0.042	0.043	0.043
	(0.005)***	(0.005)***	(0.006)***	(0.006)***	(0.006)***
Food[4]					
Animal origin		0.009	0.008	0.009	0.009
		(0.007)	(0.007)	(0.007)	(0.007)
Cereals[5]		0.007	0.007	0.009	0.006
		(0.009)	(0.009)	(0.009)	(0.009)

Table 2.6. (Cont'd).

	(1)	(2)	(3)	(4)	(5)
Fruit and vegetables[6]		0.026	0.026	0.028	0.026
		(0.008)***	(0.008)***	(0.008)***	(0.008)***
Soft drinks		0.015	0.015	0.017	0.016
		(0.015)	(0.015)	(0.016)	(0.015)
Snacks and sugar		0.076	0.082	0.060	0.073
		(0.030)**	(0.031)***	(0.031)*	(0.031)**
Sanitary services					
Private toilet			-0.047		
with moat			(0.074)		
Shared/outdoors/other[7]			0.002		
			(0.114)		
Health services[8]					
Public clinic/hospital					
Kms. < 0.2				0.001	
				(0.071)	
Kms. ≥ 0.2 or DK				0.062	
				(0.070)	
Private clinic/hospital					
Kms. < 0.2				-0.256	
				(0.095)***	
Kms. ≥ 0.2 or DK				-0.010	
				(0.074)	
Traditional healer or Midwife					
Kms. < 0.2				0.016	
				(0.063)	
Kms. ≥ 0.2 or DK				-0.060	
				(0.057)	
Access to information					
TV[9]					-0.004
					(0.007)
State and population size[10,11]					
Baja California Sur	-1.311	-1.420	-1.420	-1.382	-1.416
	(0.237)***	(0.243)***	(0.244)***	(0.245)***	(0.243)***
Coahuila	-0.611	-0.764	-0.754	-0.731	-0.748
	(0.195)***	(0.212)***	(0.212)***	(0.214)***	(0.213)***
Durango	-1.050	-1.134	-1.119	-1.114	-1.124
	(0.183)***	(0.192)***	(0.192)***	(0.195)***	(0.193)***
Guanajuato	-0.563	-0.747	-0.738	-0.610	-0.732
	(0.198)***	(0.188)***	(0.188)***	(0.201)***	(0.189)***
Jalisco	-0.325	-0.356	-0.358	-0.324	-0.350
	(0.191)*	(0.193)*	(0.194)*	(0.200)	(0.194)*
Mexico	-0.015	-0.130	-0.112	-0.103	-0.133
	(0.182)	(0.178)	(0.177)	(0.187)	(0.178)
Michoacan	-0.655	-0.764	-0.756	-0.713	-0.768
	(0.187)***	(0.184)***	(0.186)***	(0.191)***	(0.185)***

Table 2.6. (Cont'd).

	(1)	(2)	(3)	(4)	(5)
Morelos	-0.204	-0.339	-0.336	-0.271	-0.328
	(0.197)	(0.209)	(0.209)	(0.214)	(0.210)
Nuevo Leon	-0.716	-0.889	-0.883	-0.831	-0.875
	(0.198)***	(0.224)***	(0.224)***	(0.230)***	(0.226)***
Oaxaca	-0.610	-0.722	-0.705	-0.687	-0.730
	(0.188)***	(0.193)***	(0.193)***	(0.198)***	(0.194)***
Puebla	-0.880	-1.035	-1.042	-0.949	-1.038
	(0.187)***	(0.184)***	(0.186)***	(0.192)***	(0.184)***
Sinaloa	-0.963	-1.063	-1.067	-0.916	-1.049
	(0.205)***	(0.216)***	(0.217)***	(0.224)***	(0.218)***
Sonora	-0.662	-0.896	-0.896	-0.824	-0.890
	(0.203)***	(0.220)***	(0.221)***	(0.228)***	(0.220)***
Veracruz	-0.552	-0.827	-0.824	-0.753	-0.824
	(0.193)***	(0.201)***	(0.203)***	(0.205)***	(0.202)***
Yucatan	-0.795	-0.863	-0.829	-0.840	-0.857
	(0.213)***	(0.226)***	(0.233)***	(0.231)***	(0.227)***
Pop. > 100,000	-0.060	0.097	0.085	0.129	0.097
	(0.070)	(0.076)	(0.087)	(0.088)	(0.076)
Pop. 15,000 - 100,000	-0.207	-0.039	-0.062	-0.033	-0.037
	(0.088)**	(0.093)	(0.108)	(0.102)	(0.094)
Pop. 2,500 - 15,000	-0.104	-0.001	-0.012	0.039	0.001
	(0.071)	(0.076)	(0.088)	(0.081)	(0.076)
Constant	12.248	11.036	11.041	10.919	11.066
	(0.332)***	(0.615)***	(0.617)***	(0.628)***	(0.622)***
R-squared	0.20	0.20	0.20	0.20	0.20
Observations	3,968	3,968	3,968	3,968	3,968

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Column (1): basic independent variables.
Column (2): (1) plus mean altitude at municipality level.
Column (3): (2) plus diet variables at community level; median % food expenditure at community level.
Columns (4)-(6): (3) plus sanitary services, health services and access to information, respectively.
[1] Baseline of child's age: 5 years.
[2] Monthly, 2002 Mx pesos.
[3] Average at municipality-level.
[4] % of total food expenditure, median at the community-level.
[5] Includes tortillas and bread.
[6] Includes legumes.
[7] Baseline of sanitary services: Private toilet with drainage. Outdoors may be lake/river or yard/field.
[8] Distance dummy variables, baseline is service not present in community. DK if don't know distance.
[9] Median-community weekly hours that mothers' watch TV.
[10] Dummy variables with baseline: Mexico DF (excludes metropolitan area).
[11] Dummy variables with baseline: Community with population < 2,500 (officially considered as rural).

(iii). Other results:

- The effect of maternal cognitive ability remains negative and, unexpectedly, becomes 3.5 times larger and more significant than the OLS—three additional points in the Raven Score is related with a decrease of 0.11-0.12 in hemoglobin levels[61].
- Effects of mother's age also become larger (and more significant) relative to the OLS case. The average child with a mother who is 5 years younger would decrease *H* by 0.04 standard deviations.
- Total income is no longer significant when applying 2SLS and its effect become ambiguous across specifications.
- Remaining results are similar to those of OLS.

Table 2.7 shows maternal education effects on child height. These results reveal that three additional years of maternal education translate into an increase approximately 0.24 of a standard deviation of height—the analogous effect is approximately 0.15 of a standard deviation of hemoglobin. A relatively larger estimate in the case of height seems reasonable since general education is more likely to provide basic nutrition and health knowledge that eventually affects height, than specific instruction on, for example, food containing supplying iron and effects of iron deficiency. Moreover, height and growth retardation are easier to observe and "diagnose" by the mother than low hemoglobin levels and anemia.

[61] The estimated coefficient is also negative when Raven Scores are in terms of Z-scores.

Table 2.7. Education effects on child height, 2SLS results.

(1) Basic + altitude	0.082
	(0.025)***
(2) + Diet variables at community level	0.081
	(0.026)***
(3) (2) + sanitary services	0.078
	(0.025)***
(4) (2) + health services	0.082
	(0.026)***
(5) (2) + access to information	0.083
	(0.026)***

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Basic specification includes: labor hours, cognitive ability and age of mother; child's gender and age; number of children in the household; presence of father; whether the household is agricultural; and, state and population size dummies.
See notes in table 2.6.

2.4.3. Interactions

In this section, I examine possible mechanisms through which maternal education affects child's health. Above, I directly included variables of infrastructure and access to information, where the effect of education remained practically unchanged and only private health services coefficients were statistically significant.

Now, I incorporate interactions between education and infrastructure and between education and access to information to analyze possible complementarities or substitution effects. Results are shown in Table 2.8.

Table 2.8. Interactions results. Dependent variable: hemoglobin levels.

	(1)	(2)	(3)
Maternal Education	0.048	0.197	0.073
	(0.030)	(0.043)***	(0.039)*
Interactions:			
With sanitary services			
Private toilet with moat	-0.021		
	(0.034)		
Shared/outdoors/other	0.080		
	(0.056)		
With health services			
Public clinic/hospital			
Kms. < 0.2		-0.127	
		(0.041)***	
Kms. ≥ 0.2 or DK		-0.100	
		(0.045)**	
Private clinic/hospital			
Kms. < 0.2		-0.066	
		(0.052)	
Kms. ≥ 0.2 or DK		-0.006	
		(0.033)	
Traditional healer or midwife			
Kms. < 0.2		-0.052	
		(0.032)	
Kms. ≥ 0.2 or DK		-0.028	
		(0.030)	
With access to information			
TV			0.000
			(0.003)
R-squared	0.21	0.18	0.20
Observations	3,968	3,968	3,968

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
All regressions include basic covariates, mean-municipality altitude, and median % food-types expenditure.
Column (1): Sanitary services and interactions of education and sanitary services
Column (2): Health services and interactions of education and health services
Column (3): Access to information and interactions of education and median-community weekly hours of TV watching by mothers.
Identifying instruments: mother's height and its square, mother's birth order, proportion of graduates in mother's cohort by school levels.

When including interactions with sanitary services the effect of education decreases and becomes statistically not significant. In the case of access to information the effect is similar than before. Only estimates of public clinic/hospital coefficients are statistically significant. The presence of this health service decreases the effect of education and more so the closest the service to the community center (downtown); may be reflecting a substitution effect between education and public health services. The estimated effect of 3 additional years of education when public health service is not present in the community is equivalent to 0.4 standard deviations of hemoglobin levels, but only 0.14, if this service is relative close to the community center, and 0.19 standard deviations, if service is relatively far. In other words, the presence of a public hospital reduces the effect of maternal education with the total effect remaining similar than before and becomes slightly higher if the public hospital is relatively distant.

2.5. Conclusions

I find that effects of maternal education on hemoglobin levels are consistently positive across different specifications and procedures. Evidence suggests that education is endogenous and possibly contaminated by measurement error, producing biased estimates from OLS procedures. Most accurate estimates show that an increase of 3 years in mother's education affects a child's hemoglobin level by 0.15-0.16 of a standard deviation, which are small. However, this does not imply that it is not valuable to educate women, rather that strategies to improve the quality of education would be valuable. For example, education programs in Mexican schools and health prevention programs in facilities could be improved by including specific nutrition-health topics that are of public health relevance, emphasizing the relationship between dietary intakes and nutritional-health outcomes. These would be particularly important in the case of health problems that are not obvious or which symptoms may be misleading.

I also find evidence indicating that maternal education may operate with public health services (clinic/hospital) through a substitution effect. I also find evidence suggesting that mother's labor supply may not be endogenous, which is reasonable, since low hemoglobin levels are not obvious to the mother and her labor decisions are likely to be independent of this aspect of her child's health. However, further analysis would be needed to confirm this. Additionally, I find that younger mothers have less healthy children and that, although, girls appear to be healthier than boys this difference is not statistically significant.

CHAPTER 3

DO PUBLIC INITIATIVES CHANGE SEXUAL AND REPRODUCTIVE BEHAVIOR OF WOMEN?

3.1. Introduction

Sexual and reproductive education intends to change sexual/reproductive behavior. It is expected to translate into better (more conscious) sexual and reproductive health practices: pregnancy control, prevention of AIDS and other sexually transmitted diseases, and, in the case of women, prevention of breast and cervical cancers. As Michael (2004) states "the value of capital associated with sexual behavior…involves resources that are both capabilities and habits that are embedded or become part of the person's pattern of behavior", which would imply an important role of sexual and reproductive education in the formation of such a capital. Yet opponents of programs of sexual education argue that instead it encourages sexual activity and increases unwanted pregnancies, particularly among younger (unmarried) people (Oettinger, 1999).

During the 1970s the Mexican government, like that of other countries, introduced policies to promote birth control and family planning in order to reduce the pressure of population growth. These policies were implemented through two essential sectors: education and health care. In 1974, sexual education programs were implemented in Mexican schools for the first time and contents upgraded as new social and public concerns rose: in 1987, with the AIDS epidemic, the emphasis was put on prevention; and, in 1994-1998, gender issues, sexual, and reproductive rights were included (Rodriguez, 2001). Along with education programs, in 1972 and 1973, public health institutions incorporated family planning and birth control programs at large. In 1973, a new Sanitary Code eliminated the prohibition on contraceptives sales and advertising.

The purpose of this study is to examine whether the sexual and reproductive behavior of Mexican women changed due to public initiatives launched in the 1970s. I use a variety of indicators to characterize sexual and reproductive behavior: first sexual encounter, first and second pregnancies, and utilization of contraceptive methods. To identify the effects of public programs, I make use of individual exposure to in-school sexual education and to birth control promotion in public health facilities. In a previous work, Miranda (2006) finds that young cohorts of Mexican women are actually postponing first birth compared to older ones. However, to my knowledge, no study so far has aimed to explicitly disentangle the effect of birth control and family planning public initiatives on the reproductive and sexual behavior of Mexican women. My contribution consists of analyzing changes in various components of sexual and reproductive behavior, exploiting the fact that exposure to programs varied across women of different cohorts, schooling attainments, and utilization of health facilities.

The following section contains a brief account of the family planning policies implemented in Mexico since the 1970s. Section 3.3 presents a review of the literature. Econometric models are described in section 3.4. Data and empirical analysis are in section 3.5. Results are in section 3.6. Section 3.7 concludes.

3.2. Background

In the 1970s, the Mexican government launched several initiatives to promote birth control and family planning, in line with international trends[62], to reduce the pressure of the population growth: (i) sexual education in schools as part of the natural science curricula at the elementary and secondary levels; (ii) family planning and birth control programs in public health institutions; and (iii) foundation of the Mexican National Council of Population (CONAPO) in charge of demographic plans and research. These public initiatives consisted of education, informative campaigns, and direct promotion in schools, hospitals and clinics, and mass media. The principles regarding the new population policies were introduced in both the Federal Constitution (CPEUM) and the General Population Law (LGP)[63,64]:

> "Every individual has the right to freely, responsibly, and well-informed decide on the number and timing of her/his children." (CPEUM, Title First. Chapter I. Article 4. Modification published in 1974).

> "...carry out family planning programs through public education and public health services, and supervise that such programs and those managed by private organizations are respectful of the human rights and family dignity..."(LGP, Chapter I. Article 3. Part II. Modified in 1973).

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[62] For example, the United Nations founded the Fund for Population Activities (UNFPA) in 1969.
[63] The General Population Law was first promulgated in 1936 and explicitly promoted fertility and population growth (Palma C., 2005 and Sánchez L., 1997). Note acronyms are in Spanish.
[64] Own translation.

"...influence the population dynamics through education, public health, professional and technical training, and children protection systems..." (LGP, Chapter I. Article 3. Part IV. Modified in 1973).

The aim of the Mexican government was to promote birth control and family planning[65]. Yet, the use of contraception methods and the development of a new perception regarding sexuality always emphasized the role of the family [wedlock] as the [only] acceptable space for sexual practices (García A., 2001)[66]. Overall, these public policies were effective, annual average population growth rate decreased from 3.4 (1960-70) to 1.0 (2000-05)[67] and global fertility rates dropped from 5.7 (1976) to 2.2 (2006).

Starting in 1974, sexual education was included in the contents of the textbooks[68] at the elementary level, beginning in fifth grade, and at the secondary level (seventh thru ninth grades). In 1974, the curriculum included menstrual functioning, changes due to puberty and adolescence, and reproductive processes (fifth grade textbook); and birth control, contraceptive use, and prevention of sexually transmitted diseases (secondary textbooks). Since 1987, with the AIDS epidemic an emphasis was put on prevention in the secondary courses. Beginning in 1994-1998, from fifth grade on, the program has added the formation of values: gender-equality issues, sexual and reproductive rights, sexual relationships, love, and sexual violence, among others. While curricula upgrading

[65] Figure 3.1 presents a timeline indicating basic initiatives in the 1970s.
[66] At the beginning the idea was based on "biological and neo-malthusian" principles, but then due to the intervention of the Catholic Church and the National Parents Union (Union Nacional de Padres de Familia, UNPF)—a conservative institution that defends religious-related moral principles—the emphasis shifted.
[67] *Dinámica de la población*—population dynamics—at the National Institute of Statistics, Geography and Informatics (INEGI) webpage (http://www.inegi.gob.mx/est/default.aspx?c=2343).
[68] Textbooks published by the Secretaría de Educación Pública (Ministry of Education) are free and mandatory in public schools and while also free for private schools their use is discretionary (Torres S., 2002).

tried to adapt to social and environmental needs, many young Mexican people (12-29 years old) still believe that they have received important sexual health information in places other than school. According to the 2000 Mexican Youth Survey (Rodriguez, 2001): 34.1% of the young people believed that they received important sexual health information from school; 24.4 % believed that they got it from parents, 19.4% from own learning; 9.7% from friends; 5.9% from media; 4% other and church.

Along with education programs, other sexual-reproductive policies were launched in the 1970s[69]. In 1972 and 1973, public health facilities with large coverage[70] started to incorporate family planning and birth control programs. In 1973, a new Sanitary Code eliminated the prohibition on contraceptives sales and advertising, and between 1973 and 1976 the politics, organization, and agenda were set to integrate family planning into the health services. The government founded the CONAPO in 1974, and, in 1977, the first National Program for Family Planning (PNPF). Many important strategies were initiated, among which was the Family Planning Communication Program, with the purpose to "inform, make aware, and generate changes in attitudes with respect to reproductive behavior"[71], and an expansion strategy to reach rural communities (population size: 500-2500). It was not until 1984 that family planning was included in the General Health Law

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[69] The following brief historical account of the sexual/reproductive programs of the health sector is based on Palma and Rivera (1996), unless otherwise noted.
[70] Large coverage institutions: Instituto Mexicano del Seguro Social (Mexican Social Security Institute, IMSS), Secretaría de Salud y Asistencia (Health Ministry, SSA); and Instituto de Seguridad y Servicios Sociales para los Trabajadores del Estado (Social Security for State Workers, ISSSTE). Before the public initiatives of the 1970s two private organizations were founded with the objectives of providing family planning services (Asociación Pro Salud Materna, in 1958), doing research, providing education and supplying medical services for family planning (Fundación para Estudios de la Población, A.C., in 1965—now Fundación Mexicana para la Planeación Familiar, Mexfam). Also, in 1968, previous to other and more general public initiatives, the Instituto Nacional de la Nutrición Salvador Zubirán (Nacional Nutrition Institution, INNSZ) started a research program and the provision of family planning services. (All acronyms are in Spanish).
[71] In *¿Qué es el CONAPO?* (What is CONAPO?) at www.conapo.gob.mx.

(LGS) under similar principles as those in the LGP. During 1980s other approaches were adopted as more results of social (surveys) and medical (contraceptive methods and techniques) research were obtained. Also, policies for the prevention of AIDS were developed like, in 1988, the creation of the National Council of AIDS in Mexico (now CENSIDA)[72]. In the 1990s, the PNPF emphasis was set on specific population groups (teenagers, rural, and men) and it continued to provide planning services, information, and education.

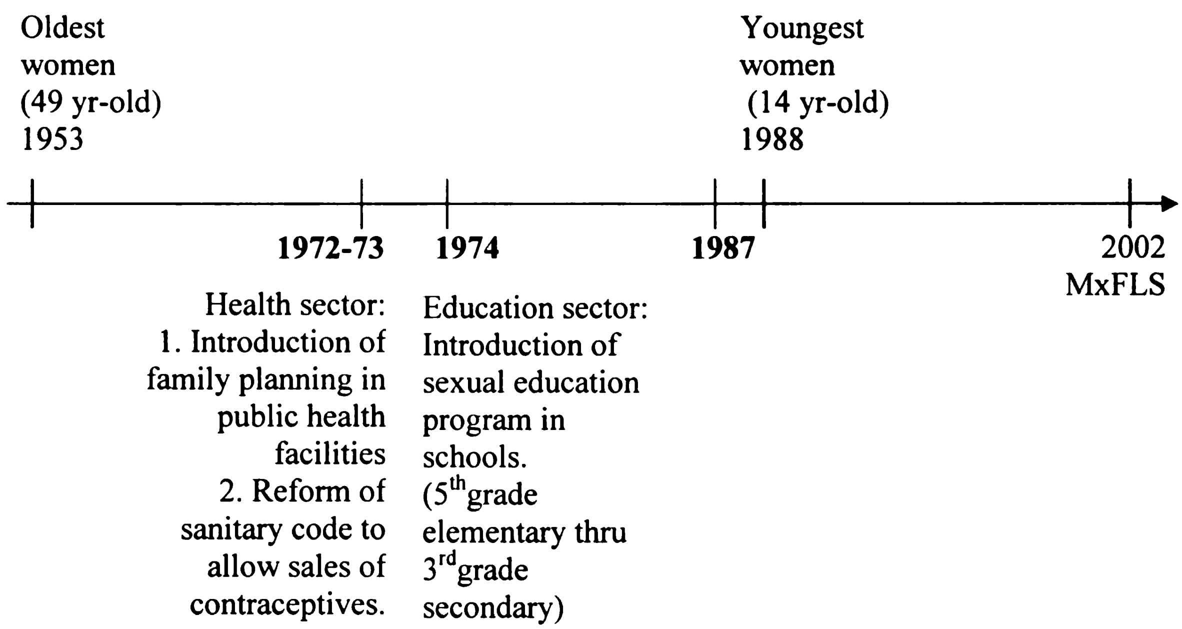

Figure 3.1. Timetable of major public initiatives to promote birth control and family planning in Mexico.

[72] Hernández-Chávez (1995).

At the same time, other factors may have also contributed to changes in sexual and reproductive behavior of the Mexican population. For example, the increase in schooling attainment of both females and males may be associated with higher opportunity costs of unwanted consequences of sexual activity, i.e. unwanted pregnancies[73]. New generations may develop different religious and social conventions compared to older ones, e.g. the "correct" role of women with respect to marriage and children[74]. However, it is not possible to know the extent to which these socio-cultural attitudes have been influenced by the public initiatives to promote sexual and reproductive health.

3.3. Literature Review

Table 3.1 contains a synthesis of related literature. Most of these works analyze the relationship between sexual and reproductive behavior and sex education, birth control promotion, or other similar policies. This literature mostly focuses on teenagers in the USA and the UK. I also include the paper by Miranda because he examines the postponement of first birth by younger Mexican women, although he does not explicitly look at the impact of sex education or family planning policies.

Oettinger (1999) and Tremblay and Ling (2005) examine the association between sex education and sexual behavior among American teenagers. Oettinger theoretically models the impact of sexual education on sexual activity. Oettinger's model predicts different outcomes resulting from various types of sexual education: risk altering, risk revealing, and utility altering.

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[73] Figure A3.1 shows how education attainment increased in Mexico in last decades.
[74] Figures A3.2–A3.4 present results from the World Value Survey that suggest how Mexican society has changed its attitudes toward motherhood and the role of women.

Table 3.1. Previous studies analyzing sexual and reproductive behavior.

Author	Sample	Conceptual Framework	Empirical Strategy	Comments
Oettinger (1999)	USA NLSY individuals born between 1957-64 (Teenagers in 1970s and early 1980s).	Examine link between sex education and sexual behavior among American teenagers. Theoretically model teenagers' decisions on sexual activity. Simulates effects of various types of sexual education: risk altering, risk revealing, and utility altering. Discusses systematic variation due to individual characteristics.	Uses hazard rate models that are estimated with: (i) dummy variables to form the baseline (Meyer, 1990); (ii) Cox partial likelihood; and (iii) a logit hazard specification with a nonparametric baseline. All of these provide qualitatively identical estimates. Uses whole sample and same-sex sibling sub-sample to account for unobserved heterogeneity. Findings: sex education associated with earlier sexual activity for females. Some weaker evidence on the effects on pregnancies for some female groups. In both cases, effects were larger for females with relatively less sources of information. Effects on males less important.	Types of sex education. 1. Risk altering: information that may alter risk of pregnancy for sexually active teens. Increases activity with ambiguous effect on teen pregnancies. 2. Risk revealing: information on contraception methods and correct usage. Activity and pregnancies results depend on whether perceived risk of pregnancy is revised upward or downward. 3. Utility altering: changes expected utilities of different outcomes of sexual activity. Activity and pregnancies change depending on how relative utilities shift.

Table 3.1. (Cont'd).

Author	Sample	Conceptual Framework	Empirical Strategy	Comments
Paton (2002)	UK Regional-level panel data from Health Authorities. Statistics of teenagers 1984-97.	Adapts Oettinger's model to analyze family planning for teenagers. Theoretical predictions are: (i) increased availability of family planning leads to an increase in rate of teenagers' sexual activity, (ii) impact is ambiguous on pregnancy rates; (iii) ambiguous on whether access to family planning has greater of less impact on underage abortions than on overall conceptions.	Use natural experiment provided by a change in public policy (1984 Gillick Ruling), which reduced attendance by teens at family planning clinics. Runs fixed effects on models of conception and abortion rates, measuring the effect of 1984 ruling using a dummy variable for year 1985. Using rates of family planning attendance to identify 1984 ruling, runs: (i) IV procedure for a static model, treating family planning as endogenous; and, (ii) GMM procedure to estimate a dynamic version of (i).	1984 Gillick ruling: contraception advice for teens below 16 years old required parent consent. Findings: No evidence of a reduction of underage conception and abortion rates. Some evidence that more access to family planning is associated with an increase in underage conceptions.

Table 3.1. (Cont'd).

Author	Sample	Conceptual Framework	Empirical Strategy	Comments
Averett et al. (2002)	USA National Survey of Family Growth. Women 15-19 years old.	Analyze the effects of government policies and laws that may alter the costs of being sexually active and of using contraception methods. Also, look at effects of neighborhood characteristics on teenage sexual behavior. If cost of abortion drops then teens may increase sexual activity or use less contraception methods.	Use a probit model to estimate probabilities of being sexually active and of contraception use (if sexually active).Main covariates: (i) Existence of abortion provider in county. (ii) Medicaid funding for therapeutic abortion. (iii) Need of parental consent law in state. (iv) Neighborhood-level variables: proportions of non-white population and median income.	Findings: No evidence on costs of abortion affecting sexual activity or contraception use. Evidence on family planning having a positive effect on contraception use. Evidence of neighborhood characteristics affecting sexual activity and contraception methods use.
Tremblay and Ling (2005)	USA Youth Risk Behavior Supplement of the National Health Interview Survey (1992)	Adaptation of Oettinger's model for the abstinence-intercourse decision conditional on optimal condom use (i.e. use or non use). Extend classification of education to AIDS education: risk altering, risk revealing, and utility altering. Examine link between AIDS education and sexual outcomes.	Multinomial logit to analyze probability of abstinence, intercourse with condom, and intercourse with condom. Use whole sample and subsamples by gender and age groups. Controls for characteristics and source of AIDS education: school, home, and both. Add religion at state level and family characteristics, and, alternatively, price of condoms. Test specifications.	Findings: AIDS education increases probability of condom use relative to unprotected intercourse and does not encourage sexual activity. Risk altering and risk revealing dominates utility altering effects. AIDS education has a larger influence on women than it does on men.

Table 3.1. (Cont'd).

Author	Sample	Conceptual Framework	Empirical Strategy	Comments
Miranda (2006)	MEXICO. ENADID (1997) Women in fertile age born between 1942–82	Examines whether young cohorts of Mexican women are delaying first birth. Large increase of utilization of female permanent sterilization (FPS) while demand for temporary methods decreased during last decades. Contributing factors: (i) promotion of FPS in public health system for women with 3 or more children; (ii) FPS is perceived by Mexican women as the most effective and least risky method in terms of causing serious illness (e.g. cancer); and (iii) adoption of contraception methods begin mostly after first or second child.	Uses discrete time duration models to estimate hazard function. Uses two procedures for estimation: (i) extreme value as a benchmark and (ii) probit. Estimates average partial effects, concentrates on covariates of religion, attained education at 12, proxy for ethnicity, and birth cohorts. Analysis using whole sample and cohorts sub-samples. Explicitly accounts for lifetime childlessness by including a mass point at $-\infty$. Controls for unobserved heterogeneity by estimating a mixing density function of unobservables with a non-parametric MLE (approximated by mass points) (Heckman and Singer, 1984).Tests for model selection: AIC, CAIC, LS.	Findings: younger women are postponing first birth relative to older ones. Catholicism and education are negatively associated with the hazard of entering motherhood, the former possibly due to postponement of marriage and sex abstinence. The role of education is not discussed by the author in depth but he implicitly relates it to a higher opportunity cost of higher schooling attainment. Indigenous speakers are more likely to have first child at a younger age more so in the case of younger generations.

Risk altering consists of information that may alter perceived risk of pregnancy for sexually active teens. As a result sexual activity increases but the effect on teen pregnancies is ambiguous. Risk revealing education provides knowledge on contraception methods and their correct use. Outcomes of sexual activity and pregnancies depend on whether perceived risk of pregnancy is revised upward or downward but both outcomes move in the same direction. Utility altering education changes expected utilities of different outcomes of sexual activity. Predictions of the model with respect to utility altering education are not conclusive, sexual activity and pregnancies change depending on how relative utilities shift and both move in same direction. This model suggests that magnitudes of these predictions vary with individual characteristics: gender and access to alternative sources of information. Oettinger empirically estimates hazard models to analyze the effects of reported enrollment in sex education on teen sexual activity and teen pregnancy. He finds that sex education is associated with earlier sexual activity for females and (weakly) with pregnancy for some female groups. For both sexual activity and pregnancy, effects are larger for females with fewer sources of information relative to males and groups with more sources of information.

Tremblay and Ling adapt Oettinger's model to analyze the effect of AIDS education on the abstinence-intercourse-condom use decisions. They adjust the original classification of education types, i.e. risk altering, risk revealing, and utility altering, for AIDS education. They empirically estimate a multinomial logit model to analyze probability of abstinence and intercourse, finding that AIDS education increases probability of condom use relative to unprotected intercourse but it does not encourage sexual activity. Additionally, they find that AIDS education has a larger influence on women than it does on men.

Paton (2002) also adapts Oettinger's model to analyze the effect of family planning on British teenagers' sexual behavior. Predictions of the model are extended to examine aggregate level data. Theoretical predictions of this approach may be summarized as follows: (i) increased availability of family planning leads to an increase in the rate of teenagers' sexual activity and (ii) impact on pregnancy rates and whether access to family planning has greater or less impact on underage abortions than on overall conceptions are ambiguous. Paton uses a natural experiment generated by a policy change, the 1984 Gillick Ruling, which prohibited teenagers below 16 from obtaining advice on family planning without parental consent. He finds no evidence that provision of family planning information reduces underage conception and abortion rates but finds that child care services and the unemployment rate are positively associated with pregnancy rates while proportion of young people staying in post-compulsory education has a negative effect on both pregnancy and abortion rates.

Averett et al. (2002) analyze the effects of government policies, laws, and neighborhood characteristics on sexual activity and contraceptive use among American female teenagers. Policies and laws are included in the form of the existence of an abortion provider in a county, availability of Medicaid funding for therapeutic abortion, existence of consent law in state (need of parental consent for abortion), and family planning clinics in county. Neighborhood effects are measured by the proportions of non-white populations and median income. Averett et al. do not find any evidence of costs of abortion affecting sexual activity or contraception use. But they find evidence that family planning clinics have a positive effect on contraception use, and that neighborhood characteristics affect both sexual activity and contraception methods employed.

Miranda empirically estimates discrete time duration models of first birth, finding that younger Mexican women are postponing first birth relative to older ones. He also finds that Catholicism and education are negatively associated with the hazard of entering motherhood, while, ceteris paribus, indigenous women are more likely to have their first child at a younger age, more so in the case of younger generations. There is evidence on effects of religion, education, and ethnicity varying across cohorts. In this paper, I extend Miranda's work on Mexican women in three ways. Because I am interested in changes in sexual and reproductive behavior, I analyze a variety of outcomes seeking to complement his findings. Miranda indirectly looks at the role of family planning campaigns by defining cohorts of women who "were already at risk, or about to become at risk, at the time of the policy innovation [1963-72]", who became "at risk after the start of the new policy [1973-82]", and who were born between 1942 and 1962. Since I am trying to establish a (causal) connection between differences among cohorts and the implementation of public education policies, I directly include covariates that capture the effect of such campaigns besides 5-year cohort dummy variables. Due to data restrictions Miranda does not observe actual menarche age and has to assume 12 years old. I am able to calculate durations with respect to actual (reported) menarche ages—except in the cases of contraception method and condom use in which duration is measured with respect to age of first sexual encounter, and second pregnancy in which duration is calculated with respect to first pregnancy.

3.4. Econometric Models

I estimate duration-hazard models following econometric treatments by Miranda and Oettinger (1999). As indicators of sexual and reproductive behavior, I specifically analyze first sexual encounter, first and second pregnancies, first use of contraception method, and first use of condom by woman's partner. I also estimate a multinomial logit model of contraception method use, i.e. traditional, temporary (local and hormonal), or permanent—a procedure similar to that used by Tremblay and Ling (2005) for condom use and intercourse among youths. This analysis of contraception methods becomes very important in the Mexican context since, in the last decades, the demand for permanent contraception (female operation) has dramatically increased relative to other methods (Miranda, 2006; also see Figure A3.5).

3.4.1. Duration-hazard models

I use proportional hazard models that contain both time-varying $(x(t))$ and time-invariant (z) covariates.

$$\lambda[t; x(t), z, \beta] = \kappa[x(t), z, \beta]\lambda_0(t) \tag{3.1}$$

where $\lambda_0(t)$ is the baseline hazard. If $\kappa[x(t), z] = exp\left[x(t)\beta_{x(t)} + z\beta_z\right]$ then

$$\lambda[x(t), z, \beta_{x(t)}, \beta_z] = \lambda_0(t) exp\left[x(t)\beta_{x(t)} + z\beta_z\right] \tag{3.2}$$

where ith coefficient in either vector $\beta_{x(t)}$ or β_z may be interpreted as the proportion by which the hazard changes due to a one unit increase in the ith covariate (see Wooldridge, 2002 and Cameron and Trivedi, 2005). I estimate several outcomes in order to depict sexual and reproductive behavior: first sexual encounter, first pregnancy, second pregnancy, first-time temporary contraception method, and first-time condom use. Durations of time to first sexual encounter and first pregnancy are calculated with respect to age of menarche, duration of time to second pregnancy is computed with respect to age of first pregnancy, duration of time to first use of contraception methods (temporary and condom) are measured with respect to age of first sexual encounter. The original cross section sample is converted into a panel-type database expanding each observation by the corresponding woman's age. In the panel dataset each observation is a woman-year and the "history" of each woman is described by her (time-varying) age, durations until failures, education, and exposure to sexual education.

I am interested in analyzing how the hazard functions shift when covariates change. Thus estimation of $\lambda_0(t)$ is not necessary and I use a Cox procedure to estimate equation (3.2). Vector $x(t)$ includes exposure to sex education that captures either the effect of the introduction of sexual education in schools (1974) or the program upgrading due to AIDS epidemics (1987). Vector z contains: (i) exposure to family planning promotion in public health facilities; (ii) education controls: a dummy indicating whether a woman attended a private school at highest level of schooling, interactions between private school and exposure, and highest level attained; (iii) cohort and marital status dummy variables; (iv) characteristics of community of residence at age 12 that serves to controlling for possible unobserved heterogeneity due to, for example, differences in background like past relative wealth or access to basic services; and, (v) state and community-level population size dummy variables. In the cases of first and second pregnancies, I do not include a marital status variable due to potential endogeneity.

It is worth noting that Miranda explicitly takes into account childless women, i.e. women who may be sterile or dislike children, by including a mass point. However, according to MxFLS sample only 2.5% (1.4%) of women have long durations to first pregnancy—durations of more than 20 years (25 years). Since the sample consists of women in fertile ages, it is difficult to assume that these women will definitely remain childless, except perhaps for those over 45. Possibly a group closest to the childless category would be that with long durations and no sexual intercourse ever: 1.8% (1%) of women with durations of more than 20 years (25 years). Moreover, if one believes that average sterility or preferences for children do not really change across generations, one would not expect that the lack of control for childlessness would affect results.

3.4.2 Multinomial logit model

A woman or her partners could have used more than one birth/disease control (contraception methods for simplicity). I group these methods in three types, traditional, temporary, and permanent. Traditional type consists of rhythm (periodic abstinence), withdrawal (*coitus interruptus*), and herbs or teas. Temporary type includes pills, emergency pills, and other hormonal methods, intra-uterine device (IUD), and masculine condom. Permanent types are female operation (tubal occlusion) and male operation (vasectomy).

None, one, or some of three types of methods may have been used by a woman (or her partner). Let *CM* be a set of all possible methods—for convenience let it include a "no method" possibility—, then *CM* = {never used any method, used only traditional methods, used traditional and temporary methods, used traditional and permanent methods, used only temporary methods, used temporary and permanent methods, and used only permanent}. I am interested in three possible outcomes: (i) never used a contraception method or have used only traditional types, (ii) have used temporary types (may have used traditional but never permanent), or (iii) woman or partner presently use permanent, i.e. either is operated (may have used traditional or temporary). I construct a variable y that categorizes such choices, taking a value j (j = 0, 1, 2) for each alternative in (i) thru (iii), respectively. Table 3.2 presents a matrix summarizing *CM* and y, for example, if a woman is operated (permanent) then her response is categorized as 2, even if she used other types of methods during her life; or, a woman's response would be 1 if she has used temporary methods but never a permanent one, even if she has used traditional methods as well. The unconditional probabilities associated with these choices are $P(y=0)$ = the probability of not using contraception methods or having used only traditional types $P(y=1)$ = the probability of having used temporary contraception methods but never permanent, and $P(y=2)$ = the probability of using a permanent method.

Table 3.2. Contraception methods use matrix.

	None	Traditional	Temporary	Permanent
None	None	-	-	-
Traditional	-	Traditional	Traditional and Temporary	Traditional and Permanent
Temporary	-		Temporary	Temporary and Permanent
Permanent	-			Permanent
y=	0		1	2

Using a binary response model would not capture all possibilities of contraception methods potentially available to a woman. Also, since a woman's decision to use permanent rather than temporary contraception methods likely reflects a very different life situation, it seems pertinent to analyze the former apart from the latter. Thus, I use a multinomial logit model in order to fully understand decisions over contraception:

$$P(y = j|x) = exp(x\delta_j) / \left[1 + \sum_{h=1}^{J} exp(x\delta_h)\right], \qquad j = 0, 1, 2 \tag{3.3}$$

where x is a vector of covariates and δ a vector of parameters (Note: elements in these vectors differ from those in section 3.4.1). I estimate the probabilities of using temporary and permanent methods with respect to the baseline $j = 0$, never used contraceptive methods or have used only traditional methods. Variables in vector x are the following: exposure to sex education program in school, age of first sexual encounter, education controls (same as in duration models), cohort and marital status dummy variables, number of children, and state and population size dummy variables.

3.5. Data and empirical analysis

3.5.1 Data

I use data drawn from the module on Reproductive Health of the Mexican Family Life Survey (MxFLS-1). The Reproductive Health Questionnaire (RHQ) was applied to all women of fertile age (14-49 years old) within each household. The sample size is 8,500 households and representative at all national, regional, and urban-rural levels. The RHQ gathered information on history of pregnancies, contraception, and sexual health.

Table 3.3 presents summary statistics of relevant variables. Total sample of women in fertile age is 8,743; 2,034 of the original sample are women between 14 and 19 years old. The number of observations after excluding teenagers is 6,709 and this is the final sample I refer to hereafter. I exclude teenagers because they may not have completed the highest level of schooling by the time of the survey, so in their case this would not be a good control of completed education. Average age is 33.1 years and the cohorts are distributed as follows: 11.5% of the women were born in 1953-57; 14.8% in 1958-62; 16.7% in 1963-67; 19.2% in 1968-72; 18.2% in 1973-77; and, 19.6% in 1978-82. In terms of marital status: 20.3% of the women report being single, 5.5% separated, 58.2% married, 2.5 divorced, 1.6% widow, and 11.9% live in consensual union.

Sexual and reproductive indicators reveal that 85.6% of the women reported having had sexual intercourse, with an average duration to first sexual intercourse of 6.4 years after menarche. 82.2% of these women have used contraception methods: 4.0%, traditional methods; 57.4%, temporary methods; and, 38.6%, permanent methods. 23.3% of the women who have had sex reported that their partners have used (male) condom. On average, duration from first sexual intercourse to first use of a contraception method is 3.6 years, duration to first use of a temporary method is 4.1 years, and to first use of condom is 5.3 years. Of all women, 81.4% have been pregnant and their average time duration from menarche to first pregnancy is 7.4 years. 75.1% of these women had a second pregnancy (69.1% of all women) and their average duration from first to second pregnancy is 2.8 years.

Most women were potentially[75] exposed to the first in-school sex education program (1974) for at least one year; on average, they were exposed 3.9 years. 33.3% of the sample was not exposed to sex education either because they did not attain 5th grade of elementary school or because they quit or finished school before 1974, and 40.1% of the sample was exposed to sex education for 5 years. Only 33% of the sample was exposed to the 1987 program upgrading for at least one year; on average, they were exposed 3.6 years. In total, 15.7% of the sample was exposed to the program upgrading for 5 years. According to general education statistics, average schooling is 7.3 years; 54.0% attained less than secondary schooling; 27.9% completed secondary school; 18.0% completed

[75] Information on whether a woman actually received sexual education or not is not available. I assume that the program was put into operation (i.e. contents of free textbooks actually taught in class) in all public schools and probably in private schools since 1974.

high school or a higher level; and, relatively few women attended a private school at their highest level attained (7.6%).

Exposure to birth control and family planning in health facilities began around 1972. I assume that women who were taken care of during their first pregnancy in public clinics and hospitals were exposed to these programs: 97.3% of the women had a first pregnancy in or after 1972 and 59.3% received care in public facilities.

I define characteristics of community of residence at 12 years with respect to available sources of drinking water and sanitary services. 46.0% of the women lived in a community where WC was available regardless of the source of drinking water (bottled, tap, or other); 21.3% lived in a community where sanitary service was a latrine or other and drinking water was obtained from tap; and, 32.7% lived in a community with a latrine or other sanitary service and source of drinking water was other than tap (bottled or other).

Finally, women are distributed by current communities of residence (in 2002) mostly in large cities and rural areas. 39.7% live in places with more than 100,000 habitants; 9.6% live in smaller cities with 15,000-100,000 habitants; 11.3% live in communities with 2,500-15,000 habitants; and, 39.4% live in rural communities with population less than 2,500.

Table 3.3. Summary Statistics.

Variable	Mean	Std Dev.
Sexual and reproductive indicators		
Sexual intercourse (%)	85.6	35.2
Duration (years)	6.4	3.9
Contraception use (%)	82.2	38.2
Traditional (%)	4.0	19.6
Temporary (%)	57.4	49.5
Permanent (%)	38.6	48.7
Condom (%)	23.3	42.3
Duration any method (years)	3.6	4.5
Duration temporary method (years)	4.1	5.2
Duration condom (years)	5.3	5.5
First pregnancy (%)	81.4	38.9
Duration (years)	7.4	4.2
Second pregnancy (%)	69.1	46.2
Duration (years)	2.8	2.5
Exposure variables		
In-school		
Exposure-1974 (years)	3.9	1.5
0 years (%)	33.3	47.1
1 year (%)	4.3	20.2
2 years (%)	16.5	37.1
3 years (%)	2.5	15.5
4 years (%)	3.4	18.2
5 years (%)	40.1	49.0
Exposure-1987 (years)	3.6	1.6
0 years (%)	67.0	47.0
1 year (%)	4.3	20.4
2 years (%)	7.5	26.3
3 years (%)	2.4	15.4
4 years (%)	3.0	17.1
5 years (%)	15.7	36.4
In-health facility (First pregnancy)	0.0	0.0
In or after 1972 (%)	97.3	16.3
Care in public facility (%)	59.3	49.1
Birth cohort (%)		
1953-57	11.5	31.9
1958-62	14.8	35.5
1963-67	16.7	37.3
1968-72	19.2	39.4
1973-77	18.2	38.6
1978-82	19.6	39.7

Table 3.3. (Cont'd).

Variable	Mean	Std Dev.
Education		
Years	731.8	385.6
Less than secondary school (%)	54.0	49.8
Secondary school completed (%)	27.9	44.9
High school or higher (%)	18.0	38.5
Attend private school (%)	7.6	26.5
Age (average)	33.1	8.4
Marital status (%)		
Single	20.3	40.2
Separated	5.5	22.8
Married	58.2	49.3
Divorced	2.5	15.5
Widow	1.6	12.6
Union	11.9	32.4
Community of residence at 12 years (%)		
WC available and any source of drinking water	46.0	49.8
Latrine/other and drinking water from tap	21.3	40.9
Latrine/other and drinking water from	32.7	46.9
State of residence		
Baja California Sur	3.9	19.3
Coahuila	5.4	22.6
Distrito Federal	2.4	15.2
Durango	5.8	23.4
Guanajuato	6.5	24.7
Jalisco	5.3	22.5
Estado de México	7.1	25.6
Michoacán	7.9	27.0
Morelos	4.9	21.5
Nuevo León	8.8	28.3
Oaxaca	6.5	24.7
Puebla	5.2	22.2
Sinaloa	8.2	27.5
Sonora	8.4	27.7
Veracruz	9.2	29.0
Yucatán	4.6	20.9
Community of residence population size		
> 100,000	39.7	48.9
15,000 - 100,000	9.6	29.5
2,500 - 15,000	11.3	31.7
< 2,500	39.4	48.9
Sample size[1]:	6,709	

3.5.2 Empirical analysis

Sexual education programs implemented since 1974 begin at the elementary level in 5th grade and 6th grades, and continue through all three grades at the secondary level—the structure of education levels in Mexico is described in Table 3.4. This implies some women were not exposed to in-school sexual education: (i) those not attaining 5th grade before and after 1974 and (ii) those that finished secondary school before 1974. I exploit this fact to identify the effect of exposure to sexual education. I construct specific year-grades for each individual and an indicator for whether a woman completed targeted school grades before or in/after 1974. I then interact years of schooling attainment with the 1974-dummy to obtain years of exposure (YRSEXP) to program (see Figure 3.2). Figure 3.3 shows the average exposure to the 1974-program by cohort of birth, women born before 1959 were practically not exposed. Posterior generations were increasingly exposed but it is the birth cohort of 1960-1965 the one that faced the most important transition. In Figure 3.4, one can actually observe that, although duration from first sexual intercourse and contraception use was already declining, a significant discontinuity shows between the generations born in 1959 and 1960.

To analyze possible effects of program-upgrading due to social and public health concerns, I design a variable that captures the effect of programs since 1987, when the AIDS epidemic led to an emphasis on protection and condom use. This variable is constructed in the same way as YRSEXP, adjusting calendar-school year to 1987. Both years of exposure-to-education variables are treated as time varying covariates, $x(t)$ in equations (3.1) and (3.2).

Table 3.4. Mexican education system: elementary thru high school.

School Level	Grades (school-years)	
Elementary	1st - 6th	Starting at 6 years old.
Secondary	1st - 3rd	
High school	1st - 3rd	Individuals are around 18 years old when graduating. Required to enroll in college.

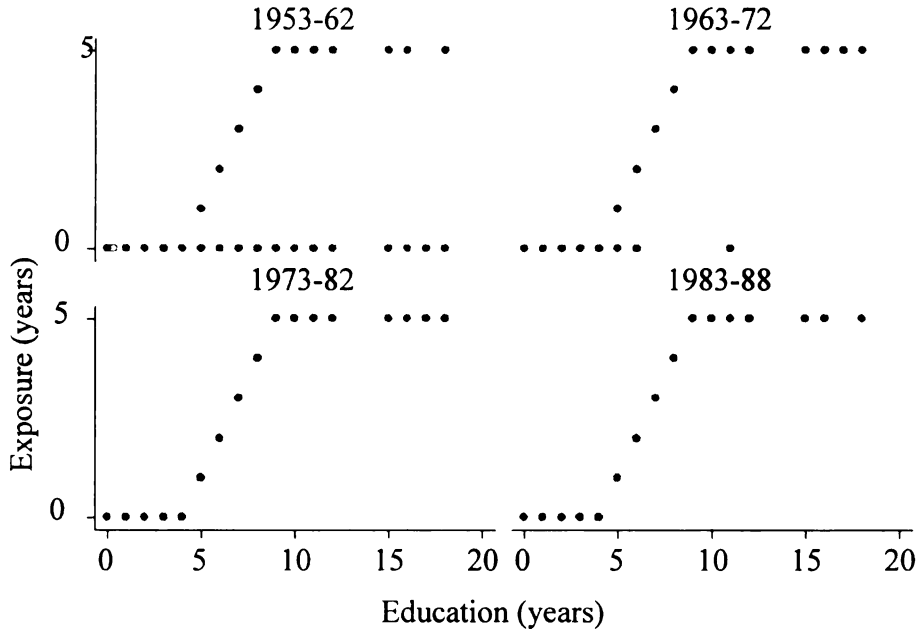

Figure 3.2. Potential exposure to sexual education program at different education years by cohort groups.

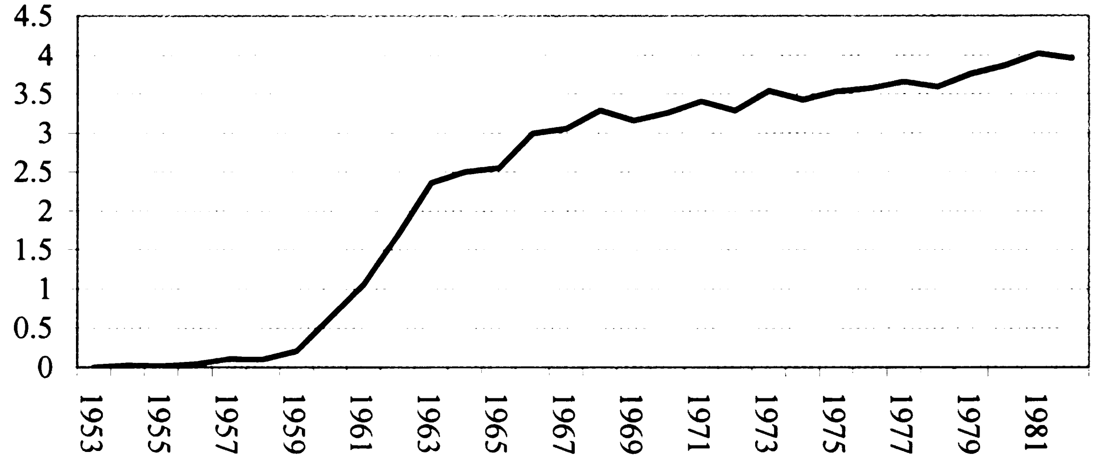

Figure 3.3. Exposure to 1974-Program, average by birth cohort.

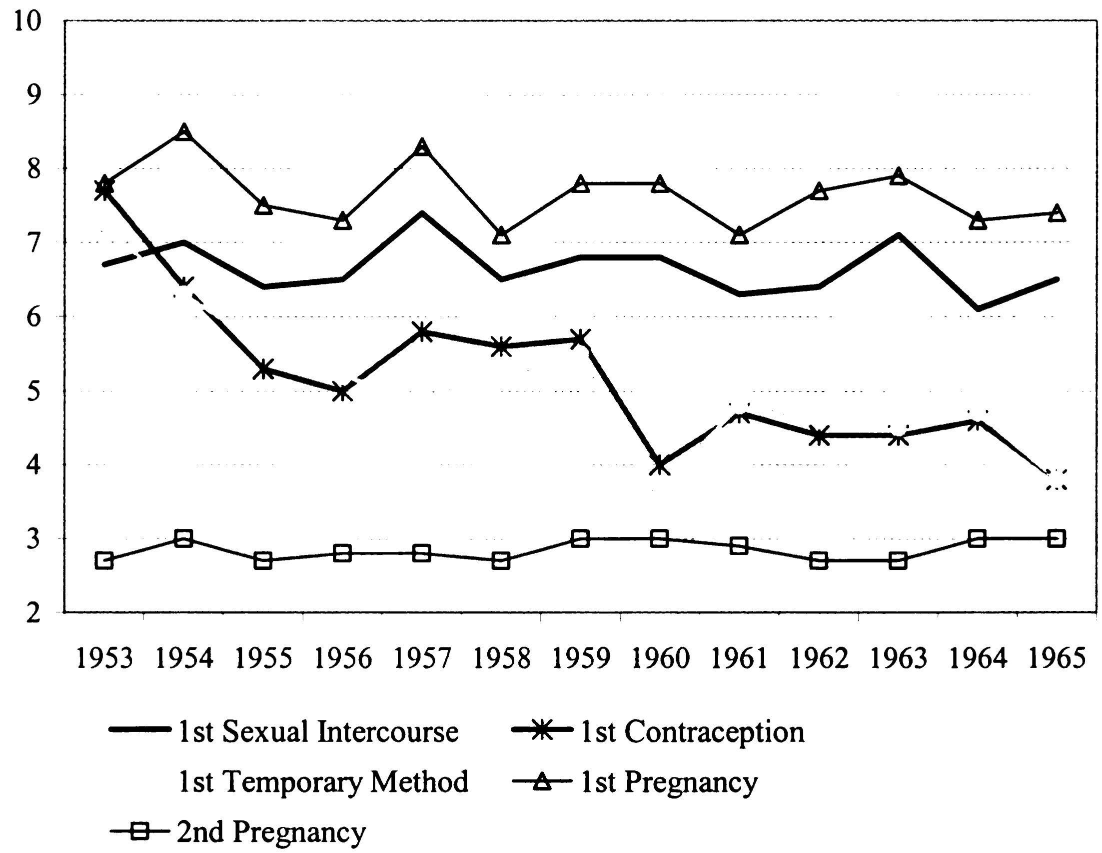

Figure 3.4. Sexual and reproductive behavior, average durations by birth cohort.

To isolate the effect of exposure from that of schooling, I control for the highest level of completed education (a time-invariant variable). In addition, notice that official textbooks are not compulsory for private schools, so to control for this potential source of bias, I include dummy variable indicating whether woman attended a private school.

Public initiatives in the 70s also involved the promotion of birth control and family planning in the health sector. In order to estimate the potential impact of these policies, I estimate the hazard of a second pregnancy, conditional on having been pregnant a first time. This model includes additional variables indicating whether the first child was born in or after 1972 and whether delivery of first child was in a public facility. For a more precise assessment of the effect of obtaining information on birth control in public facilities since 1972, I include an interaction of public facility and year-1972 dummy variables. It is worth noticing that those women who used public health facilities in the 1970s may have been different from those who did not. For example, wealthier women may have been less likely to use public facilities. Ideally, one would look at demand indicators from that period, but they are difficult to obtain. Taking this caveat into account together with the shortcoming that the following data include men, I examine recent evidence in order to get an idea of what types of people use public facilities.

Available information from the National Health Survey (ENSA, 2000)[76] reveals that the proportion of insured people in the upper quartile of income that prefer to attend public facilities is relatively smaller (70.9%) that those in the lower quartiles (80.7%-84.2%). Also, proportion of insured people in the upper quartile (24.5%) that prefer to use private services is relatively larger than those in lower quartiles (12.1%-14.8%).The

[76] Valdespino et al. (2003).

same pattern is observed for uninsured people, but differences between quartiles are bigger. However, actual use of inpatient services[77] do not vary as much across income quartiles: 66.5% of the highest quartile used public health facilities *versus* 70.5% of the lowest quartile, and 29.9% of the highest quartile used private facilities *versus* 25.5% of the lowest quartile. Thus, bias perhaps is not a serious problem and besides can be reduced by controlling for other covariates, such as educational attainment and characteristics of the community of residence at age 12.

All specifications control for cohort, state, and population size (community of residence) dummies to account for socio-cultural factors that may differ across generations, regions, and rural/urban areas. In the cases of first sexual encounter, first contraception method, and type of contraception method used, I also control for marital status—I do not include marital status in analyses of pregnancies since it may be endogenous.

3.6. Results

3.6.1. Duration models

Tables 3.5 and 3.6 contain results of the proportional hazard Cox estimation. These estimates are hazard ratios, $\exp(\beta_i)$, rather than coefficients (β_i)[78]. Results in terms of coefficients can be found in Tables A3.1 and A3.2 in Appendix 3. In Table 3.5, columns (1) thru (3) present estimates of models for first sexual encounter, first pregnancy, and second pregnancy, respectively. Notice that if the hazard ratio is greater (smaller) than

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[77] Approximately, 71% of total inpatient services were used by women, around 49% of them used these services due to pregnancy, birth, and related motives. Of all women using inpatient services for pregnancy and birth attention 71% used public services.

[78] Note that $\beta_i \approx \exp(\beta_i) - 1$ (Cameron and Trivedi, 2005).

one, the coefficient is positive (negative): if $\exp(\beta_i) > 1$ then $\beta_i > 0$ and if $\exp(\beta_i) < 1$ then $\beta_i < 0$.

Exposure to initiatives

Results show that exposure to in-school sex education: (i) increases the hazard of first sexual intercourse; (ii) does not affect the hazard of first pregnancy; and, (iii) decreases the hazard of second pregnancy. Exposure to sex education increases the hazard of first sexual encounter if a woman attended a public school.

For example, for women with no exposure to sex education and who attended a public school, a year of exposure would increase their hazard of first sexual encounter by 4.1%, other things equal. If a woman attended a private school, exposure to sex education has a positive (2.3%) but not significant effect on the hazard of first sexual encounter. Exposure to sex education has a positive but small and statistically insignificant effect (0.3%, if public school) on the hazard of first pregnancy. The effect on the hazard of first pregnancy of exposure having attended a private school is larger but still not statistically significant.

The hazard of second pregnancy is reduced by 2.7%, if a woman attended a public school but not significant if a woman attended a private school. In any of the cases the interaction between exposure and private school is significant. Given that the use of free textbooks is not compulsory for private schools it is likely that actual exposure to sex education of women who attended private schools differs from that of women who attended public schools. Moreover, many private schools are also religious and may try to avoid teaching sex education entirely or delay it until students are older (15-18 years old).

Women who had a first pregnancy in or after 1972 are less likely to become pregnant for a second time (column 3). The exposure to campaigns in public health facilities is captured by an interaction term between having a first pregnancy in or after 1972 and having been cared in a public facility during first pregnancy. The exposure to campaigns reduces the hazard of becoming pregnant for the second time by 31.4%.

Table 3.6 presents estimates of the first time a temporary contraception method was used and the first time a woman's partner used a condom. Both columns include the same covariates except for the exposure variable: In column (1), the exposure variable is designed to capture the introduction of sex education in schools in 1974, whereas the exposure variable in column (2) captures the program upgrading in 1987. Evidence reveals that exposure to sex education increases the hazard of using contraception methods by 7%. When interacted with private school, the exposure effect becomes negative and significant, reducing the hazard of using a contraception method by almost 7% (6.6%). The total effect of exposure for a woman who attended a private school practically disappears. Again, it seems that religiosity in private schools may be playing a role here by promoting traditional contraception methods over temporary ones. In the case of condom use, exposure to sex education has a positive but small (1.2%) and not significant effect, also if a woman attended a private school. Notice that a more complete analysis of the effects of sex education on condom use would involve using a male sample as well.

Other covariates

So far I have discussed the estimates of the interaction between exposure and private school. However, notice that the estimated coefficients of the private school dummy are in all cases, except second pregnancy and condom use, relatively larger and statistically significant. I mentioned the plausible role of religious schools in providing "sex education". Actually, Miranda finds that being a Catholic reduces the risk of first birth even among younger generations of Mexican women. The Catholic Church prohibits the use of 'non-traditional' contraception methods (e.g. pills and condoms), apparently increasing risk of pregnancy. But it also discourages sexual activity out-of-wedlock, which may translate into the delay of first sexual encounter [and potentially first pregnancy] (Miranda, 2006).

However, other factors associated with attendance to a private school could be wealth and, with it, unobservables as, for example, perception of better prospects for education investment that may translate into higher opportunity costs. In turn, a woman with higher opportunity costs could postpone first sexual intercourse if she perceives that risk of pregnancy is high, and/or use contraception methods to delay pregnancy if sexually active. The private school estimated coefficients are negative in Table 3.5 and positive in Table 3.6. The hazards of first sexual encounter and pregnancy decrease by 16% and 19%, respectively. The total effect on the hazard of first contraceptive use is an increase of 48% for a woman who attended a private school and had no exposure to sexual education, while for each additional year of exposure this total effect decreases by around 7%.

Attained education level has large effects on sexual and reproductive behavior, indicating higher opportunity costs of pregnancy. The hazard of first sexual intercourse decreases by 36%, if the highest level of schooling attained was secondary, and by 53%, if high school or more was attained. The hazard of first pregnancy diminishes by 19% and 27%, respectively. The effect of secondary level on the hazard of second pregnancy is negative but relatively small and statistically not significant, while having attained high school or more reduces the hazard of second pregnancy by 26%. The higher the school level attained the larger the hazard of using contraception methods. The hazard of using temporary contraception methods increases by 16%, if secondary, and 24%, if more than secondary. The hazard of partner using condom increases by 73% and 151%, respectively. In the next subsection, I present complementary results on the probability of using different types of contraception methods.

Finally, estimates of cohort coefficients reveal that relatively younger women are having first sexual intercourse earlier than did older ones. The effect on hazard of first sexual intercourse is larger for cohorts born after the early 1970s. Younger women, born since the late 1960s, are also delaying first pregnancy. But this effect is only statistically significant for those born in 1978-82. Also notice that the effect of delaying second pregnancies is not seen until the late 1978-82 generation.

Table 3.5. Cox-proportional hazard models. Hazard ratio estimates.

	(1)	(2)	(3)
Exposure to program in school[1]	1.041	1.003	0.973
	(0.013)***	(0.014)	(0.014)**
Education controls[2]			
Private school (highest level)	0.838	0.814	0.988
	(0.070)**	(0.074)**	(0.120)
Exposure * Private school	1.023	1.011	0.999
	(0.021)	(0.023)	(0.030)
Highest level attained			
Secondary	0.641	0.726	0.928
	(0.029)***	(0.035)***	(0.050)
High school	0.468	0.411	0.744
	(0.022)***	(0.022)***	(0.045)***
Exposure to program in health service[3]			
First child born in or after 1972			0.615
			(0.077)***
Public health facility birth of first child			1.265
			(0.237)
Interaction			0.686
Year 1972 * public health facility			(0.130)**
Cohort dummies[4]			
1958-62	1.074	1.138	1.108
	(0.053)	(0.055)***	(0.061)*
1963-67	1.051	1.053	1.186
	(0.059)	(0.062)	(0.072)***
1968-72	1.039	0.979	1.086
	(0.059)	(0.059)	(0.067)
1973-77	1.177	0.957	1.019
	(0.068)***	(0.059)	(0.066)
1978-82	1.475	0.783	0.770
	(0.089)***	(0.052)***	(0.060)***
Single woman (dummy variable)	0.138		
	(0.008)***		

Table 3.5. (Cont'd).

	(1)	(2)	(3)
Community at 12 years[5]			
Latrine/other and drinkable water from tap	1.087	1.103	0.970
	(0.038)**	(0.042)***	(0.039)
Latrine/other and drinkable water from other source	1.074	1.083	1.016
	(0.037)**	(0.040)**	(0.038)
State and population size dummies[6]			
Baja California Sur	1.144	1.243	1.106
	(0.108)	(0.122)**	(0.124)
Coahuila	1.129	1.125	1.185
	(0.106)	(0.117)	(0.132)
Durango	1.087	1.226	1.250
	(0.097)	(0.118)**	(0.134)**
Guanajuato	0.709	0.680	1.234
	(0.064)***	(0.067)***	(0.138)*
Jalisco	0.774	0.894	1.211
	(0.071)***	(0.085)	(0.135)*
Mexico	1.080	1.231	1.186
	(0.096)	(0.116)**	(0.126)
Michoacan	0.941	1.029	1.211
	(0.083)	(0.096)	(0.127)*
Morelos	1.070	1.118	1.125
	(0.103)	(0.114)	(0.128)
Nuevo Leon	0.796	0.907	1.054
	(0.069)***	(0.082)	(0.110)
Oaxaca	1.204	1.183	1.190
	(0.114)**	(0.118)*	(0.131)
Puebla	1.087	1.084	1.250
	(0.108)	(0.111)	(0.138)**
Sinaloa	1.099	1.235	1.262
	(0.096)	(0.114)**	(0.129)**
Sonora	1.088	1.074	1.137
	(0.096)	(0.099)	(0.122)
Veracruz	1.092	1.034	1.030
	(0.096)	(0.096)	(0.107)
Yucatan	0.773	0.844	1.098
	(0.070)***	(0.082)*	(0.124)

Table 3.5. (Cont'd).

	(1)	(2)	(3)
Population > 100,000	1.054	1.056	0.931
	(0.034)	(0.036)	(0.033)**
Population 15,000 - 100,000	0.974	1.076	0.979
	(0.045)	(0.055)	(0.049)
Population 2,500 - 15,000	0.956	0.959	1.008
	(0.041)	(0.046)	(0.049)
Observations	54,913	62,638	20,434
Pseudo R-squared	0.03	0.01	0.00
Log-pseudolikelihood	-43,829.96	-42,860.19	-31,002.88
Wald Chi^2	1840.25	943.39	298.10

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Column (1): First sexual encounter. Duration calculated with respect to menarche.
Column (2): First pregnancy. Duration calculated with respect to menarche.
Column (3): Second pregnancy. Duration calculated with respect to first pregnancy.
[1] Potential exposure to in-school sexual education programs calculated as the interaction between attained education and calendar years of school attendance for 1974 or after.
[2] Other education covariates: dummy variable indicating the highest level of schooling an individual attended, representing a higher opportunity cost of becoming pregnant and possibly more access to information and/or understanding of contraceptive method.
[3] Health sector covariates account for public initiatives for promoting family control.
[4] Baseline: women born between 1953 and 1957, i.e. who were 40-45 years old in 2002.
[5] Baseline: WC available and any source of drinkable water (bottled, tap, or other).
[6] Baseline: Mexico, D.F and communities with <2,500 habitants. Dummies are of current state of residence, using state of residence at 12 makes no difference on estimated coefficients.

Table 3.6. Cox-proportional hazard models. Hazard ratio estimates.

	(1)	(2)
Exposure to program in school (1974)[1]	1.070	
	(0.016)***	
Exposure to program in school (1987)[2]		1.012
		(0.029)
Education controls[3]		
Private school (highest level)	1.480	1.166
	(0.199)***	(0.143)
Exposure * Private school	0.934	1.018
	(0.030)**	(0.049)
Highest level attained		
Secondary	1.160	1.727
	(0.066)***	(0.135)***
High school	1.238	2.506
	(0.081)***	(0.228)***
Cohort dummies[4]		
1958-62	1.259	1.807
	(0.074)***	(0.253)***
1963-67	1.269	2.437
	(0.082)***	(0.332)***
1968-72	1.517	3.869
	(0.100)***	(0.522)***
1973-77	1.828	5.940
	(0.124)***	(0.872)***
1978-82	2.020	7.182
	(0.147)***	(1.252)***
Marital status[5]		
Separated	1.477	1.023
	(0.142)***	(0.169)
Married	1.867	1.328
	(0.140)***	(0.153)**
Divorced	2.025	1.296
	(0.232)***	(0.245)
Widow	1.912	1.195
	(0.243)***	(0.324)
Living with partner (not married)	1.649	1.083
	(0.134)***	(0.145)

Table 3.6. (Cont'd).

	(1)	(2)
Community at 12 years[6]		
Latrine/other and drinkable water from tap	0.974	0.949
	(0.039)	(0.075)
Latrine/other and drinkable water from other source	0.823	0.936
	(0.034)***	(0.078)
State and population size dummies[7]		
Baja California Sur	1.677	1.441
	(0.211)***	(0.298)*
Coahuila	1.256	0.795
	(0.154)*	(0.169)
Durango	1.464	1.034
	(0.172)***	(0.210)
Guanajuato	0.743	1.244
	(0.096)**	(0.254)
Jalisco	1.014	1.424
	(0.126)	(0.279)*
Mexico	0.948	0.941
	(0.114)	(0.190)
Michoacan	0.796	0.847
	(0.096)*	(0.173)
Morelos	1.046	0.878
	(0.136)	(0.192)
Nuevo Leon	1.128	0.824
	(0.132)	(0.166)
Oaxaca	0.755	0.681
	(0.096)**	(0.150)*
Puebla	0.639	0.426
	(0.083)***	(0.104)***
Sinaloa	1.938	1.372
	(0.220)***	(0.260)*
Sonora	1.288	1.408
	(0.151)**	(0.270)*
Veracruz	0.950	0.664
	(0.113)	(0.135)**
Yucatan	0.988	0.788
	(0.125)	(0.173)

Table 3.6. (Cont'd).

	(1)	(2)
Population > 100,000	1.101	1.143
	(0.042)**	(0.084)*
Population 15,000 - 100,000	1.125	1.131
	(0.063)**	(0.122)
Population 2,500 - 15,000	1.083	1.298
	(0.058)	(0.127)***
Observations	45,197	80,903
Pseudo R-squared	0.02	0.04
Log-pseudolikelihood	-31,655.00	-10,398.62
Wald Chi2	1260.60	843.73

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Column (1): First contraception method. Durations are calculated with respect to first sexual encounter.
Column (2): First condom use. Durations are calculated with respect to first sexual encounter.
[1] Potential exposure to in-school sexual education programs calculated as the interaction between attained education and calendar years of school attendance for 1974 or after.
[2] Potential exposure to in-school sexual education programs calculated as the interaction between attained education and calendar years of school attendance for 1987 or after. Due to AIDS epidemic sexual protection started to be emphasized.
[3] Other education covariates: dummy variable indicating the highest level of schooling an individual attended, representing a higher opportunity cost of becoming pregnant and possibly more access to information and/or understanding of contraceptive method.
[4] Baseline: women born between 1953 and 1957, i.e. who were 40-45 years old in 2002.
[5] Baseline: Single women.
[6] Baseline: WC available and any source of drinkable water (bottled, tap, or other).
[7] Baseline: Mexico, D.F and communities with <2,500 habitants.

3.6.2 Multinomial logit models

Exposure to initiatives

Table 3.7 contains the results of multinomial logit models for contraception method decisions. Column (1) refers to temporary methods (2,820 observations) and column (2) refers to permanent methods (1,790 observations), using the "never used or used only traditional methods" outcome as the baseline for comparison (1,345 observations). According to these results, exposure to in-school sex education is weakly correlated with use of modern contraception methods. An additional year of exposure to in-school sex education increases the log-odds of using temporary contraception methods by 0.06 if a woman attended a public school. But an additional year of exposure to sex education decreases by 0.06 the log-odds of using permanent contraception methods—weakly significant. If a woman attended a private school the total effect of exposure to sex education decreases in the case of temporary methods and increases (in absolute terms) in the case of permanent methods, but the interaction estimate is not statistically significant in any specification.

Other covariates

The coefficients of the private school dummy are large, positive and, although statistically insignificant, provide some indication confirming the findings from the duration models: women attending private schools may, probably due to unobservables associated with wealth, face relatively higher opportunity costs. As in the duration model results, the use of contraception methods is positively correlated with school attainment: (i) the log-odds of using temporary methods increase by 0.30 if highest education level is secondary and by 0.40 if high school or more; and, (ii) the log-odds of using permanent methods increase by 0.59, if secondary, and by 0.43, if high school.

Table 3.7. Multinomial logit: types of contraception methods. [1]

	(1)		(2)		(3)	
	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent
Age of first sexual encounter	-0.044	-0.053	-0.044	-0.050	-0.044	-0.049
	(0.010)***	(0.012)***	(0.010)***	(0.012)***	(0.011)***	(0.012)***
Exposure to program[2]	0.059	-0.067	0.059	-0.062	0.059	-0.060
	(0.031)*	(0.036)*	(0.031)*	(0.036)*	(0.031)*	(0.037)
Education controls[3]						
Private school (highest level)	0.243	0.488	0.239	0.492	0.238	0.500
	(0.347)	(0.351)	(0.346)	(0.347)	(0.346)	(0.348)
Exposure * Private school	-0.011	-0.088	-0.011	-0.089	-0.012	-0.092
	(0.082)	(0.086)	(0.081)	(0.085)	(0.081)	(0.085)
Highest level attained						
Secondary	0.304	0.591	0.303	0.584	0.303	0.581
	(0.126)**	(0.147)***	(0.126)**	(0.147)***	(0.126)**	(0.147)***
High school	0.404	0.432	0.403	0.440	0.397	0.429
	(0.151)***	(0.175)**	(0.151)***	(0.175)**	(0.151)***	(0.175)**
Cohort dummies[4]						
1958-62	0.562	0.940	0.559	0.919	0.561	0.923
	(0.129)***	(0.134)***	(0.129)***	(0.135)***	(0.129)***	(0.135)***
1963-67	0.629	0.991	0.630	0.976	0.635	0.985
	(0.131)***	(0.138)***	(0.131)***	(0.138)***	(0.131)***	(0.138)***
1968-72	0.747	0.876	0.749	0.879	0.752	0.887
	(0.127)***	(0.138)***	(0.127)***	(0.139)***	(0.127)***	(0.139)***
1973-77	0.973	0.156	0.971	0.166	0.976	0.181
	(0.129)***	(0.154)	(0.129)***	(0.154)	(0.129)***	(0.154)
1978-82	0.443	-1.887	0.434	-1.872	0.443	-1.851
	(0.132)***	(0.250)***	(0.131)***	(0.250)***	(0.131)***	(0.250)***

Table 3.7. (Cont'd).

	(1)		(2)		(3)	
	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent
Marital status[5]						
Separated	0.667	1.173	0.682	1.191	0.668	1.172
	(0.176)***	(0.242)***	(0.176)***	(0.242)***	(0.176)***	(0.242)***
Married	1.106	1.927	1.124	1.946	1.110	1.921
	(0.125)***	(0.193)***	(0.124)***	(0.193)***	(0.125)***	(0.193)***
Divorced	1.045	1.616	1.057	1.650	1.036	1.613
	(0.258)***	(0.307)***	(0.258)***	(0.306)***	(0.257)***	(0.307)***
Widow	1.199	1.411	1.218	1.432	1.190	1.392
	(0.279)***	(0.359)***	(0.277)***	(0.354)***	(0.279)***	(0.355)***
Living with partrner (not married)	0.856	1.644	0.873	1.674	0.863	1.656
	(0.144)***	(0.212)***	(0.143)***	(0.212)***	(0.143)***	(0.212)***
Pregnancies and children						
Pregnancies	0.068	0.270				
	(0.027)**	(0.028)***				
Alive children			0.062	0.286	0.061	0.284
			(0.028)**	(0.030)***	(0.028)**	(0.030)***
Dead children					-0.332	0.015
					(0.190)*	(0.185)
Lost baby while pregnant					0.140	0.182
					(0.081)*	(0.084)**
Community at 12 years[6]						
Latrine/other and drinkable water from tap	-0.042	-0.107	-0.042	-0.115	-0.039	-0.112
	(0.105)	(0.119)	(0.104)	(0.119)	(0.105)	(0.119)
Latrine/other and drinkable water from other	-0.426	-0.551	-0.425	-0.573	-0.424	-0.576
	(0.095)***	(0.111)***	(0.095)***	(0.111)***	(0.095)***	(0.111)***

Table 3.7. (Cont'd).

	(1)		(2)		(3)	
	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent
State and population size dummies[7]						
Baja California Sur	0.227	1.343	0.226	1.308	0.234	1.330
	(0.331)	(0.358)***	(0.331)	(0.356)***	(0.331)	(0.357)***
Coahuila	0.072	0.177	0.073	0.148	0.068	0.161
	(0.300)	(0.340)	(0.300)	(0.337)	(0.300)	(0.338)
Durango	0.562	0.503	0.565	0.476	0.554	0.477
	(0.297)*	(0.341)	(0.297)*	(0.340)	(0.297)*	(0.340)
Guanajuato	-1.010	-1.489	-1.010	-1.544	-1.008	-1.542
	(0.280)***	(0.340)***	(0.280)***	(0.339)***	(0.280)***	(0.340)***
Jalisco	-0.296	-0.554	-0.303	-0.611	-0.300	-0.590
	(0.291)	(0.336)*	(0.291)	(0.334)*	(0.291)	(0.335)*
Mexico	-0.373	-0.163	-0.379	-0.210	-0.380	-0.193
	(0.279)	(0.323)	(0.279)	(0.321)	(0.279)	(0.321)
Michoacan	-0.844	-0.935	-0.855	-1.018	-0.846	-0.991
	(0.271)***	(0.319)***	(0.271)***	(0.317)***	(0.271)***	(0.318)***
Morelos	-0.197	0.550	-0.204	0.496	-0.199	0.522
	(0.300)	(0.338)	(0.300)	(0.336)	(0.300)	(0.336)
Nuevo Leon	0.179	0.112	0.170	0.056	0.176	0.084
	(0.283)	(0.322)	(0.283)	(0.320)	(0.283)	(0.321)
Oaxaca	-0.904	-0.693	-0.904	-0.720	-0.894	-0.699
	(0.278)***	(0.325)**	(0.278)***	(0.323)**	(0.278)***	(0.323)**
Puebla	-1.037	-0.961	-1.038	-1.008	-1.034	-0.990
	(0.284)***	(0.331)***	(0.284)***	(0.329)***	(0.284)***	(0.329)***
Sinaloa	0.700	1.113	0.701	1.079	0.704	1.099
	(0.293)**	(0.330)***	(0.293)**	(0.328)***	(0.293)**	(0.329)***
Sonora	0.082	0.547	0.082	0.520	0.076	0.532
	(0.281)	(0.320)*	(0.281)	(0.318)	(0.281)	(0.318)*
Veracruz	-0.285	-0.076	-0.290	-0.125	-0.281	-0.098
	(0.273)	(0.315)	(0.273)	(0.313)	(0.273)	(0.313)
Yucatan	-0.359	0.309	-0.360	0.282	-0.359	0.294
	(0.310)	(0.344)	(0.310)	(0.341)	(0.310)	(0.342)

Table 3.7. (Cont'd).

	(1)		(2)		(3)	
	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent
State and population size dummies[7]						
Population > 100,000	0.333	0.781	0.341	0.814	0.333	0.804
	(0.093)***	(0.107)***	(0.093)***	(0.107)***	(0.093)***	(0.108)***
Population 15,000 - 100,000	0.092	0.795	0.097	0.812	0.092	0.811
	(0.138)	(0.147)***	(0.138)	(0.147)***	(0.138)	(0.147)***
Population 2,500 - 15,000	0.155	0.138	0.162	0.172	0.166	0.165
	(0.121)	(0.142)	(0.121)	(0.142)	(0.122)	(0.143)
Constant	-0.058	-1.873	-0.036	-1.899	-0.053	-1.952
	(0.362)	(0.426)***	(0.361)	(0.424)***	(0.362)	(0.426)***
Observations	5,955		5,955		5,955	
Pseudo R-squared	0.15		0.15		0.15	
Log-likelihood	-5,335.85		-5,327.89		-5,322.19	
LR Chi^2	1,355.52		1,366.73		1,376.48	

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Column (1): controls for number of pregnancies.

Column (2): controls for number of children born alive.

Column (3): controls for number of children born alive, born dead, and lost during pregnancy.

[1] Base: Have not used contraceptive methods or have used only traditional methods (periodic abstinence, teas or herbs). Temporal: Have used temporal methods (hormones and local) (may have used traditional as well but not permanent). Permanent: Permanent methods (may have used temporal and/or traditional as well).

[2] Potential exposure to in-school sex education programs calculated as the interaction between attained education and calendar years of school attendance for 1974 or after.

[3] Other education covariates: dummy variable indicating the highest level of schooling an individual attended, representing a higher opportunity cost of becoming pregnant and possibly more access to information and/or understanding of contraceptive method

[4] Baseline: women born between 1953 and 1957, i.e. who were 40-45 years old in 2002.

[5] Baseline: Single women

[6] Baseline: WC available and any source of drinkable water (bottled, tap, or other).

[7] Baseline: Mexico, D.F and communities with <2,500 habitants.

Finally, the higher the age at which a woman experiences her first sexual encounter, the less likely it is that she uses contraception methods, both temporary and permanent. Age-cohort variables capture the lifecycle or fertility profiles that change as women get older. The log-odds of using temporary methods increase among younger cohorts, ranging from 0.56 to 0.97. This effect becomes smaller among those born in 1978-82 (20-24 years old in 2002) most likely because they are actually trying to get pregnant. Similarly, the increase in the log-odds of using a permanent contraception method starts diminishing for the 1968-72 generation (30-34 years old), becoming negative for the youngest women. That younger cohorts are less likely to use permanent methods reflects that they are looking forward to start motherhood or have more children. Finally, non-single women are more likely to use contraception methods than single women, also an intuitive result.

3.7. Conclusions

In this chapter, I examine whether public initiatives launched in the 1970s contributed to change sexual and reproductive behavior of Mexican women. I characterize sexual and reproductive behavior using information on first sexual encounter, first and second pregnancies, and utilization of contraceptive methods. I use duration-hazard procedures to model first sexual encounter, first and second pregnancies, first use of contraception method, and first use of condom by woman's partner and multinomial logit models to estimate the choice of contraception method type.

Results suggest that exposure to in-school sex education increases the hazard of first sexual intercourse and decreases the hazard of second pregnancy but does not affect the hazard of first pregnancy, regardless of the type of school a woman attended. Also, I find that exposure to campaigns in public facilities reduces the hazard of becoming pregnant for the second time. Additionally, evidence reveals that exposure to sex education increases the hazard of using (all kinds of) temporary contraceptives, but this effect practically disappears if a private school was attended. And, specifically, sex education that emphasizes protection seems to have no effect on condom use; however, a more accurate result would require the analysis of male behavior as well. On the other hand, according to results on the choice of contraception types, I find evidence of exposure to in-school sex education influencing the use of modern methods.

Other important factors associated with sexual and reproductive behavior are completed education, private school attendance, and birth cohorts. Completed education has negative effects on first sexual encounter and first and second pregnancies, and positive effects on the utilization of contraception methods. The choice of modern contraception methods over traditional is also positively correlated with school attainment. These results may be indicating higher opportunity costs of pregnancy.

Attending a private school is associated with larger durations to first sexual encounter and first pregnancy. Many private schools in Mexico are religious and thus religion may be encouraging postponement of first sexual encounter and pregnancy until marriage. However, it should also be discouraging the use of non-traditional contraception methods, i.e. temporary; but, attendance to a private school is associated with a smaller duration from first sexual encounter to first use of temporary contraception methods. So maybe it is wealth influencing the latter result, since relative wealthier people—with higher expectations of education investment—are more likely to attend private schools. In this sense, a woman with higher opportunity costs may have higher incentives to use contraception methods in order to delay pregnancy or to postpone first sexual encounter if her perceived risk of pregnancy is high enough. Yet, this is only weakly consistent because attendance at a private school does not have a (statistically) significant effect on the choice of contraception method.

Finally, age-cohort variables capture the lifecycle or fertility profiles that change as women get older, as well as generational differences. Relatively younger women are having first sexual intercourse earlier than did older ones but are postponing first and second pregnancies. They tend to use contraception methods earlier with respect to first sexual encounter. Younger women are less likely to use temporary and permanent methods than older women maybe due to seeking pregnancy.

CONCLUSIONS

This study consists of three essays on the economics of health using the first wave of the Mexican Family Life Survey (2002). The first two chapters focus on school age children and the third one on women in fertile age. Chapter 1 addresses the questions of whether overweight has increased among Mexican school age children and, if so, what factors may have contributed to this. Chapter 2 analyzes whether more educated mothers have healthier children as measured by hemoglobin concentrations in blood and through which possible ways may maternal education operate to affect child health. Chapter 3 deals with whether public initiatives launched in the 1970s affected sexual and reproductive behavior of women. These works contribute to health economics literature in several ways.

The first proposes a theoretical model of a mother's allocation of food and time. It complements existing empirical evidence of an increase in prevalence of overweight in Mexico in recent years. Moreover, it analyzes the case of school age children, a group largely overlooked by nutritional and health national surveys. In particular, it provides evidence supporting that Mexican children are heavier than before, and that some indications that contributing factors might be an increase in mother's BMI especially for girls, an increase of maternal labor supply in the case of boys, less presence of father at home for boys, and an increase in adult males BMI at a community level. Future research should investigate the channels through which community level patterns affect individual children's behavior with respect to, for example, dietary and activity habits.

Second, the estimates of maternal education effects on child hemoglobin levels complement the extensive research on the function of parental role in child health, mainly measured by anthropometrics, mortality, immunization, and dietary intakes. Also, since labor market participation of Mexican women is relatively low, so that market returns to schooling fail to fully capture the impact of educating Mexican women, estimated effects of maternal education on child health provide an appraisal of non-market returns to schooling. Estimated effects of maternal education are positive, although small in terms of falling into or recovering from anemia. Evidence suggests that maternal education may be operating with public health services (clinic/hospital) through a substitution effect. Additionally, there is some indication that mother's labor supply may not be endogenous, which is not implausible since low hemoglobin levels are not obvious to the mother. Yet, further analysis would be needed to confirm this.

Finally, the third essay is distinguished from previous studies because it explicitly deals with the effect of sexual education, birth control, and family planning public initiatives on the reproductive and sexual behavior of Mexican women. More precisely, it analyzes possible changes in sexual and reproductive behavior due to exposure to programs in schools and in health facilities. Sexual and reproductive behavior is characterized by various indicators: first sexual encounter, first and second pregnancies, and utilization of contraceptive methods. Public programs are identified by individual exposure to in-school sexual education and to birth control promotion in public health facilities. Results suggest that exposure to in-school sex education is associated with earlier first sexual intercourse without affecting the hazard of first pregnancy. Both in-school and in-health facility exposure decreases the hazard of second pregnancy.

Evidence reveals that sex education may be effective in promoting an earlier use of contraception but not specifically condoms, which would also require changes in male behavior. On the other hand, evidence is weak regarding the influence of exposure to in-school sex education on the use of modern contraception methods rather than traditional ones.

APPENDICES

APPENDIX 1

Total differentiation of (1.2) and ΔB leads to equations A1.1 and equation A1.2:

$$- wdt - pdF - dX = Fdp - (T - t)dw - dY$$

$$-wd\lambda + \left[v' f_{tt} + v'' f_t^{\,2}\right]dt + \left[v' f_{tF} + v'' f_t f_F\right]dF = \lambda dw \tag{A1.1}$$

$$- pd\lambda + \left[v' f_{Ft} + v'' f_F f_t\right]dt + \left[u_{FF} + v' f_{FF} + v'' f_F^2\right]dF + u_{FX} dX = \lambda dp$$

$$- d\lambda + u_{XF} dF + u_{XX} dX = 0$$

$$d\Delta B = f_t dt + f_F dF \tag{A1.2}$$

Derivation of expressions in (1.3):

From (A1.2), it is easy to see that

$$\frac{d\Delta B}{dw} = f_t \frac{dt}{dw} + f_F \frac{dF}{dw}$$

$$\text{(A1.3)}$$

$$\frac{d\Delta B}{dp} = f_t \frac{dt}{dp} + f_F \frac{dF}{dp}$$

Using (A1.1) obtain and substitute the following into (A1.3):

$$\frac{dt}{dw} = \varphi_{tt} + (T - t)\omega_t, \quad \frac{dF}{dw} = \varphi_{Ft} + (T - t)\omega_F,$$

$$\frac{dF}{dp} = \varphi_{FF} - F\omega_F, \quad \frac{dt}{dp} = \varphi_{tF} - F\omega_t$$

where

$$\varphi_{tt} = \lambda\left[\frac{-p^2 u_{XX} + 2pu_{XF} - \cup_{FF}}{|\overline{H}|}\right],\ \varphi_{FF} = \lambda\left[\frac{-w^2 u_{XX} - \cup_{tt}}{|\overline{H}|}\right],$$

$$\varphi_{Ft} = \varphi_{tF} = \lambda\left[\frac{w(pu_{XX} - u_{XF}) + \cup_{tF}}{|\overline{H}|}\right],$$

$$\omega_t = \frac{u_{XX}(p\cup_{tF} - w\cup_{FF}) + wu_{XF}{}^2 - \cup_{tF}u_{XF}}{|\overline{H}|},$$

$$\omega_F = \frac{u_{XX}(w\cup_{tF} - p\cup_{tt}) + \cup_{tt}u_{XF}}{|\overline{H}|},$$

$$\cup_{FF} = u_{FF} + v' f_{FF} + v'' f_F^2 = u_{FF} + \beta^2\left(1 - \frac{t}{T}\right)^2 v'',$$

$$\cup_{tt} = v' f_{tt} + v'' f_t^2 = \left(-\frac{\beta F}{T}\right)^2 v'',$$

$$\cup_{tF} = \cup_{Ft} = v' f_{tF} + v'' f_t f_F = v' f_{Ft} + v'' f_t f_F = -\frac{\beta}{T}\left[v' + \beta F\left(1 - \frac{t}{T}\right)v''\right], \text{ and}$$

$$|\overline{H}| < 0.$$

Note that $\cup_{tF} = \cup_{Ft}$ is "small enough" for $\varphi_{tF} = \varphi_{Ft} > 0$, if

$$w(u_{XF} - pu_{XX}) > v' f_{tF} + v'' f_t f_F .$$

APPENDIX 2

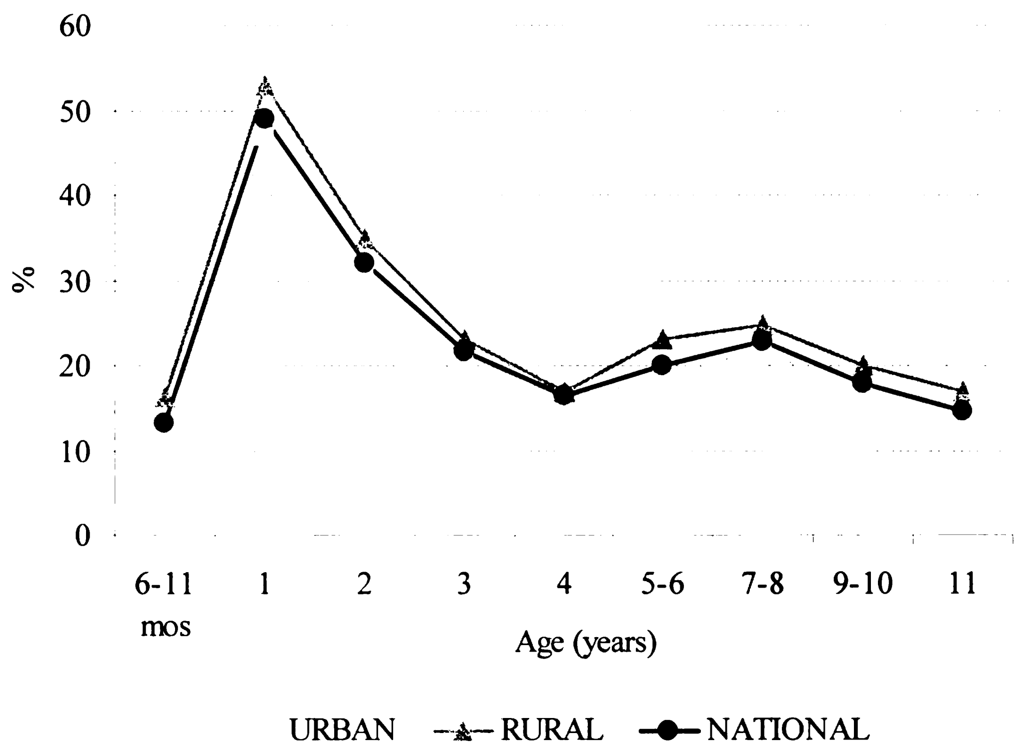

Figure A2.1. Prevalence of anemia among Mexican children by age groups.

Source: Own graph using estimates by Villalpando et al., 2003.

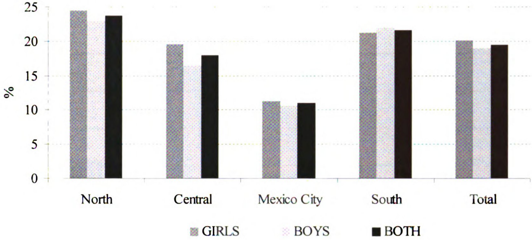

Figure A2.2. Prevalence of anemia among Mexican children by regions.

Source: Own graph using estimates by Rivera et al., 2001.

APPENDIX 3

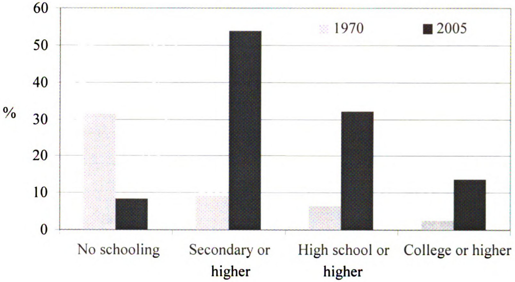

Figure A3.1. Education attainment in Mexico (1970 and 2005).

Source: INEGI. Selected years and indicators of education statistics—*Estadísticas sociodemográficas: educación*. (Downloaded from http://www.inegi.gob.mx/est/default.aspx?c=2359).

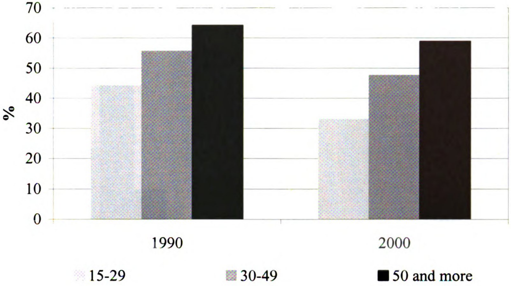

Figure A3.2. Attitudes towards role of women as mothers in Mexico: % who thinks a woman needs to have children to be fulfilled by age groups.

Source: Own figure using selected years and indicators of the World Value Survey, WVS. (Online Data Analysis at http://www.worldvaluessurvey.org/). Question: Do you think that a woman has to have children in order to be fulfilled or is this not necessary? Answers: Not necessarily or Needs children.

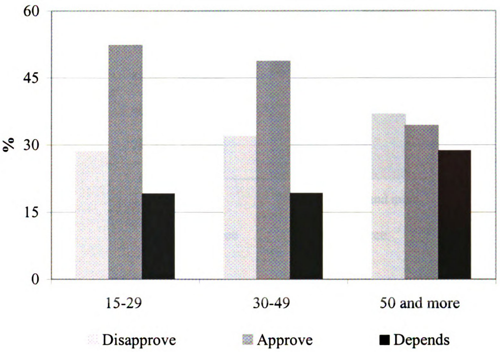

Figure A3.3. Attitudes towards women deciding to become single parents in Mexico: % of approval by age groups.

Source: Own figure using pooled samples (1990, 1996 and 2000) and selected indicators of the World Value Survey, WVS (Online Data Analysis at http://www.worldvaluessurvey.org/). Question: If a woman wants to have a child as a single parent but she doesn't want to have a stable relationship with a man, do you approve or disapprove?

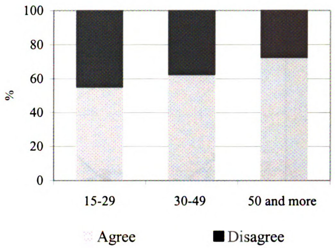

Figure A3.4. Attitudes toward women wanting a home and children in Mexico (%).

Source: Own figure using 1990 sample and selected indicators of the World Value Survey, WVS (Online Data Analysis at http://www.worldvaluessurvey.org/). Question: Strongly agree, agree, disagree or strongly disagree with the statement: "A job is alright but what most women really want is a home and children." These four answer categories were collapsed into two groups.

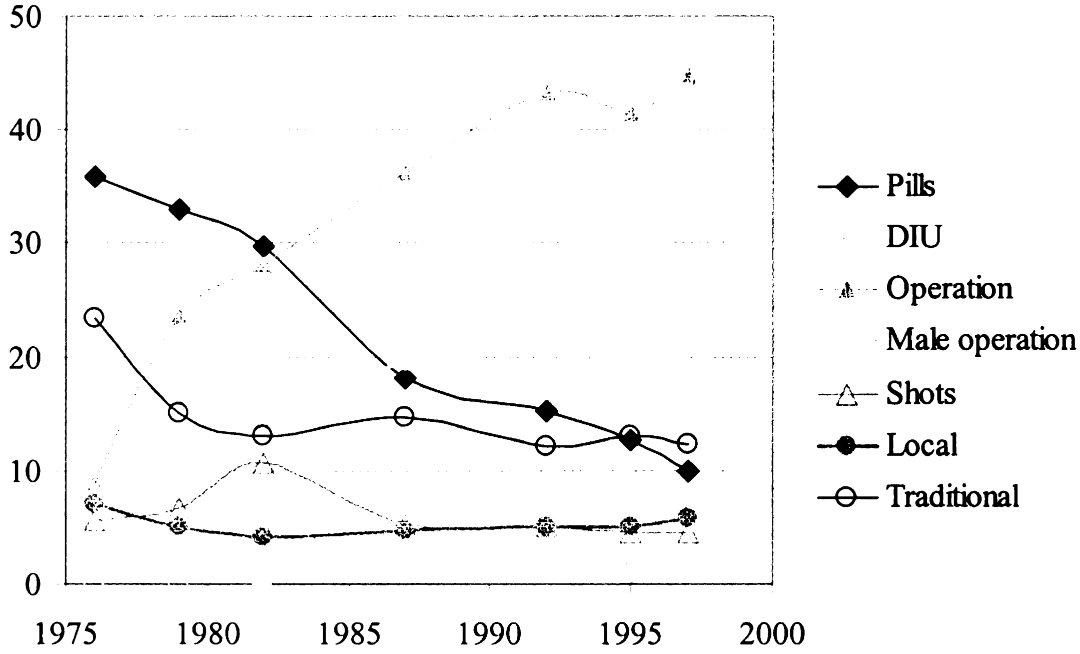

Figure A3.5. Demand for contraception of Mexican users (%), 1976-1997.

Source: Own figure with estimates of the Mexican National Population Council based on national demographic surveys. Original Figure may be found in CONAPO (2000).

Table A3.1. Proportional hazard models, Cox estimation. Observation level: woman-year.

	(1)	(2)	(3)
Exposure to program in school[1]	0.040	0.003	-0.027
	(0.013)***	(0.014)	(0.014)**
Education controls[2]			
Private school (highest level)	-0.177	-0.206	-0.012
	(0.084)**	(0.091)**	(0.122)
Exposure * Private school	0.023	0.011	-0.001
	(0.021)	(0.023)	(0.031)
Highest level attained			
Secondary	-0.445	-0.320	-0.074
	(0.045)***	(0.048)***	(0.054)
High school	-0.758	-0.889	-0.296
	(0.048)***	(0.053)***	(0.061)***
Exposure to program in health service[3]			
First child born in or after 1972			-0.486
			(0.125)***
Public health facility birth of first child			0.235
			(0.187)
Interaction			-0.377
Year 1972 * public health facility			(0.190)**
Cohort dummies[4]			
1958-62	0.072	0.129	0.102
	(0.049)	(0.049)***	(0.055)*
1963-67	0.050	0.052	0.171
	(0.056)	(0.059)	(0.061)***
1968-72	0.039	-0.021	0.082
	(0.057)	(0.060)	(0.061)
1973-77	0.163	-0.044	0.019
	(0.058)***	(0.062)	(0.065)
1978-82	0.389	-0.245	-0.261
	(0.060)***	(0.067)***	(0.078)***
1983-88			
Single woman (dummy variable)	-1.978		
	(0.056)***		
Community at 12 years[5]			
Latrine/other and drinkable water from tap	0.084	0.098	-0.030
	(0.035)**	(0.038)***	(0.040)
Latrine/other and drinkable water from other	0.072	0.080	0.016
	(0.035)**	(0.037)**	(0.038)

Table A3.1. (Cont'd).

	(1)	(2)	(3)
State[6] and population size dummies			
Baja California Sur	0.134	0.218	0.101
	(0.095)	(0.098)**	(0.112)
Coahuila	0.121	0.118	0.170
	(0.094)	(0.104)	(0.111)
Durango	0.084	0.204	0.223
	(0.090)	(0.096)**	(0.107)**
Guanajuato	-0.344	-0.386	0.210
	(0.090)***	(0.099)***	(0.112)*
Jalisco	-0.256	-0.112	0.191
	(0.091)***	(0.095)	(0.112)*
Mexico	0.077	0.208	0.170
	(0.089)	(0.094)**	(0.106)
Michoacan	-0.061	0.028	0.191
	(0.088)	(0.093)	(0.105)*
Morelos	0.067	0.111	0.118
	(0.096)	(0.102)	(0.114)
Nuevo Leon	-0.228	-0.098	0.052
	(0.087)***	(0.090)	(0.105)
Oaxaca	0.186	0.168	0.174
	(0.095)**	(0.100)*	(0.110)
Puebla	0.083	0.080	0.223
	(0.099)	(0.102)	(0.110)**
Sinaloa	0.094	0.211	0.232
	(0.087)	(0.093)**	(0.102)**
Sonora	0.085	0.072	0.128
	(0.088)	(0.093)	(0.107)
Veracruz	0.088	0.034	0.029
	(0.088)	(0.093)	(0.104)
Yucatan	-0.257	-0.169	0.093
	(0.090)***	(0.097)*	(0.113)
Population > 100,000	0.053	0.055	-0.072
	(0.033)	(0.034)	(0.036)**
Population 15,000 - 100,000	-0.026	0.073	-0.021
	(0.046)	(0.051)	(0.050)
Population 2,500 - 15,000	-0.045	-0.042	0.008
	(0.043)	(0.048)	(0.048)
Observations	54,913	62,638	20,434
Pseudo R-squared	0.03	0.01	0.00
Log-pseudolikelihood	-43,829.96	-42,860.19	-31,002.88
Wald Chi^2	1840.25	943.39	298.10

Notes in Table 3.5.

Table A3.2. Proportional hazard models, Cox estimation. Observation level: woman-year.

	(1)	(2)
Exposure to program in school (1974)[1]	0.067 (0.015)***	
Exposure to program in school (1987)[2]		0.012 (0.029)
Education controls[3]		
Private school (highest level)	0.392 (0.134)***	0.154 (0.122)
Exposure * Private school	-0.068 (0.032)**	0.018 (0.048)
Highest level attained		
Secondary	0.149 (0.057)***	0.546 (0.078)***
High school	0.213 (0.065)***	0.919 (0.091)***
Cohort dummies[4]		
1958-62	0.230 (0.059)***	0.592 (0.140)***
1963-67	0.238 (0.065)***	0.891 (0.136)***
1968-72	0.417 (0.066)***	1.353 (0.135)***
1973-77	0.603 (0.068)***	1.782 (0.147)***
1978-82	0.703 (0.073)***	1.972 (0.174)***
1983-88		
Marital status[5]		
Separated	0.390 (0.096)***	0.022 (0.165)
Married	0.625 (0.075)***	0.284 (0.115)**
Divorced	0.706 (0.115)***	0.259 (0.189)
Widow	0.648 (0.127)***	0.178 (0.271)
Living with partner (not married)	0.500 (0.081)***	0.080 (0.134)
Community at 12 years[6]		
Latrine/other and drinkable water from tap	-0.027 (0.041)	-0.052 (0.079)
Latrine/other and drinkable water from other	-0.195 (0.042)***	-0.067 (0.083)

Table A3.2. (Cont'd).

	(1)	(2)
State and population size dummies[7]		
Baja California Sur	0.517	0.365
	(0.126)***	(0.207)*
Coahuila	0.228	-0.229
	(0.122)*	(0.212)
Durango	0.381	0.033
	(0.117)***	(0.204)
Guanajuato	-0.297	0.218
	(0.129)**	(0.204)
Jalisco	0.014	0.354
	(0.124)	(0.196)*
Mexico	-0.053	-0.061
	(0.120)	(0.201)
Michoacan	-0.228	-0.166
	(0.121)*	(0.204)
Morelos	0.045	-0.130
	(0.130)	(0.219)
Nuevo Leon	0.121	-0.194
	(0.117)	(0.202)
Oaxaca	-0.281	-0.384
	(0.127)**	(0.220)*
Puebla	-0.447	-0.853
	(0.131)***	(0.244)***
Sinaloa	0.662	0.316
	(0.113)***	(0.189)*
Sonora	0.253	0.342
	(0.117)**	(0.192)*
Veracruz	-0.052	-0.409
	(0.119)	(0.204)**
Yucatan	-0.012	-0.238
	(0.127)	(0.219)
Population > 100,000	0.097	0.134
	(0.038)**	(0.074)*
Population 15,000 - 100,000	0.117	0.123
	(0.056)**	(0.107)
Population 2,500 - 15,000	0.080	0.261
	(0.053)	(0.098)***
Observations	45,197	80,903
Pseudo R-squared	0.02	0.04
Log-pseudolikelihood	-31,655.00	-10,398.62
Wald Chi^2	1,260.60	843.73

Notes in Table 3.6.

APPENDIX 4

The Mexican Family Life Survey (MxFLS) is representative at the national, rural-urban, and regional levels. It contains a variety of information of individuals, households, and communities. This survey adapts the design of the Indonesian Family Life Survey (IFLS), preserving comparability with Mexican population based surveys.

The first wave of the MxFLS (MxFLS-1) was collected in 2002. The MxFLS-1 sample consists of 8,400 households (approximately, 38,000 individuals) in 150 communities. These communities are located in 16 out of the 32 states, which include Baja California Sur, Coahuila, Distrito Federal, Durango, Guanajuato, Jalisco, Estado de México, Michoacán, Morelos, Nuevo León, Oaxaca, Puebla, Sinaloa, Sonora, Veracruz, and Yucatán. The Mexican institute of statistics *Instituto Nacional de Estadística, Geografía e Informática* (INEGI) was in charge of the sampling design: a probabilistic sample, stratified, multi-staged, and independent at each study dominion.

Household members of age 15 and older were directly interviewed and information of children younger than 15 years was collected from the parents or responsible person. The following list summarizes topics included in the MxFLS-1 at the individual (I) and household (H) levels. For a detailed account of all sections contained in the questionnaires refer to tables A4.1 and A4.2 below.

1. Expenditure and consumption (H).

2. Savings, credits, loans, assets, labor and non-labor income, public and private transfers, and participation in social programs. (I), (H)
3. Family businesses and land use. (H)
4. School attendance, grade repetition, and completed schooling. (I)
5. Time allocation. (I)
6. Current and past employment. (I)
7. Socio-demographic and geographic information of non co-resident relatives. (I)
8. Permanent and temporal migrations. (I)
9. Self-reported health status: own perception, habits and functioning indicators, chronic diseases, and morbidity. (I)
10. Inpatient and outpatient use of health services. (I)
11. History of marriages and unions. (I)
12. Sexual and reproductive health of women of fertile age: history of pregnancies and births; sexual activity; use of contraception methods; and use of related-health services. (I)
13. Crime incidence and victimization. (H)

Additionally, the health of all individuals was evaluated in terms of anthropometric dimensions, blood pressure, and hemoglobin levels. Also, individuals of age 5 and older answered Raven tests of progressive matrices for adults and children, which measure abstract reasoning and cognitive ability. Information on general characteristics of the community, schools, and health providers and facilities was gathered in questionnaires applied to political authorities and school and health facilities administrators.

Table A4.1 MxFLS contents: individual and household information.

Questionnaire	Description	Sections
Book C	Control book	DF- Definitions
		LS- Household Roster
		CV- Dwelling characteristics
		RC- Information for re-contact
		SP- Family planning and health
		EH- Schooling of household members
		CVO- Direct observation of the dwelling characteristics
		NE- Interview session notes
Book 1	Household Consumption	CS- Consumption
		NE- Interview session notes
Book 2	Household Economy	SU- Land
		INR- Rural income
		NNA- Non-agricultural business
		AH- Household Assets
		CRH- Household Credit
		IN- Household non-labor income
		SE- Household economic shocks
		VLH- Household crime and victimization
		NE- Interview session notes
Book 3A	Characteristics of Adult Household Members	ED- Education
		IE- Schooling interruptions
		AH- Household assets
		IIN- Individual non-labor income
		HM- Marital history
		DH- Household decision making
		MG- Permanent migration
		MT- Temporary migration
		TB- Employment
		ATA- Adult time allocation
		SHI- Individual shocks
		VLI- Individual crime and victimization
		NE- Interview session notes

Table A4.1 (Cont'd).

Questionnaire	Description	Sections
Book 3A	Characteristics of Adult Household Members	ES- Health condition
		SM- Emotional well-being
		EC- Acute Morbidity
		ATS- Self-treatment
		CE- Outpatient Utilization
		HS- Inpatient Utilization
		CA- Insurance condition
		CR- Credit
		RE- Re-contact information of relatives in the United States
		TP- Non co-resident parents transfers
		TH- Non co-resident siblings transfers
		THI- Non co-resident child transfers
		TO- Transfers of other non-resident persons
		NE- Interview session notes
Book 4	Reproductive Health	RES- Pregnancy summary
		HE- Pregnancy history
		AC- Contraception
		NE- Interview notes
Book 5	Characteristics of Children	EDN- Child's education
		EMN- Child employment
		ATN- Child's time allocation
		CEN- Child outpatient utilization
		ESN- Child's health condition
		HSN- Child inpatient utilization
		AUTN- Child self treatment
		VAC- Child vaccination
		NE- Interview session notes

Table A4.1 (Cont'd).

Questionnaire	Description	Sections
Proxy Book	Characteristics of Household Members not present at interview	HM- Marital history
		MG- Permanent migration: one year or more
		ED- Education
		TB-Employment
		CR- Credit
		GH- Tastes and habits
		ES- Health condition
		CE-Outpatient Utilization
		HS- Inpatient Utilization
		CA-Insurance condition
		TP- Non co-resident parents transfers
		TH- Non co-resident siblings transfers
		THI- Non co-resident child transfers
		TO- Transfers of other non-resident persons
		RES- Pregnancy summary
		HE- Pregnancy history
		AC- Contraception
		NE- Interview notes
Book S	Anthropometrics and biomarkers	
Book EA	Adult Cognitive Ability	
Book EN	Child Cognitive Ability	

Table A4.2 MxFLS contents: community information.

Questionnaire	Sections
Community Characteristics	PB- Population
	ASC- Community social aspects
	DN- Natural disasters
	HI- Infrastructure history
	AS- Social attendance
	SED- History of the presence of schools
	SM- History of the presence of health facilities
	AC- Communitarian activities
	MT- Transportation
	INF- Infrastructure
	EL- Availability of electricity
	FA- Water source and sanitation
	OC- Credit opportunities
	I- Industry
	EF- Enterprises and factories
	BC- Community welfare
	CM- Migrants clubs
	OD- Direct observation
	NE- Interview session notes
Schools Questionnaire	DG- General descriptions
	DE- Schools principal
	NE1- Interview session notes
	FE- School's function
	NE2- Interview session notes
	AM- Students and teachers
	NE3- Interview session notes
	CA- Education costs and school aids
	NE4- Interview session notes
	IN- Infrastructure
	NE5- Interview session notes
	PRM- Questions to teachers
	NE6- Interview session notes
	PRM- Questions to teachers
	NE7- Interview session notes

Table A4.2 (Cont'd).

Questionnaire	Sections
Health Service Infrastructure	RS- Responsible for the services
	AG- General aspects of the unit
	NE1- Interview session notes
	PS- Personnel and services that the unit has
	NE2- Interview session notes
	SER- Activities and services provided by the unit
	NE3- Interview session notes
	LAB- Laboratory for clinical tests
	LB- Direct observation of laboratory
	NE4- Interview session notes
	FM- Drugstore/Medicines
	NE5- Interview session notes
	RM- Direct observation of exploration room
	SE- Direct observation of waiting room
Small Health Providers	GP- General data of provider
	POS- Problems when offering services
	AGC- General aspects of the town
	SV- Services offered
	MS- Health material, equipment and set of instruments
	MED- Medicines
	PT- Traditional midwife
	SRM- Medical exploration room
	SA- Waiting room
	NE- Interview session notes

The MxFLS-1 databases and the information contained in this appendix may be downloaded from http://www.radix.uia.mx/ennvih/ and http://www.mxfls.cide.edu.

REFERENCES

Alderman, H, Jere R. Behrman, Victor Lavy and Rekha Menon. (2001). Child Health and School Enrollment: A Longitudinal Analysis. Journal of Human Resources: 36(1), 185-205.

Alderman, H., Jere Behrman and John Hoddinott. (2003). Nutrition, Malnutrition and Economic Growth. PAHO/IDB Workshop: On Health, Human Development Potential and the Quality of Life: Towards Biological-Based Index of Human Development Potential for Assessing the Quality of Life. (Later published in Health and Economic Growth: Findings and Policy Implications. Guillem López-Casasnovas, Berta Rivera and Luis Currais, eds. (2004) Cambridge, MA: MIT Press).

Allen, L. and Jennifer Casterline-Sabel. (2001). Prevalence and Causes of Nutritional Anemias. Nutritional Anemias, Usha Ramakrishnan, ed. Florida: CRC Series in Modern Nutrition.

Anderson P. M., Phillip B. Levine and Kristin F. Butcher. (2002). Maternal Employment and Overweight Children. Paper No. 8770, National Bureau of Economic Research, Cambridge, MA.

Anderson, P. M., Kristin F. Butcher and Phillip B. Levine. (2003). Economic perspectives on childhood obesity. Economic Perspectives: 3Q, 30-48.

Anderson, P. M. and Kristin F. Butcher. (2005). Reading, Writing, and Raisinets: Are School Finances Contributing to Children's Obesity? Paper No. 11177, National Bureau of Economic Research. Cambridge, MA.

Anderson, P. M. and Kristin F. Butcher. (2006). Childhood Obesity: Trends and Potential Causes. The Future of Children:16(1), 19-45.

Averett, Susan L., Daniel I. Rees and Laura M. Argys. (2002). The Impact of Government Policies and Neighborhood Characteristics on Teenage Sexual Activity and Contraceptive Use. American Journal of Public Health: 92(11), 1773-1778.

Ávila, A., Teresa Shamah L. and Adolfo Chávez V. (1997). Encuesta Nacional de Alimentación y Nutrición en el Medio Rural 1996. México, DF.: Instituto Nacional de la Nutrición Salvador Zubirán.

Ávila, A., Teresa Shamah L., Adolfo Chávez V.,and Carlos Galindo G. (2003). Encuesta Urbana de Alimentación y Nutrición en la Zona Metropolitana de la Ciudad de

México 2002. México, DF: Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, Instituto Nacional de Salud Pública.

Bhattacharya, Jayanta, Janet Currie and Steven Haider. (2004). Poverty, food insecurity, and nutritional outcomes in children and adults. Journal of Health Economics: 23, 839–862.

Bhattacharya, Jayanta, Thomas DeLeire, Steven Haider and Janet Currie. (2002). Heat or eat? Cold weather shocks and nutrition in poor American families. Paper No. 9004, National Bureau of Economic Research, Cambridge, MA.

Birch, L. L. and Jennifer O. Fisher. (2000). Mothers' child-feeding practices influence daughters' eating and weight. American Journal of Clinical Nutrition: 71,1054-1061.

Blau, D. M., David K. Guilkey and Barry M. Popkin. (1996). Infant Health and the Labor Supply of Mothers. Journal of Human Resources: 31(1), 90-139.

Bobonis, G., Edward Miguel and Charu Puri Sharma. (2004). Iron Deficiency Anemia and School Participation. Paper No.7, Poverty Action Lab MIT, Cambridge, MA.

Brewis, Alexandra. (2003). Biocultural aspects of obesity in young Mexican schoolchildren. American Journal of Human Biology:15, 446-460.

Burton, P., Shelley Phipps and Lori Curtis. (2002). All in the Family: A Simultaneous Model of Parenting Style and Child Conduct. AEA Papers and Proceedings: 92(2), 368-372.

Cameron, A. C. and Pravin K. Trivedi. (2005). Microeconometrics Methods and Applications.NY: Cambridge University Press.

Case, A., Angela Fertig and Christina Paxson. (2005). The Lasting Impact of Childhood Health and Circumstance. Journal of Health Economics: 24(2), 365-389.

CONAPO. (2000). Cuadernos de Salud Reproductiva: República Mexicana. Primera edición. México, D.F. México. (Downloaded from http://www.conapo.gob.mx)

CPEUM. Constitución Política de los Estados Unidos Mexicanos: Artículo 4. Instituto de Investigaciones Jurídicas, UNAM. (Downloaded from http://info4.juridicas.unam.mx/ijure/fed/9/default.htm?s=)

Currie J. and Enrico Moretti. (2005). Biology as destiny? Short and long-run determinants of intergenerational transmission of birthweight. Paper No.11567, National Bureau of Economic Research, Cambridge, MA.

Chou, SY., Michael Grossman and Henry Saffer. (2002). An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System. Paper No. 9247, National Bureau of Economic Research, Cambridge, MA.

Cole, T. J., Mary C. Bellizi, Katherine M. Flegal, William H. Dietz. (2000). Establishing a standard definition for child overweight and obesity worldwide international survey. British Medical Journal: 320, 1240-1245.

Cutler, D. M., Edward L. Glaeser and Jesse M. Shapiro. (2003). Why Have Americans Become More Obese? Journal of Economic Perspectives:17(3), 93-118.

Desai, S. and S. Alva (1998). Maternal education and child health: Is there a strong causal relationship? Demography: 35(1), 71-81.

Doak, C. M., Linda S. Adair, Carlos Monteiro and Barry M. Popkin. (2000). Overweight and Underweight Coexist within Households in Brazil, China and Russia. Journal of Nutrition:130, 2965-2971.

García A., M. Guadalupe. (2001). La educación sexual en la reforma educativa de los años setenta. Revista Educar: 17, Abril/Junio. (Downloaded from: http://educacion.jalisco.gob.mx/consulta/educar/17/GarciaA.html)

Ghuman S., Jere R. Behrman, Judith B. Borja, Socorro Gultiano and Elizabeth M. King. (2005). Family Background, Service Providers, and Early Childhood Development in the Philippines: Proxies and Interactions. Economic Development and Cultural Change: 54, 129–164.

Glewwe, P. (1999). Why does mother's schooling raise child health in developing countries? Evidence from Morocco. Journal of Human Resources: 34(1), 124-159.

Glewwe, P. and Michael Kremer. (2005). Schools, Teachers, and Education Outcomes in Developing Countries. Paper No. 122, Center for International Development, Harvard University.

Glick, P. and D. Sahn. (1998). Maternal labour supply and child nutrition in West Africa. Oxford Bulletin of Economics and Statistics: 60(3),325-355.

Handa, S. (1999). Maternal education and child height. Economic Development and Cultural Change: 47(2), 421-439.

Haveman R. and Barbara Wolfe. (1995). The Determinants of Children's Attainments: A Review of Methods and Findings. Journal of Economic Literature: 33(4),1829-1878.

Hernández, B., Lucía Cuevas N., Teresa Shamah L., Eric A. Monterrubio, Claudia I. Ramírez S., Raquel García F., Juan A. Rivera and Jaime Sepúlveda. (2003).

Factores asociados con sobrepeso y obesidad en niños mexicanos de edad escolar: resultados de la Encuesta Nacional de Nutrición 1999. Salud Pública de México: 45(supl. 4), S551-S557.

Hernández, B., S. L. Gortmaker, G. A. Colditz, K. E. Peterson, N. M. Laird, S. Parra-Cabrera. (1999). Association of obesity with physical activity, television programs and other forms of video viewing among children in Mexico City. International Journal of Obesity: 23, 845-854.

Hernández-Chávez, J.J. (1995). Mexican NGO HIV/AIDS activities. Salud Pública de México: 37, 654-660.

Hoffman, Daniel. (2001). Obesity in developing countries: causes and implications. Food, Nutrition and Agriculture: 28, 35-42.

Horton, S. and R. Ross. (2003). The economics of iron deficiency. Food Policy: 28, 51–75.

Kassouf, A. L. and B. Senauer. (1996). Direct and indirect effects of parental education on malnutrition among children in Brazil: A full income approach. Economic Development and Cultural Change: 44(4), 817-838.

Klesges, R. C., Risa J. Stein, Linda H. Eck, Terry R. Isbell and Lisa M. Klesges. (1991). Parental influence on food selection in young children and its relationships to childhood obesity. American Journal of Clinical Nutrition: 53, 859-64.

Lakdawalla, D. and Tomas Philipson. (2002). Technological Change and the Growth of Obesity. Paper No. 8946, National Bureau of Economic Research, Cambridge, MA.

LGP. Ley General de Población, 1973. Secretaría de Gobernación. (Downloaded from http://www.ordenjuridico.gob.mx/Federal/PE/PR/Leyes/07011974(1).pdf)

Lynch, S. and Ralph Green. (2001). Assessment of Nutritional Anemias. Nutritional Anemias. Usha Ramakrishnan, ed., Florida: CRC Series in Modern Nutrition.

Michael, Robert T. (2004). Sexual Capital: An Extension of Grossman's Concept of Health Capital. Journal of Health Economics: 23(4), 643-652.

Miguel, E. and M. Kremer. (2004). Worms: identifying impacts on education and health in the presence of treatment externalities. Econometrica: 72(1), 159-217.

Miranda, Alfonso. (2006). Are young cohorts of women delaying first birth in Mexico? Journal of Population Economics: 19, 55-70.

Must, A., Gerard E. Dallal and William H. Dietz. (1991). Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht2) and triceps skinfold thickness. American Journal of Clinical Nutrition: 53, 839-846.

Oettinger, Gerald S. (1999). The Effects of Sex Education on Teen Sexual Activity and Teen Pregnancy. Journal of Political Economy: 107(3), 606-644.

Padrón, M. (2002). Obesidad infantil: un problema creciente. Nutrición Clínica: 5(4), 258-262.

Palma , Yolanda (2005). Políticas de población y planificación familiar.Demos Carta Demográfica sobre México: 16. (Downloaded from: http://www.ejournal.unam.mx/demos/demos_index.html)

Palma, Yolanda and Gabriela Rivera. (1996) La planificación familiar en México. Mujer: Sexualidad y salud reproductiva en México. Ana Langer y Kathryn Tolbert, eds. México, DF: EDAMEX.

Passi, S. J. and Sheila C. Vir. (2001). Functional Consequences of Nutritional Anemia in School Age Children. Nutritional Anemias. Usha Ramakrishnan, ed., Florida: CRC Series in Modern Nutrition.

Paton, David (2002). The economics of family planning and underage conceptions. Journal of Health Economics: 21, 207-225.

Paxson, C. and Jane Waldfogel. (1999). Parental Resources and Child Abuse and Neglect. AEA Papers and Proceedings: 89(2), 239-244.

Philipson, T. J. and Richard A. Posner. (1999). The Long-Run Growth in Obesity as a Function of Technological Change. Paper no. 7423, National Bureau of Economic Research, Cambridge, MA.

Pollitt, E. (1997). Iron deficiency and educational deficiency. Nutrition Reviews: 55(4), 133-141.

Popkin, B. M. (2001). The Nutrition Transition and Obesity in the Developing World. Journal of Nutrition: 131, 871S–873S.

Popkin, B. M., M. K. Richards and C. A. Monteiro. (1996). Stunting is associated with overweight in children of four nations that are undergoing the nutrition transition. Journal of Nutrition:126(12), 3009-3016.

Rashad, I., Michael Grossman and Shin-Yi Chou. (2005). The Super Size of America: An Economic Estimation of Body Mass Index and Obesity in Adults. Paper No. 11584, National Bureau of Economic Research, Cambridge, MA.

Reed. B.A., J.P. Habicht, C. Niameogo (1996). The effects of maternal education on child nutritional status depend on socio-environmental conditions. International Journal of Epidemiology: 25(3), 585-592.

Rivera, J., Teresa Shamah L., Salvador Villalpando, Teresita González de Cossío, Bernardo Hernández and Jaime Sepúlveda. (2001). Encuesta Nacional de Nutrición 1999: Estado nutricio de niños y mujeres en México. Cuernavaca, México: Instituto Nacional de Salud Pública.

Rivera, J. and Jaime Sepúlveda. (2003). Conclusions from the Mexican National Nutrition Survey 1999: translating results into nutrition policy. Salud Pública de México: 45(supl. 4), S565-S575.

Rivera, J., Simón Barquera, Teresa González-Cossío, Gustavo Olaiz and Jaime Sepúlveda. (2004). Nutrition Transition in Mexico and in Other Latin American Countries. Nutrition Reviews: 62(7), S149-S157.

Rodríguez, Gabriela (2001). ¿Cuáles son los beneficios de la educación sexual? Documento de Red Democracia y Sexualidad, A.C., México. (Downloaded from http://www.libertadeslaicas.org.mx/pdfS/educac/beneficios.pdf)

Rolland-Cachera, M. F., T. J. Cole, M. Sempé, J. Tichet, C. Rossignol and A. Charraud. (1991). Body mass index variations: centiles from birth to 87 years. European Journal of Clinical Nutrition: 45, 13-21.

Rubalcava L. and Graciela Teruel. (2004). The Role of Maternal Cognitive Ability on Child Health. Paper No. R-497, Inter-American Development Bank.

Ruhm, Christopher J. (2004). Maternal Empoyment and Adolescent Development. Paper No. 10691, National Bureau of Economic Research, Cambridge, MA.

Sánchez L., Gabriela. (1997). Población, desarrollo y su marco jurídico. Boletín Mexicano de Derecho Comparado Nueva Serie: XXX(90). (Downloaded from http://www.juridicas.unam.mx/publica/rev/boletin/cont/90/art/art14.htm)

Shamah-Levy, T., Salvador Villalpando, Juan A. Rivera, Fabiola Mejía-Rodríguez, Martha Camacho-Cisneros, Eric A Monterrubio. (2003). Anemia in Mexican women: A public health problem. Salud Pública de México: 45(4), S499-S507.

Strauss, J. (1990). Household, Communities, and Preschool Children's Nutrition Outcomes: Evidence from Rural Cotê d'Ívoire. Economic Development and Cultural Change: 38(2), 231-261.

Strauss, J. and Duncan Thomas. (1995). Human Resources: Empirical Modeling of Household and Family Decisions. Handbook of Development Economics 3A. Jere R. Behrman and T. N. Srinivasan, eds., Amsterdam: North-Holland.

Strauss, J. and Duncan. Thomas. (1998). Health, nutrition and economic development. Journal of Economic Literature: XXXVI, 766-817.

Thomas, D. (1994). Like Father, Like Son; Like Mother, Like Daughter. Parental Resources and Child Height. Journal of Human Resources: 29(4), 950-988.

Thomas, D. (2001). Health, Nutrition, and Economic Prosperity: A Microeconomic Perspective. Paper No. WG1: 7. Commission on Macroeconomics and Health, World Health Organization.

Thomas, D., Elizabeth Frankenberg, Jed Friedman, Jean-Pierre Habicht, Nathan Jones, Christopher McKelvey, Gretel Pelto, Bondan Sikoki, James P. Smith, Cecep Sumantri and Wayan Suriastini. (2004). Causal Effect of Health on Labor Market Outcomes: Evidence from a Random Assignment Iron Supplementation Intervention. Paper CCPR-022-04. California Center for Population Research, University of California, Los Angeles.

Thomas, D., John Strauss and Maria-Helena Henriques. (1991). How Does Mother's Education Affect Child Height? Journal of Human Resources: 26(2), 183-211.

Torres S., Valentina. (2002). La Educación Privada en México. Diccionario de la Historia de la Educación en México. Publicaciones digitales, UNAM. (Downloaded from http://biblioweb.dgsca.unam.mx/diccionario/htm/articulos/sec_20.htm)

Tremblay, Carol H. and Davina C. Ling. (2005). AIDS education, condom demand, and the sexual activity of American youth. Health Economics: 14, 851-867.

Uauy, R., Cecilia Albala and Juliana Kain. (2001). Obesity Trends in Latin America: Transiting from Under- to Overweight. Journal of Nutrition:131, 893S–899S.

Valdespino JL, Olaiz G, López-Barajas MP, Mendoza L, Palma O, Velázquez O, Tapia R, Sepúlveda J. (2003). Encuesta Nacional de Salud 2000. Tomo I. Vivienda, población y utilización de servicios de salud. Cuernavaca, México: Instituto Nacional de Salud Pública.

Variyam, J. N., James Blaylock, Biing-Hwan Lin, Katherine Ralston and David Smallwood. (1999). Mother's Nutrition Knowledge and Children's Dietary Intakes. American Journal of Agricultural Economics: 81(2), 373-384.

Villalpando, S., Teresa Shamah-Levy, Claudia I. Ramírez-Silva, Fabiola Mejía-Rodríguez and Juan A Rivera. (2003). Prevalence of anemia in children 1 to 12 years of age. Results from a nationwide probabilistic survey in Mexico. Salud Pública de México: 45(4), S490-S498.

WHO. (2000). Obesity: Preventing and Managing the Global Epidemic. Technical Report 894. Geneva: World Health Organization. (Downloaded from http://www.who.int/nutrition/publications/obesity/en/index.html)

WHO. (2003). Information sheet on Obesity and Overweight. Global Strategy on Diet, Physical Activity and Health: World Health Organization. (Downloaded from http://www.who.int/dietphysicalactivity/publications/facts/obesity/en/)

WHO. (2004). Global Strategy on Diet, Physical Activity and Health. Geneva: World Health Organization. (Downloaded from: http://www.who.int/dietphysicalactivity/strategy/eb11344/en/)

WHO. (2005). The challenge of obesity in the WHO European Region. Fact sheet EURO/13/05. Copenhagen: World Health Organization. (Downloaded from. http://www.euro.who.int/mediacentre/20020617_1)

WHO/CDC. (2005). Assessing the iron status of populations: report of a Joint World Health Organization/Centers for Disease Control and Prevention Technical Consultation on the Assessment of Iron Status at the Population Level. Geneva, Switzerland: 6–8 April 2004.

WHO/UNICEF. (2004). Focusing on anaemia: Towards an integrated approach for effective anaemia control. Joint statement. World Health Organization. (Downloaded from http://www.who.int/topics/anaemia/en/).

Wolfe, B. and R. Haveman. (2001). Accounting for the Social and Non-Market Benefits of Education.. The Contribution of Human and Social Capital to Sustained Economic Growth and Well Being. International Symposium Report. John Helliwell, ed., Organization for Economic Co-operation and Development and Human Resource Development Canada, Paris and Ottawa.

Wolfe, B. and R. Haveman. (2002). Social and nonmarket benefits from education in an advanced economy. Education in the 21st Century: Meeting the Challenges of a Changing World. Y. Kodrzyck, ed., Federal Reserve Bank of Boston.

Wooldridge, Jeffrey M. (2002). Econometric Analysis of Cross Section and Panel Data. Cambridge, MA: MIT Press.

Wooldridge, Jeffrey M. (2003). Introductory Econometrics: A Modern Approach. Second edition. Cincinnati, OH: South-Western College Publishing.

Zambrano, E. and Carolina Guzmán. (2002). Desnutrición intrauterina y factores de riesgo de la obesidad. Nutrición Clínica: 5(4), 241-245.