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The Human Capital 2002–04 Study in Guatemala: A Follow-up to the INCAP Longitudinal Study 1969–77

Reynaldo Martorell, Jere R. Behrman, Rubén Grajeda, and John Hoddinott, guest editors

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Prologue

This supplement to the *Food and Nutrition Bulletin* details the purpose, methods, and achievements of the Human Capital Study, carried out between 2002 and 2004 by a multidisciplinary team representing Emory University, the University of Pennsylvania, the International Food Policy Research Institute (IFPRI), and the Institute of Nutrition of Central America and Panama (INCAP). It is a follow-up study of former participants of the INCAP Longitudinal Study of 1969–77, a randomized, community trial of nutrition supplementation. The original study began in 1969 and included all children 7 years and younger at that time and all children born thereafter until the end of the study in 1977. Thus, the participants of the INCAP Longitudinal Study were born between 1962 and 1977.

The Human Capital Study is the latest in a series of efforts to trace the effects of improved early childhood nutrition on adult function. The subjects of study were 26–41 years of age in 2003, the midpoint of data collection; this allowed for the collection of data on adult body size and composition, health and lifestyle characteristics, education and intellectual performance, marriage formation and fertility, and, most importantly, occupation, income and wealth. The first paper in this supplement, by Martorell el al., provides the historical context and rationale for a follow-up focusing on economic productivity and outlines how the Human Capital Study will contribute to the literature in nutrition, health, and economics. The recent follow-up of 2002–04 included both subjects who remained in the original four study villages as well as those who migrated to other parts of the country. Thanks to an effective field team led by Drs. Grajeda and Melgar of INCAP, it was possible to locate and measure or interview more than 80% of the eligible subjects first studied three decades ago, a remarkable achievement; the organization of data collection and coverage are detailed in this volume's second paper by Grajeda et al. The villages were originally chosen for their inhabitants' similarity in health and nutrition, and to a lesser extent in social and economic development, but these characteristics have evolved differently over time. In the third paper, by Maluccio et al., village-specific changes in social and economic development are described from 1969, when the INCAP study began, to today. This provides a context for guiding and interpreting the analyses, and also to generate ideas for variables to incorporate the history of the villages into our models.

The next seven papers cover the main areas of data collection and describe the methods used and provide descriptive statistics for key variables. Our group discussed how best to present descriptive data and decided on tables containing information separately for men and women and stratified by either birth cohort (1962–65,1966–68,1969–73, and 1974–77 [in most cases this was collapsed to two groups corresponding to before and after the study: 1962–68 and 1969–77]), current place of residence (original villages or surrounding areas, Guatemala City, and other areas of Guatemala) or tertiles of parental socioeconomic status in 1975 (the final paper is a research note explaining the derivation of this socioeconomic index). Some of these tables were omitted from publication where there were few findings of interest to report. Those familiar with our study will note that we do not present information by type of supplement received in the 1969–77 study, the nutritious "*atole*" or the control beverage "*fresco*." We felt that comparisons of outcomes of human capital or economic productivity by type of supplement would be misleading, as these require control for a range of potentially confounding factors to be valid. Future papers will address nutrition effects in detail.

This supplement was developed through a process of intense collaboration. Members of the research team volunteered to be team leaders or co-authors of papers. Team leaders were responsible for coordinating the analyses, producing the first drafts, and servings as first author on manuscripts. Because it proved difficult to weigh the relative contribution of co-authors, we decided to list co-authors in alphabetical order.

The lead editor was Reynaldo Martorell (Emory); co-editors included a representative from each of the participating institutions in alphabetical order:

Jere R. Behrman (University of Pennsylvania), Rubén Grajeda (INCAP), and John Hoddinott (IFPRI). The editors reviewed the papers for content and consistency and Dr. Martorell did the final review.

The papers all include the following note of acknowledgment:

"The Human Capital Study 2002–04 would not have been possible without the dedication and outstanding work of a field team coordinated by Dr. Paúl Melgar of INCAP, a data coordination center directed by Humberto Méndez and Luis Fernando Ramírez, both of INCAP, and data management by Alexis Murphy at IFPRI and Meng Wang at Emory University. We gratefully acknowledge the financial support of the US National Institutes of Health (R01 TW-05598: PI Martorell; R01 HD-046125: PI Stein) and the US National Science Foundation (SES0136616: PI Behrman) for present activities and the many organizations (US National Institutes of Health, Thrasher Research Fund, Nestle Foundation) that have funded the work of the INCAP Longitudinal Study since inception. Finally, the investigators thank the participants of the INCAP Longitudinal Study for their cooperation and past investigators and staff for establishing and maintaining this invaluable sample."

In addition, we wish to thank Sandra Smith of Emory University, who assisted with the final preparation of the manuscripts and who assured that they were formatted as required and Susan Karcz, for guiding us through the entire process and for her editorial contributions.

Reynaldo Martorell, Jere R. Behrman, Rubén Grajeda, and John Hoddinott
Guest Editors

Rationale for a follow-up study focusing on economic productivity

Reynaldo Martorell, Jere R. Behrman, Rafael Flores, and Aryeh D. Stein

Abstract

Past studies of nutrition, human capital formation, and economic productivity have been limited by the fact that biomedical researchers and economists work largely in isolation, with loss of complementarity. Biomedical researchers are faulted for not adequately addressing bias and measurement issues and for naïve analyses and interpretation of results, whereas economists are criticized for using simplistic nutrition and physiological measures and for relying on statistical methods rather than experimental designs. To avoid these problems, a multidisciplinary team of biomedical investigators and economists undertook a follow-up study in 2002–04 of a cohort of young men and women, who participated as young children in a randomized community trial of nutrition supplementation carried out from 1969–77. Previous studies, particularly the original trial and a 1988–89 follow-up, are described to provide an overview of the data available for linkage with the 2002–04 follow-up. Key results from these earlier studies are reviewed but judged inconclusive because the data used were collected when many subjects were still growing and developing physically, in school, unmarried, and/or not yet settled into occupations. The subjects were 26 to 41 years of age in 2003, permitting a more complete assessment of human capital and economic productivity. The experimental design of the 1969–77 original study, 35 years of follow-up, use of robust methods of data collection, and the participation of a multidisciplinary team will likely lead to the most comprehensive assessment to date of the importance of nutrition for economic productivity.

Key words: Guatemala, Institute of Nutrition of Central America and Panama (INCAP), Human Capital Study, child nutrition, nutrition and economics, nutrition and productivity

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Introduction

Nutrition and economic productivity

There is general agreement that the root cause of poor human development is poverty and there is also consensus that the relationship between human development and poverty is bidirectional [1, 2]. That is, poor human development is both a consequence as well as a cause of poverty. Here we focus on the link between poor human development, particularly as mediated by nutrition in early life, and adult economic well-being.

Adam Smith, the noted political economist of the 18th century, believed that the ultimate source of a nation's wealth is the quality of its labor force and that the achievement of an "abundance of the necessities of life," made possible by the "the liberal reward of labor" (i.e., adequate wages) is both an indicator of national economic development as well as an engine for further growth [3]. Interestingly, Smith attacked a prevailing notion in his time that hunger, poor health, and economic necessity make workers more industrious out of sheer desperation. He proposed the contrary, that poor health and malnutrition lower the productivity of workers. He wrote: "…that men in general should work better when they are ill fed than when they are well fed, when they are disheartened than when they are in good spirits, when they are frequently sick than when they are generally in good health, seems not very probable," [3, p. 74]. Although Smith wrote passionately of the horrible effects of poverty on child health and mortality, he did not comment on how poor child nutrition and

health might affect the quality of the future labor force, which is the core of our follow-up study.

There is much that is known about the economic returns of investments in human development [4–8]. There is overwhelming evidence that the returns from investments in education and in the control of infectious diseases have high benefit-cost ratios. On the other hand, the evidence documenting that improving nutrition, particularly child nutrition, leads to significant economic returns remains limited, but is growing rapidly because of new research and considerable interest in the subject.

Some of the relevant research has focused on the physical size, body composition, and diets of adults, and on the importance of these factors for physical work [5]. Many of these studies were cross-sectional and used limited characterizations of nutrition and physiology. Nutrition has often been represented by simple anthropometric measures such as height and weight; when dietary measures have been used, they have often been restricted to energy intakes, and in some studies, to household energy availability. Dietary quality and micronutrient status, particularly anemia, have rarely been considered nor have measures of lean body mass, work capacity, or physical fitness. Despite these limitations, there is strong evidence of a positive relationship between adult nutrition and wages and productivity, particularly at low levels of nutrition and health and for jobs requiring physical strength [5]. Adam Smith would not have been surprised by these conclusions. Strauss and Thomas in 1998 speculated that the impact of adult nutrition on productivity will decline over time because jobs requiring hard physical labor will tend to disappear [5]. However, early childhood nutrition influences not only adult body size and composition but also schooling and educational achievement, and in this manner may affect occupation and productivity across a range of jobs, now and in the future.

There is a considerable literature on the relationship between nutrition and education but many studies suffer from severe limitations [9–11]. Many studies are cross-sectional and are unable to trace the effects of early childhood nutrition and its determinants and test causal models. Education is frequently measured by years of schooling and is often characterized by the highest grade achieved. There are some excellent studies, for example from Cebu, that include rich characterization of schooling and achievement [10]. However, because the Cebu study lacks an experimental dietary intervention, statistical methods must be used to control for confounding factors. A recent analysis of the Cebu data concludes that better nourished (as reflected by greater height for age) children performed significantly better in school, partly because of an earlier age at enrollment and mostly because of greater learning productivity per year of schooling [11]. There are also a handful of other recent studies that use longitudinal data and statistical methods to control for confounding factors that also find significant impact of early childhood nutrition on aspects of schooling and education in developing countries. Using econometric methods, Alderman, et al. in 2001 used past price shocks to identify the impact of earlier nutrition on age of school enrollment in rural Pakistan [12] and Alderman, Hoddinott, and Kinsey in 2003 used weather shocks to identify the impact of pre-school nutrition on various dimensions of schooling and education in rural Zimbabwe [13].

A feature that limits the rigor and effectiveness of work on this topic is that biomedical investigators and social scientists, particularly economists, work largely in isolation. When reading the literature outside their fields, they find much to criticize about each other. Biomedical scientists are criticized for not adequately addressing bias and measurement issues and for naive analyses and interpretations of results. Economists are criticized for using simplistic nutrition and physiologic measures and for relying on statistical methods with their concomitant assumptions rather than exploiting experimental designs. However, there are a few recent exceptions that use experimental designs or natural experiments to investigate the impact of nutrition [14, 15].

These concerns led us to form an interdisciplinary team (including researchers with specialties in epidemiology, nutrition, medicine, economics, demography, psychology, anthropology, sociology, and statistics) to conduct a study in Guatemala of the long-term impact of nutrition in early childhood on human capital formation and economic productivity. Specifically, we undertook a follow-up study from 2002–04 of a cohort of young men and women who had participated as young children in a randomized, community trial of nutrition supplementation conducted by the Institute of Nutrition of Central America and Panama (INCAP). The role of this paper is twofold: to provide historical context to the 2002–04 follow-up study and to explain how our interdisciplinary team will overcome the limitations described above. We begin by summarizing previous INCAP studies and their key findings to give the reader an overview of the data available for linkage with our recent follow-up study; we also point out the limitations of our analyses to date. We describe briefly the 2002–04 follow-up, review in general the uniqueness of our efforts, and comment on the contributions we hope to make to the literature on nutrition and economics.

Description and main results of previous INCAP studies

This section provides a general and brief description

of the studies to which our 2002–04 follow-up study is a complement. We also provide a general review of their key findings and their limitations. Additional information on these results is found in Martorell et al. [15] and Martorell [16].

Key findings from the INCAP Longitudinal Study 1969–77

The INCAP Longitudinal Study was conducted from 1969–77 in four villages of the Department of El Progreso in Eastern Guatemala. This is a part of the country rarely visited by tourists; the environment is dry and dusty and the population is Spanish speaking. The study was a randomized nutrition intervention trial. The villages were selected after a long and careful process from which two pairs of similar villages were identified; then, one village from each pair was chosen randomly to receive a nutritious supplement and the remaining two villages a control drink. The fact that only two villages were selected per group is a serious limitation.

Nutrition and medical interventions

Detailed descriptions of the INCAP initial and subsequent studies are found elsewhere [16]. The main purpose of the initial study was to assess the effect of improving protein intake on the mental development of preschool children. At the time, protein deficiency was believed to be the major cause of much of the child malnutrition in the world. The "treatment" drink was formulated as an "*atole*," or a type of hot gruel widely consumed in Guatemala, and was made from Incaparina, a vegetable protein mixture developed by INCAP, dry skim milk, sugar and flavoring (**table 1**). *Atole* delivered 11.5 grams of high-quality protein and 163 kilocalories per cup (180 ml).

The control drink called "*fresco*," was devoid of protein and had only a small amount of sugar and flavoring; it was similar to locally available drinks and was served at room temperature. *Fresco* provided 59 kcal/cup. Fear of "empty calories" and a desire to further isolate the contrast in protein between the two drinks led to vitamins, iron, and fluoride being added to *fresco* to achieve similar concentrations (by volume) as those of *atole* (**table 1**).

The psychologists involved with the project were concerned that the social interaction resulting from attending the supplementation center could by itself influence child development. For this reason, procedures in *atole* and *fresco* villages were similar, including the layouts of the supplementation centers and the measurements of attendance and intake.

Each supplement was provided in a supplementation center twice a day, in mid-morning and mid-afternoon, to minimize possible influences on meal patterns at home. Attendance was open to all villagers but was recorded only for pregnant and breastfeeding women and for children 7 years or younger. Thus, from 1969 to 1977, children were included in the study who were born between 1962 and 1977. A pre-filled cup was given to each person but more was given if desired. Research staff recorded intakes carefully, after subtracting leftovers from the amounts given.

TABLE 1. Formula and nutrient composition of beverages per cup serving (180 ml) [16]

	Atole	
	For subjects over 4 months[a]	*Fresco*
Ingredients (g/180 ml)		
Incaparina (g)	13.5	—
Dry skim milk (g)	21.6	—
Sugar (g)	9.0	13.3
Flavoring	—	2.1
Nutrients (per 180 ml)		
Energy (kcal)	163.0	59.0
Protein (g)	11.5	—
Carbohydrates (g)	27.8	13.3
Fats (g)	0.8	—
Calcium (g)	0.4	—
Phosphorous (g)	0.3	—
Iron (mg)	1.2, 5.0[b]	5.0[b]
Fluoride (mg)	0.0, 0.2[b]	0.2[b]
Thiamin (mg)	0.4, 1.1[b]	1.1[b]
Riboflavin (mg)	0.5, 1.5[b]	1.5[b]
Niacin (mg)	1.3, 18.5[b]	18.5[b]
Ascorbic acid (mg)	0.0, 4.0[b]	4.0[b]
Vitamin A (mg)	0.5	0.5[b]

a. There was a modified formula for younger children but this was rarely consumed.
b. Values as of October 1, 1971. Until Oct. 1, 1971 the *fresco* contained no micronutrients.

INCAP also established medical clinics offering preventive and curative services; these were staffed by auxiliary nurses under the supervision of a physician. Medical services were free and not tied to participation in the study.

Dietary impact

Home diets of mothers and children were measured using 24-hour recall surveys; by analyzing dietary and supplement intake data it was possible to estimate the net impact of the supplements on total nutrient intakes.

The supplementation program was designed to create a large difference in net protein intakes between subjects in *atole* and *fresco* villages. This was achieved in the target sample of women and children. However, unexpected differences were produced in other nutrients because patterns of consumption of the supplements in women and children differed between

atole and *fresco* villages. Women drank larger volumes of *fresco* than *atole*, so that the energy contribution of the *fresco* and *atole* were similar despite their different energy densities. This also meant that intakes of vitamins and minerals among women were greater in *fresco* than in *atole* villages because they were present in similar concentrations in the supplements.

On the other hand, in children less than 3 years of age, supplement intakes were much lower in *fresco* compared with *atole* villages, such that intakes of protein but also of energy and other nutrients were greater in *atole* villages. In young children, home diets were measured at 15 months and every 3 months thereafter until 36 months of age, or a total of 8 times over this interval. Using these data and information about daily supplement intakes, researchers calculated that average daily total protein intakes (home diet plus supplement) were 9 grams greater in *atole* compared with *fresco* villages; average daily total energy intake was 90 to 100 calories greater in *atole* villages [17]. Average home dietary intakes in this age range were about 770 ± 213 calories and 21 ± 6 grams of protein per day, making the contribution of *atole* large relative to base amounts. Also, intakes of vitamins and minerals were greater for young children from *atole* villages compared with those in *fresco* villages. Finally, for children 3 to 7 years of age, as for women, a greater volume of *fresco* was consumed than *atole*.

These patterns of consumption probably reflect the nature and appeal of the drinks. Mothers and older children could drink larger amounts of the *fresco*, a light drink, than of the hot and denser *atole*. Mothers, on the other hand, may have viewed *atole* as a food and *fresco* as a refreshing drink, and they may have been more motivated to offer *atole* to young children. Thus, the "protein" design was complicated by perceptions and behaviors of the subjects. For women, both supplements contributed nearly similar amounts of energy but only one had protein. For young children, the contributions to diets were along a broad front and were not limited to protein.

Key findings

One of the major findings from the study was that maternal food supplementation improved birthweight [18]. However, this analysis was not performed using the randomized design. Comparison of mean birthweights of newborns of women consuming *atole* during pregnancy with those of newborns of women consuming *fresco* showed a small but non-significant difference in favor of *atole* villages. Other analyses showed that increased consumption of *atole* and, unexpectedly, of *fresco*, was associated with improved birthweight. Women who consumed more than 20,000 calories from the supplements during pregnancy (about 111 calories/day if ingested in the last 6 months of pregnancy), whether in *atole* or *fresco* villages, had half the risk of delivering a low-birthweight baby (< 2500 grams) compared with those who ingested less than 20,000 kcal. These analyses also showed that energy intake, rather than intakes of protein or other nutrients in the supplement, best explained the relationship between supplement intake during pregnancy and birthweight. The analyses utilized the overlapping ranges in supplement energy intakes during pregnancy in *atole* and *fresco* villages. Because the mean energy contributions from the two supplements were similar, by virtue of women consuming more of the less-energy-dense *fresco* than *atole*, intent-to-treat analyses failed to show a difference between *atole* and *fresco* villages. However, comparisons of high and low consumption groups suggested improvements in birthweight. Care was taken to control for potentially confounding factors; this was much needed because these comparisons did not use the experimental design.

The key outcome of interest in the original study was mental development. Physical growth was considered as an important secondary outcome, because confirmation was needed that *atole* was biologically efficacious in order to properly interpret effects on mental development. For example, lack of an effect on growth might indicate that the nutrition experiment was biologically ineffective and cast doubt on any possible conclusion about effects on mental development. As it turned out, *atole* had a substantial effect on growth but only in the first 3 years of age [19]. Within *atole* villages, there was a dose-response relationship between amount of supplement ingested and growth rates but only in children younger than 3 years of age. The reasons for an effect during the first 3 years but not from 3 to 7 years of age include greater growth rates, greater relative nutrition requirements, and more frequent and more severe diarrheal diseases in younger children, which in turn were reflected in growth failure being a problem only in children younger than 18 months. By about 24 months, children grew in length at rates similar to those of children in developed countries [20]. Thus, although most growth failure occurred before 2 years of age, these children retained some capacity up to their third year of life to grow better in response to improved nutrition.

A simple analysis true to the randomized design was used by Habicht, Martorell, and Rivera [21] to examine the effect of the nutrition intervention on child growth. This analysis used villages as the unit of analysis and compared *atole* and *fresco* villages in terms of length at 3 years of age before and after supplementation. The baseline information came from a cross-sectional survey of children in 1968, one year before the beginning of the study. The similarities of the four villages at baseline were striking, reflecting the care with which the villages were matched with regard to nutrition and health. The difference in length at 3 years between the large *atole* and *fresco* villages was

0.2 cm (*atole* larger); the corresponding difference for small villages was 0.8 cm (*fresco* larger). (Similarly the mothers of children exposed to *atole* in early life were 148.9 cm tall, nearly identical to mothers from *fresco* villages who were 149.0 cm tall, with a pooled SD of 5.3 cm [22].) Children exposed to *atole* throughout their first 3 years of life were 3.3 and 2.6 cm taller in the large and small villages, respectively, whereas those exposed to *fresco* changed little, increasing by 0.7 and 0.2 cm, respectively. The small change in *fresco* villages may be attributed to chance but could also be owing to energy and other nutrients in the *fresco*, to the effects of *fresco* on birthweight, to the medical care program, to underlying secular trends, or to any combination of these factors. The differences in net change (*atole* differences minus fresco differences with respect to baseline values) were 2.6 cm in the large villages and 2.4 cm in the small villages. The mean of these differences was 2.5 and the SD was 0.1 cm. Despite having only two degrees of freedom, the t-test was 2.5, with a two-tailed probability of $p < .005$. Because the analysis used the randomized design, the potential effects of confounding factors were incorporated into the probability statement as was the medical care program. Few other analyses published from the study have used the randomized design on the village level because power becomes very limiting, but it is re-assuring that the evidence for an effect on child length is robust at the village level despite the small number of villages.

There were other biologic effects beyond physical growth. Infant mortality rates were markedly reduced; compared with rates between 1949 and 1968, infant mortality from 1969 to 1977 declined by 66% in *atole* villages compared with 24% in *fresco* villages [23]. While the number of days children were ill with diarrhea was not reduced by the nutrition intervention, diarrhea did not retard physical growth in children consuming *atole*, but did so in children consuming *fresco* [24]. Children who were wasted (i.e., very thin) regained normal weight for height proportions sooner after ingesting *atole* than they did with *fresco* [25]

The effect of *atole* on mental development in the preschool period was minor, certainly much less than anticipated when the study was conceived. Pollitt et al. (1993) reviewed previous efforts by INCAP researchers to relate the nutrition intervention to child development as assessed through an extensive battery of tests and concluded that despite the variety of approaches followed and differences in the analytic designs, sample sizes and outcome variables, the results of the various studies showed small but consistent, positive effects of *atole* supplementation [26]. The authors also reanalyzed the INCAP data, using factor analysis in the case of the preschool battery given from 3 to 7 years in order to reduce the information contained in the large number of tests to one or a few factors. *Atole* exposure in the first 24 months was related to better motor performance. The results with the preschool battery were also consistent with prior findings. The authors concluded that "the results of previous analyses as well as the re-analyses presented here indicate that there were a few moderately beneficial effects from exposure to the *atole* supplement" [26].

The 1988–89 follow-up and other studies

Results from the INCAP longitudinal study in 1977 showed that improving the diets of preschool Guatemalan children reduced growth failure dramatically during the first 3 years of life but only modestly influenced mental development. The study itself might have been largely forgotten had its usefulness not been notably enhanced by follow-up studies that are tracing the ripple of effects of the nutrition intervention of the 1970s. The follow-up studies have permitted us to examine whether the benefits found in early childhood persist into adolescence and then adulthood. A novel contribution is that of allowing examination of functional effects that can only be measured later in life, extending thereby the horizon for evaluating nutrition interventions.

The 1988–89 follow-up study

The first follow-up was carried out from 1988–89 when the subjects were 11 to 26 years of age [16]. The intent was to test the hypothesis that "better nutrition during early childhood leads to adults with a greater potential for leading healthy, productive lives." The use of the word "potential" was deliberate as many of the subjects were then adolescents, many were still growing, some were still in school and many were not yet married or working in their adult occupations. Productivity, therefore, could not be measured in 1988–89 for much of the sample, only potential.

The subjects of study were all former participants of the INCAP Longitudinal Study who were born between 1962 and 1977. Migrants to Guatemala City or to the provincial capital of the study area were included. Migrants to other areas were not included because of the high costs of tracking them, which may have led to the sample being selective and the estimates biased. The target sample in the four study villages was nearly 2000 subjects and coverage was 72%. Among those still living in the study villages, coverage was 89%.

Data were collected for many functional outcomes, four of which are emphasized here: body size and composition, work capacity, fertility milestones, and intellectual performance. Improvements in one or all are important contributions to human capital formation.

Three aspects of the body size and composition results stand out. First, adolescents who were exposed to *atole* during the first 3 years of life were taller and had greater fat-free masses than those who received *fresco* [22]. However, there was some attenuation of

the effects observed at age 3 caused by slightly greater growth from 3 years to age in 1988–89 in *fresco* villages compared with *atole* villages. Anthropometric effects were greatest in women. Height less than 149 cm (4 feet 11 inches) is often used as a criterion of obstetric risk in women. In women who as children were exposed to the supplements from birth to 3 years of age, 49% of *fresco* subjects had stature less than 149 cm compared with 34% of *atole* women [27]. Differences in fat-free mass are striking. Women from *atole* villages had 2.1 kg more fat-free mass than women from *fresco* villages, equivalent to about 0.5 SD units.

The 1988–89 follow-up study suggested that the characteristic short stature of Guatemalan adults is largely due to growth failure in early childhood [20, 28]. This analysis divided women into three groups according to the level of stunting at 3 years of age: mild (above the cut-off point of −2 SD below the World Health Organization (WHO)/National Center for Health Statistics (NCHS) reference mean), moderate (between −3 and −2 SD below) and severe (below −3 SD). The mean values for height at 3 years of age (1 cm was subtracted from length values to correct for systematic differences between measurements of height and length) for the three Guatemalan groups were designated as the first component of height (**fig. 1**). **Figure 1** also includes data describing Mexican-American children from the Hispanic Health and Nutrition Examination Survey (HHANES) of 1982–84. Mexican-American children have similar heights prior to puberty (~ 12–13 years) to the US general population but end up at the 25th percentile of height at adulthood. These patterns have not changed in recent US data. It is unlikely that the deviation that occurs in adolescence is due to nutrition or health; rather, the cause may be genetic in origin. Mexican-American children have similar ancestry, Spanish-Amerindian admixture, and may be an appropriate reference for assessing growth during puberty in our Guatemalan sample. One can ask whether there was catch-up in growth from 3 years to adulthood (here defined as 18 years of age or older), designated as the second component of height in **figure 1**. Clearly, there was no catch-up in growth. All three Guatemalan groups grew the same from 3 years to adulthood and their growth was similar to that of Mexican-Americans. Similar results were found in men as in women. These data suggest that the period of early childhood is the only period of growth failure in the Guatemalan population.

Work capacity was significantly improved in men exposed to the supplements in their first three years of life; no association was observed in women [28]. *Atole* men had maximal oxygen consumptions ($\dot{V}O_2max$) that were 0.38 L/min greater than those of *fresco* men. The difference is equivalent to about 0.7 SD units, approaching what Cohen [29] calls a large effect size. The larger working capacity of *atole* men could not be explained by differences in fat-free mass, as $\dot{V}O_2max$ per kg of fat-free mass was still greater in *atole* villages [29].

Exposure to the *atole* did not lead to earlier menarche [30] but was associated with earlier first intercourse and first birth by about a year. These effects on fertility milestones were small in comparison to the delaying effects of schooling [31]. The median age at first birth was more than 4 years later for those who completed primary school compared with those who did not.

A feature of all analyses carried out to date with respect to measures of intellectual performance is the control for years of school completed because village differences in patterns of school attendance existed prior to the study. A key finding was that intellectual performance estimated using a summary variable of intellectual performance (i.e., a factor score that combines literacy, numeracy, general knowledge, Raven's Progressive Matrices, reading and vocabulary) was

FIG. 1. Components of adult stature (cm) in Guatemalan women compared with Mexican-Americans, by level of growth retardation at 3 years of age (data from Martorell et al. [20])

more affected during adolescence and early adulthood than during early childhood [26, 32]. The *atole-fresco* differences found in children were less than 0.2 SD, compared with differences of around 0.6 SD found in adolescence. To use Cohen's [29] definitions, the effects found in children are small, while those found in adolescents are medium to large [29]. There were also strong indications that the effects in adolescence were found only in those cohorts exposed to supplementation during pregnancy and the first 2 years of life. Effects were found on four of the six tests that constitute the summary variable. Effects were found for both men and women. However, if schooling is affected positively by the nutrition supplement, the inclusion of schooling as a right-side variable in these estimates is likely to result in an underestimate of the impact of the nutrition supplement on intellectual performance because some of the effect occurs through schooling.

We collected data on wages and in participation in agricultural activities. Two dissertations were written using these data; one focused on linking work capacity and wages [33] and the second on preschool growth and cognitive skills, educational attainment, and skills and wages [34]. No relationship was found between work capacity and wages. Both preschool anthropometry (height and weight) and cognitive development were significant correlates of educational attainment. Among wage earners, each year of school raised wage rates by 6%. However, at follow-up there was no relationship between anthropometric characteristics and wages. These analyses suffered from several common problems reflective of the youth of the sample and the fact that not all work is wage work. Only about a fifth of the subjects were wage earners resulting in a highly selective sample, with considerable loss of power and potential for bias.

The birthweight and generational studies

Additional studies were carried out in the 1990s that monitored the birthweights of newborns of the female subjects of the original longitudinal study; also, a longitudinal study of growth and development in the first 3 years of these children's lives was carried out between 1996 and 1999. Unfortunately, these studies did not include migrants and the longitudinal study was restricted to women who had children less than 3 years of age in the study period. Therefore, these data are for selected subsamples of the original cohort. It is difficult to know what biases these sample selection rules introduce.

In women, exposure to *atole* compared with *fresco* led to a small but consistent improvement in the growth of their children, with this effect being mediated through greater maternal body size. Unpublished analyses indicate that newborns born to women exposed to *atole* in early life were heavier (60 grams) and longer (0.23 cm) at birth. Postnatal growth through age 36 months was improved as well, with children of mothers who themselves received *atole* as children on average 0.80 cm taller than children of women who received *fresco* [35].

In the 1996–99 longitudinal study, we updated schooling histories and intellectual functioning in women, which made it possible to reconfirm the findings of Pollitt et al. [26] from the 1988–89 follow-up a decade later as well as to improve upon the statistical methods used [26]. Five tests of educational achievement (reading, vocabulary, comprehension, numeracy, and general knowledge) were combined into a single score with possible values of 0 to 100. Li et al. [36] found a highly significant interaction between treatment and schooling on educational achievement [36]. The *atole* effect was –1 point when women did not finish school but + 9 points when they did. The impact of completing primary school was very pronounced; it was +13 points without exposure to *atole* but +23 points when women were exposed to *atole*. Thus, nutrition in early life is important for educational performance only when children complete primary school; in addition, the positive effect of completing school is magnified when preceded by improved nutrition in early life.

A cardiovascular risk factor study (1998–99) provided the data to tease apart the relative importance of prenatal and early postnatal growth, defined by Li et al. [37] as birth to 2 years of age, for adult body size and composition of men and women [37]. Both prenatal and postnatal growth retardation were equally important determinants of reduced height, weight, and fat-free mass in adulthood; on the other hand, neither aspect was related to overall fatness or to fat accumulation around the waist. Similar analyses were carried out for educational achievement using data from the 1996–99 longitudinal study [38]. In contrast to the findings about body size, only the postnatal component was associated with educational achievement. Thus, prenatal growth failure affects adult body size and composition but not educational achievement; postnatal growth failure, on the other hand, affects both size and educational achievement.

The relationship between early childhood nutrition and risk factors of cardiovascular disease in adulthood has also been investigated. The idea that poor nutrition in early childhood increases risk of the metabolic syndrome later in life, the so called Barker hypothesis, has become a popular topic of study [39]. As noted above, no relationship was found in our data between prenatal or postnatal growth and fatness in adulthood [37]. Also, we do not find birthweight to be related to the prevalence of a cluster of cardiovascular disease risk factors, including lipid levels, fasting glucose, and blood pressure [40]. Similarly, the relationships between supplementation and cardiovascular disease risk factors were weak and inconsistent [41]. Thus, contrary to

the findings of some studies, we do not find that early childhood nutrition is associated with risk factors of adult chronic diseases of dietary origin. The population is still relatively young and this may not allow us at this time to uncover these relationships. However, such relationships have been found by others even at younger ages. Perhaps, relationships between nutrition in early childhood and later disease depend on host or environmental factors that are not yet understood.

Linkages among early childhood nutrition, human capital formation, and economic output

Three key conclusions can be drawn from the previous sections:

» We have demonstrated that the nutrition intervention was efficacious at improving child diets and child growth if delivered within the first 3 years of life. Several measures of early child nutrition are available; exposure to and consumption of the nutrition supplement is the main one; others include home diets and anthropometry.
» We have shown that improved child nutrition in early childhood is related to accumulated human capital at adolescence and early adulthood (height, fat-free mass, work capacity) and educational attainment and skills.
» We have been unable to link human capital to economic output.

The failure to link human capital to economic output, of course, may reflect the relative youth of the subjects when measured and interviewed in the 1988–89 follow-up when they were 11 to 26 years old.

Human Capital Study 2002–04

The lack of evidence on the impact of early childhood nutrition in poor populations, including our inability to demonstrate this relationship in our 1988–89 follow-up, led us to conduct a second cross-sectional follow-up study in 2002–04 in the four study villages of the INCAP Longitudinal Study (1969–77) and in the places in Guatemala to which participants in the original study had migrated. This time, all migrants to all towns and villages in Guatemala—not only to Guatemala City and to the provincial capital near the study area—were eligible. The only migrants excluded were those who had left the country. The logistics of data collection for the Human Capital Study 2002–04 are reviewed elsewhere in this volume [42].

This recent follow-up provided us an opportunity to update life histories and current status for many of the aspects included in the first follow-up study. More importantly, we were able to focus on economic aspects as all subjects were by then adults (26 to 41 years of age in 2003), and almost all had finished schooling and were in adult occupations. We also collected data on marriage formation and the assets brought by individuals to marriage.

Expected contributions

Our Human Capital Study 2002–04 breaks new ground as it is being undertaken by a multidisciplinary team that includes biomedical and social scientists. Periodic meetings and constant communication among the team members have resulted in a comprehensive plan for collecting the data necessary to link nutrition and economics using methods and instruments for data collection that reflect the state-of-art in our respective disciplines.

This study overcomes many of the deficiencies of prior studies:

» It is a follow-up of a randomized community nutrition trial conducted in 1969–77, which permits causality to be established.
» The study involves 35 years of follow-up, among the longest ever in developing countries and certainly the longest evaluation of a nutrition intervention. The original study was a longitudinal study during pregnancy and childhood and provides pre-school data on nutrition, growth, and cognitive abilities—information that is rarely available to researchers on adult outcomes.
» The data sets assembled contain community and family factors collected at various points since 1969.
» There was a follow-up in 1988–89 that collected data at 11 to 26 years of age on physical and educational capital, as well as other studies conducted in the 1990s that supplement the availability of the original longitudinal study.
» We have collected data on migrants and have been able to attain high coverage [42]. Most subjects have finished school, chosen their adult occupations, and married prior to the time of measurement.
» Physical and educational capital have been measured comprehensively through multiple measures rather than just height, weight, and highest grade achieved.
» The study uses a variety of measures of wealth, expenditures, incomes, and wages to measure economic output productivity.

We are proceeding with analyses of the linkages among early childhood nutrition, physical and educational capital, and economic output. As we work together, we are learning from each others' disciplines. We use both epidemiologic and econometric approaches and will publish in a variety of journals to reach our diverse audiences. We also anticipate drawing appropriate implications of our work for policies and programs and bringing these lessons to the attention of policy makers in Central America and elsewhere. We

are certain that the 2002–04 follow-up will extend our previous findings and permit a more comprehensive evaluation of the long-term significance of nutrition in early childhood for human capital accumulation, occupation, marriage, and economic well-being.

Acknowledgments

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The Human Capital Study 2002–04: Tracking, data collection, coverage, and attrition

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Abstract

Between 2002 and 2004, the Institute of Nutrition of Central America and Panama (INCAP), in collaboration with Emory University, the International Food Policy Research Institute (IFPRI), and the University of Pennsylvania, re-surveyed young Guatemalan adults who had, as children, been participants in a nutrition supplementation trial conducted by INCAP between 1969 and 1977. This "Human Capital Study 2002–04" complements and extends data obtained in previous studies by collecting new information on measures of physical health and well-being, schooling and cognitive ability, wealth, consumption and economic productivity, and marriage and fertility histories. This paper describes the study domains and data collection procedures. Among 2,393 members of the original sample, 1,856 (77%) were targets for enrollment. Response rates varied by gender, current place of residence, and domain of data collection, with 80% of males and 89% of females completing at least one data collection instrument. Attrition was not random and appears to be associated with a number of initial characteristics of individuals and their households that should be controlled for in future analyses. We conclude that data collection was successful and data quality is high, facilitating the successful undertaking of our planned investigation of important study hypotheses.

Key words: Guatemala, Institute of Nutrition of Central America and Panama (INCAP), Human Capital Study, methods, coverage, attrition

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Introduction

Between 2002 and 2004, the Institute of Nutrition of Central America and Panama (INCAP), in collaboration with Emory University, the International Food Policy Research Institute (IFPRI), and the University of Pennsylvania, re-surveyed young Guatemalan adults who had, as children, been participants in a nutrition supplementation trial conducted by INCAP between 1969 and 1977 [1]. The present study, the Human Capital Study 2002–04, complements and extends data obtained in previous studies [1] by collecting new information on measures of physical health and well-being, schooling and cognitive ability, wealth, consumption and economic productivity, and marriage and fertility histories. The rationale and key objectives of the Human Capital Study are described in a companion paper [2]. Here we describe the procedures for tracing and contacting original sample members of the INCAP Longitudinal Study (1969–77) and for data management and the overall success in re-interviewing original study participants for the Human Capital Study from 2002–04.

Methods

Our approach to collecting data for the Human Capital Study required careful planning and execution. The tracing of former participants, the collecting and entering of data, the survey instruments that were implemented, and the mechanisms that were put in place to ensure data quality, are described below.

Tracing former participants

All 2,393 individuals born between 1962 and 1977 who participated in the INCAP Longitudinal Study were eligible for follow-up in the Human Capital Study. In 2003, during the mid-point of fieldwork, these individuals would have been between 26 and 41 years old.

Maps of the original study villages were obtained from the National Statistics Bureau and updated as needed. A census of all households in the original villages was implemented between January and April 2002. Sociodemographic information was collected from the entire population and records regarding mortality and migratory status of the 2,393 original sample members were updated. A list of "missing" sample members was created, and was then reviewed and corrected by questioning sample members' relatives, peers, (former) neighbors, and five community leaders in each of the original villages. Original sample members who had moved away from their natal villages were classified as "migrants." Research staff interviewed migrants' family members and acquaintances to obtain information about the migrants' current addresses and phone numbers, employers, work addresses, or general whereabouts. Flyers soliciting this information and invitation letters were also left with the relatives of migrants. The 102 (4%) sample members for whom no information was available even after these extensive efforts were classified as "untraceable."

Sample members still living in the original villages were visited by a team of interviewers and invited to participate in the study. Those who accepted were asked to sign a written informed consent approved by the Emory University and INCAP Institutional Review Boards. The informed consent was updated before each session of data collection (described below).

While collecting data in the original study villages, we also attempted to contact and interview migrants who were visiting their natal villages—for example, during village feast days and other major holidays. Between January 2003 and April 2004, a two-person team (one man and one woman) traveled throughout Guatemala to attempt to locate other migrants. Migrants to nearby villages, Guatemala City, or other cities or towns in Guatemala were visited wherever they were living, and invited to participate. In addition, we used a "snowball' approach whereby a list of still-missing original sample members was reviewed with each migrant located.

Data collection

Data collection was carried out between May 2002 and April 2004 (**table 1**). During the first year, data collection focused on sample members residing in the original villages, while from January 2003 to April 2004 the focus shifted to those residing elsewhere in El Progreso (the department in which the original study villages are located), in Guatemala City, and elsewhere in Guatemala.

Data were collected from residents of the original study villages between May 2002 and April 2003, in four (partly overlapping) modules, each fielded for about 4 months each (**tables 1 and 2**). Each module typically required two to three interview visits to complete. To limit respondent fatigue, interviews were scheduled at least 4 weeks apart. Most interviews were conducted in respondents' homes with the exception of the physical tests that were done at local INCAP headquarters.

TABLE 1. Schedule of data collection for the Human Capital Study 2002–04

<table>
<tr><td colspan="3">2002</td><td colspan="3">2003</td><td>2004</td></tr>
<tr><td>Jan–April</td><td>May–August</td><td>Sept–Dec</td><td>Jan–April</td><td>May–August</td><td>Sept–Dec</td><td>Jan–April</td></tr>
<tr><td rowspan="2">Preparatory phase</td><td colspan="3">Sample members residing in original villages</td><td colspan="3">Sample members residing elsewhere in Guatemala</td></tr>
<tr><td>Module 1</td><td>Module 2</td><td>Module 3</td><td colspan="3">All modules</td></tr>
<tr><td>Socio-anthropologic study
Socio-demographic characteristics (Census)</td><td rowspan="3">Literacy
Schooling
Reading skills
Intelligence
Individual diet
Physical activity</td><td>Anthropometry
Marriage and assets history
Household expenses</td><td>Reproductive history
Medical history/ physical exam
Blood test</td><td colspan="3" rowspan="3">Socio-demographic characteristics (Census)
Literacy
Schooling
Reading skills
Intelligence
Individual diet
Physical activity
Anthropometry
Marriage and assets history
Household expenses
Reproductive history
Medical history and physical exam
Blood test
Economic activity</td></tr>
<tr><td colspan="2">Module 4</td></tr>
<tr><td colspan="2">Economic activity</td></tr>
</table>

Data were collected from migrants between May 2003 and April 2004. By April 2003, each interviewer had mastered at least four different areas of data collection, enabling two interviewers and the physician to collect all the data related to a single respondent in a single session. Sample members who lived in Guatemala City were invited to INCAP headquarters for interviews and examinations. Transportation was arranged if needed. Migrants living in Guatemala City who did not come to INCAP were visited by a

TABLE 2. Study domain and data collection of the Human Capital Study 2002–04

Study domain	Data collection
Preparatory phase	
Socio-anthropologic	Current and past education and health facilities, physical infrastructure, public services, and programs, events that might have affected human capital or economic productivity
Socio-demographic characteristics (Census 2002)	Demographics: Date of birth, gender, migration status, religion, literacy, schooling, occupation, and mortality. House structure: Type of walls, roof, and floor, number of rooms, and availability of latrines was obtained by interviewers' observation of the house. Family possessions: Household appliances, animals, land tenure.
Module 1	
Literacy	Literacy, knowledge of letters, syllables, words and general reading skills, including phrases and short sentences.
Schooling	Schooling histories and scholastic achievement.
Reading performance	Reading comprehension and vocabulary section of the Interamerican Reading Series
Intelligence	Raven's Standard Progressive Matrices test.
Individual diet	A semi-quantitative food frequency questionnaire
Physical activity	Timing, duration, nature and intensity of key events (getting ready for work, household chores, means of transportation to work, type of activity at work, duration of working day and types of recreational activities).
Module 2	
Anthropometry	Weight, height, seated height, knee height, triceps and subscapular skin folds, waist, and hip circumferences.
Marriage and assets history	Marital status and history; characteristics and family background of spouses; and assets brought by both parties to the household and their source.
Household expenses	Food and non-food household expenditures including education and health expenditures.
Module 3	
Reproductive history	Males: marriage history and knowledge and practices relating to contraceptives. Females: age at menarche, date of the last menstrual period, number of pregnancies and parity, obstetrical history of each pregnancy.
Medical history and physical exam	Personal and family history of health, smoking, drinking, medication and drug consumption and any current symptoms of disease and the physical examination including body temperature, heart and respiratory rates, blood pressure and examination of eyes, ears, neck, chest, thorax (heart rates and murmurs, respiratory tremors), abdomen (gastrointestinal murmurs) and limbs (deformities and limitations) examination, physical fitness (step test, hand strength, flexibility).
Blood tests	Total cholesterol, HDL-cholesterol, triglyceride, glucose, hemoglobin
Module 4	
Current economic activity	Employment status, jobs held and migratory status, job description, contractual arrangements, incomes, wages if paid, employer characteristics, land operated, crops grown, value of harvest, income generated from non-agricultural own business activities, transfers
Other	Self-esteem, social capital, and remittances

team of interviewers and interviewed and examined in their homes.

Data management

Double-data entry (using Epi-Info, version 6.04) was carried out and, in contrast to previous studies of this sample, was done in the study field headquarters. Data were typically entered within a few days of the interview, though occasionally data entry was delayed up to 4 weeks after data collection. The "Validate" option within Epi-Info was used to compare files. The resulting files therefore accurately reflect the information registered in the forms. Cleaning routines were developed and applied. Basic checks such as range values and logical consistency across variables were conducted every few days and queries were resolved by the supervisors in the villages. When possible, potential errors were sent to the field for review, with the supervisor authorized to correct coding errors.

A data back-up system was implemented at study field headquarters, as well as at INCAP's headquarters in Guatemala City. Data files were sent to Emory University a few weeks after data collection was finished in the original villages and after migrants' data collection was completed. Emory University acted as the central repository for the data and syntax files. Conventions were established to standardize file names and to assign variable labels across all data files that were created. A second set of more complex data cleaning routines were developed and performed by researchers with expertise in specific areas; potential errors and inconsistencies were discussed with the field director and field supervisor and necessary corrections incorporated in the data set.

Data collected during the follow-up

In early 2002, a socio-anthropological study [3, 4] was implemented to describe current and past educational and health facilities, physical infrastructure, public services, and programs that operated in the study area, as well as important events that might have affected human capital or economic productivity; this information helped us to design different forms and questionnaires. Individual- and household-level data were collected related to sociodemographic information, literacy, schooling, reading skills, intelligence [5], individual diet, physical activity [6], anthropometry, medical history and physical exam, blood tests [7], reproductive history [8], marriage and assets histories [9]; household expenses [10]; economic activity [11] and other information. A more detailed description of study domains (**table 2**) and data collection methods is provided in the respective articles in this special issue [7–11]. To ensure comparability across previous studies, all questionnaires and study domains were reviewed and followed where possible; instruments for both old and new domains of interest were reviewed, updated, and validated by first applying them to citizens from nearby similar villages.

Interviewer training and field quality control

Code books were prepared for each form, questionnaire, or test. Each team of interviewers was trained and interviewing techniques and interpretations were standardized in one or two study domains in the two weeks before the module implementation. At least two re-standardization exercises were done within the module implementation; the interviewers performed a supervised reading of the code books and cross interviews applying to citizens from nearby similar villages; the interviewers' field experiences were shared with the whole field work team and lessons learned were summarized. All forms were reviewed by the interviewers after the completion of the interviews. The field workers were directly supervised, with 10% of the interviews of each study domain observed by the field supervisor. The quality of data collection was extensively monitored during data collection in the original villages; repeated measurements or cross interviews were done by the supervisors or other interviewers in at least 5% of the interviews and the percentage of agreement among interviewers or supervisors usually exceeded 95%. The results of the supervisors' observations and the repeated measurements or cross interviews were used to field-train interviewers and improve ongoing data collection. The field supervisor reviewed 40% of the forms filled in the original villages and 60% of the forms filled elsewhere in Guatemala, looking for non-permissible data, missing information, and inconsistencies between questions. Forms with inconsistencies or missing data were re-sent to the field to be corrected. After they were reviewed, the forms were delivered to the data center established at INCAP headquarters in each study village.

Results

Tracing and enrollment in the targeted sample

Of the original sample of 2,393 individuals, 272 (11%) had died by 2002, the majority due to infectious diseases in early childhood (**fig. 1**). For 102 (4%) sample members, even after extensive investigation, no information could be found. These 102 "untraceable" sample members may or may not be alive and, if alive, may or may not be living in Guatemala; 71 of these 102 also did not appear in the 1975 census. It is probable that they (and their families) had moved away nearly 30 years ago, and we have been unable to trace them since. Of the remaining 2,019 sample members, 163 (8%)

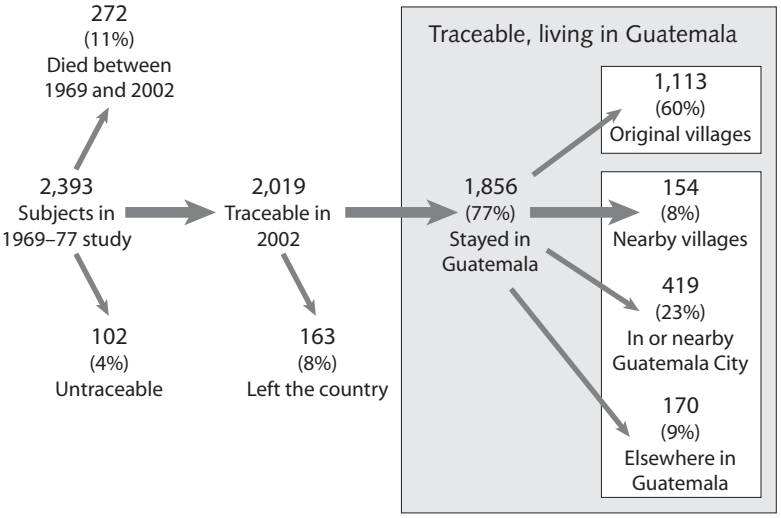

FIG 1. Tracking of the Human Capital Study 2002–04 sample. Of the original sample of 2,393 individuals in the 1969–77 INCAP Longitudinal Study, 272 (11%) had died by 2002, and 102 (4%) sample members were not found. Of the remaining 2,019 sample members, 163 (8%) had migrated out of the country. The true targeted population for the Human Capital Study 2002–04 comprises 1,856 (77%) original sample members.

had migrated out of the country, three-quarters to the United States. If all 102 untraceable sample members were either dead or living outside of Guatemala, the true targeted population would comprise 1,856 original sample members (77% of the original cohort); if all 102 were alive and living in Guatemala, there would be 1,958 (82%) potential sample members.

Coverage and attrition

In what follows, we base coverage calculations on the smaller target sample size of 1,856. Obviously, coverage rates would be lower than those reported below if we were to treat untraceable sample members as a part of the target sample, and even lower if we were to treat all original 2,393 original sample members as the target sample. Doing so, however, would lead to an unfair assessment of the success of fieldwork activities in isolation, since only the 1,856 individuals were targeted. We return to a consideration of the full original sample (2,393) in the examination of attrition below.

For the 1,856 traceable sample members living in Guatemala, 1,054 (58%) finished the complete battery of applicable interviews and measurements and 1,570 (85%) completed at least one interview (**table 3**). For two-thirds of the 286 (15%) who completed no interviews, while we learned they were alive and living in Guatemala, we were unable to obtain a current address and therefore could not make contact. As a result, the effective refusal rates for any participation among those whom we were able to contact were low, around 5%.

Coverage varied by gender, data domain, and current place of residence (**table 3**). Coverage was lower for men than for women—43% of men and 71% of women completed all the forms, and 80% versus 89%, respectively, completed at least one form (data not shown). Completion rates were higher for instruments involving only interviews as compared with those involving physical measurements; 56% of males and 78% of females responded to all interviews, while 47% of males and 73% of females completed all physical measurements (data not shown). No differences in response rates were found across birth year cohorts or tertiles of 1,975 parental SES scores, for men or women (data not shown).

Of the 1,856 target sample members, 1,113 (60%) currently reside in their native village, 154 (8%) live in nearby villages (almost all of them within 10 km from the original villages), 419 (23%) live in Guatemala City, and the remaining 170 (9%) live in other cities or towns elsewhere in Guatemala (**fig. 1**).

Among residents of the original (or nearby) villages, 77% of the females and 43% males responded to all the forms and 97% and 92%, respectively, responded to at least one form. In Guatemala City, 71% of females and 56% of males responded to at least one form. Overall, then, higher response rates were achieved for sample members living in the original villages. Due to the logistics of data collection, however, which entailed multiple visits, there was higher variability in the response rates across instruments among sample members living in the original villages than those living in Guatemala City or elsewhere in Guatemala, where all data collection usually was conducted in a

TABLE 3. Coverage in the Human Capital Study 2002–04 by type of data collection: gender and current residence

	Men (n = 937)						Women (n = 919)					
	Original or nearby villages (n = 651)		Guatemala City (n = 197)		Elsewhere in Guatemala (n = 89)		Original or nearby villages (n = 616)		Guatemala City (n = 222)		Elsewhere in Guatemala (n = 81)	
Current residence	N	%[a]	N	%[a]	N	%[a]	N	%[a]	N	%[a]	N	%[a]
Literacy/schooling	540	83	100	51	43	48	583	95	141	64	62	77
Reading performance[b]	433	78	98	50	33	42	454	92	133	62	45	69
Intelligence	528	81	100	51	43	48	578	94	140	63	61	75
Individual diet	552	85	101	51	44	49	583	95	145	65	61	75
Physical activity	552	85	101	51	44	49	584	95	145	65	61	75
Anthropometry	482	74	101	51	44	49	556	90	146	66	60	74
Married and assets history	490	75	102	51	44	49	562	91	147	66	61	75
Household expenses	594	91	107	54	50	56	571	93	143	64	59	73
Reproductive history	502	77	101	51	44	49	569	93	149	67	61	75
Medical history and physical exam	448	69	100	51	44	49	550	90	146	66	61	75
Blood test	353	54	95	48	44	49	503	82	146	66	60	74
Current economic activity	510	78	99	50	44	49	569	92	138	62	62	77
Total coverage												
Completed all forms	280	43	80	41	42	47	473	77	123	55	56	69
Completed at least one form	597	92	110	56	45	51	598	97	157	71	63	78
No address	0	0	73	84	39	89	2	11	56	86	17	94
Completed all interviews	394	61	87	44	43	48	531	86	130	59	58	72
Completed all physical exams	308	47	89	45	43	48	486	79	133	60	57	70

a. Coverage = collected (measured) /eligible.
b. Coverage is calculated only for those eligible subjects.

single visit. For both males and females, the blood test had the lowest response rate. For all data domains, response rates were higher for women than for men. No difference in response rates were found among data domains between those living in Guatemala City and living elsewhere in Guatemala.

The discussion of coverage demonstrates how successful the study was in interviewing those in the target sample, the result of the various methodologies for tracing that were put in place. Even if 100% of the target sample had been interviewed, however, the study would still have had substantial attrition, i.e., original sample members who were not interviewed in 2002–04, because not all original sample members were targeted. When making inference using these data, what is most important to the analyst is not coverage of the target sample, as defined above, but rather overall attrition. What are the characteristics of those individuals not interviewed, for whatever reason, in 2002–04? We use multinomial logistic regression to describe the factors associated with attrition, with the outcome as the dependent variable coded as at least one completed interview (the base category), dead, untraceable, migrated outside the country, and not interviewed (**table 4**). The latter group comprises those 286 in the operational target sample of 1,856 who were not interviewed in 2002–04.

Attrition in the sample is associated with a number of initial conditions, with the effects differing by the reason for attrition. Compared with those interviewed, men were more likely to have died or were not interviewed, and were slightly more likely to have migrated out of Guatemala (though this effect is not significant, $p = .18$). The association of later year of birth, i.e., younger age, with risk of death is counterintuitive and results from the inclusion in the study population of all children less than seven years in 1969. These represent the survivors of their respective birth cohorts, and hence they experienced a lower mortality rate (most of which is driven by infant mortality) compared with the later birth cohorts in the study who were followed from birth.

There was no significant pattern for death by village of birth, but those who were born in Conacaste were significantly less likely to be untraceable than those born in Santo Domingo and significantly more likely to be living outside Guatemala. Those born in Espíritu Santo and in the target sample were more likely to be interviewed compared with those from Santo Domingo; this is consistent with somewhat higher

TABLE 4. Attrition analysis for the Human Capital Study 2002–04: Logistic regression estimates[a]

	Dead			Untraced			Living outside Guatemala			Found, not interviewed		
	Odds ratio	95% CI		Odds ratio	95% CI		Odds ratio	95% CI		Odds ratio	95% CI	
Male	1.47[b]	1.12	1.93	0.65	0.39	1.07	1.25	0.90	1.75	1.85[b]	1.40	2.43
Year of birth	1.09[b]	1.06	1.13	1.02	0.95	1.09	0.98	0.94	1.02	1.02	0.99	1.05
Born in San Juan	1.09	0.74	1.62	1.10	0.58	2.07	0.61	0.34	1.07	0.83	0.57	1.22
Born in Conacaste	1.39	0.97	1.98	0.30[b]	0.14	0.65	1.64[b]	1.08	2.48	0.99	0.70	1.38
Born in Espíritu Santo	1.07	0.70	1.63	0.58	0.29	1.17	1.04	0.62	1.73	0.61[b]	0.40	0.93
Age of mother when born	1.00	0.97	1.02	1.02	0.97	1.06	0.99	0.96	1.02	1.01	0.98	1.03
Age of father when born	1.02[b]	1.00	1.05	0.99	0.95	1.03	0.99	0.96	1.02	1.00	0.97	1.02
Mother's schooling	0.97	0.88	1.07	0.79	0.60	1.04	1.03	0.92	1.15	1.05	0.96	1.14
Father's schooling	0.92[b]	0.84	0.99	1.28[b]	1.11	1.47	0.98	0.89	1.07	1.04	0.97	1.11
SES in 1975	0.99	0.90	1.09	0.72	0.51	1.02	1.14[b]	1.04	1.25	1.05	0.96	1.14
Missing SES	0.39[b]	0.20	0.76	1.50	0.54	4.13	0.56	0.27	1.18	0.44[b]	0.23	0.83

a. Dependent variable is final HCS study status (reference category is 'interviewed'). Reference categories for village of origin is Born in Santo Domingo. Regression also includes dummy control variables for indicator of whether mother's age, father's age, mother's schooling, or father's schooling are missing.

b. Significant at $p < .05$.

cooperation with the study team in Espíritu Santo, the least urbanized of the villages.

We next considered the role of a number of measures of family background on attrition in the sample, including parental age (at child birth), parental education, and a 1975 parental socioeconomic status (SES) score. Age of parents (at child birth) and maternal education have little effect on attrition. Fathers' schooling, however, is associated with lower odds that the sample member was lost to death and higher odds that he or she was untraceable. To the extent that paternal education is an indicator of long-run resources in the household, these findings are consistent with the 2002–04 sample members being from better off households in which there were fewer deaths. Another indicator of resources is the 1975 parental household SES score, which increases significantly the odds of living outside of Guatemala. Having missing household SES also substantially decreases the odds of death and the odds of not being interviewed, conditional on being in the target sample.

To probe deeper into the extent to which the factors in **table 4** or other factors vary across the different categories of attrition groups, we next examine the means and SDs for a variety of variables (**table 5**). While all but two of the variables show significant differences across categories using an analysis of variance (ANOVA) test (second to last column), fewer than half show significant differences when we compare means between the interviewed and all non-interviewed (whatever the reason) individuals together, using two sample *t*-tests or proportion tests as appropriate (final column). While there are significant differences across categories as indicated by the ANOVA tests, in many cases they are in opposite directions across categories within the not-interviewed group such that on average the group not interviewed is not significantly different from the group that was interviewed. This suggests that, while clearly not random, the average effects of attrition do not show obvious patterns of bias. Further, for those that do differ by either test, several do not appear to be very large differences. For example, the proportion living in Espíritu Santo varies by only seven percentage points across categories and the year of birth by only 2.0 years. However, household SES score in 1975 differs by a full SD across categories and the height-for-age

TABLE 5. Mean and SDs of selected variables: by attrition category of the Human Capital Study 2002–04

		Not interviewed					
	Interviewed	Dead	Untraced	Living outside Guatemala	Traced, not interviewed	ANOVA *p*	*t*-test[a] *p*
Number of observations	1570	272	102	163	286		
(1) if Santo Domingo	0.26	0.24	0.35	0.27	0.34	.02	.11
(1) if San Juan	0.23	0.21	0.31	0.12	0.20	< .01	.18
(1) if Conacaste	0.30	0.36	0.12	0.43	0.32	< .01	.19
(1) if Espíritu Santo	0.21	0.18	0.22	0.18	0.15	.16	.05
Year of birth	1970.1	1971.5	1970.1	1969.5	1970.2	< .01	.05
	(4.2)	(3.9)	(3.5)	(4.2)	(4.3)		
(1) if male	0.48	0.59	0.43	0.55	0.65	< .01	< .01
(1) if *atole*	0.53	0.58	0.43	0.55	0.52	.15	.92
Age of mother when born (years)	27.6	28.3	25.8	26.4	27.2	< .01	.22
	(7.2)	(8.0)	(7.6)	(6.9)	(7.4)		
Age of father when born (years)	32.9	35.0	31.9	31.6	32.5	< .01	.51
	(8.7)	(9.5)	(9.0)	(8.1)	(8.7)		
Mother's schooling (years completed)	1.3	1.1	0.9	1.5	1.5	.05	.99
	(1.7)	(1.4)	(1.7)	(1.4)	(1.7)		
Father's schooling (years completed)	1.7	1.3	3.0	1.7	2.0	< .01	.90
	(2.2)	(1.7)	(3.4)	(2.2)	(2.4)		
Household SES score in 1975	–0.19	–0.27	–0.60	0.36	0.16	< .01	.02
	(1.67)	(1.69)	(1.40)	(1.84)	(1.86)		
(1) if missing 1975 SES score	0.08	0.13	0.72	0.16	0.20	< .01	< .01
Height-for-age (HAZ) z score at 2 years	–2.47	–2.78	–2.37	–2.15	–2.18	< .01	.07
	(1.09)	(0.98)	(0.86)	(0.88)	(1.00)		
(1) if missing HAZ score	0.54	0.84	0.90	0.66	0.69	< .01	< .01

a. Two sample *t*-test except where variable is a proportion, where it is a test of equality of proportions.

z score by 0.6 SD, with those best-off living outside Guatemala or traced but not interviewed.

This analysis, while descriptive, underscores that attrition in the sample is not random. Analysts will need to consider its potential effects when using these data and, at a minimum, control for some of these initial factors.

Spouses of original sample members were also targeted for interview. Because the original study covered all children born in the villages over a 15-year period, many target sample members intermarried, with the consequence that in many instances, interviewing spouses meant interviewing an original sample member; there were 216 couples formed by two original study sample members. In the end, we interviewed 703 spouses who were not part of the original study, out of 1,038 projected. To project the total number of spouses who were not original sample members (in order to calculate coverage for them), we do the following within each location (original villages, Guatemala City, elsewhere in Guatemala). First we calculate the number of spouses identified in the field work who were not original sample members. Then, we divide by the number of original sample members interviewed. This fraction is then applied to the total number of original sample members (regardless of whether they were interviewed) to obtain the projected number of spouses who are not original sample members. Coverage of spouses was 84%, 45% and 53% for spouses living in original villages, Guatemala City and elsewhere in Guatemala, respectively—broadly similar rates to original male sample members.

Conclusion

The strategies implemented to track and locate former participants of the INCAP Longitudinal Study (1969–77) allowed us to trace and re-interview 84% of those individuals alive and known to be living in Guatemala, which was 66% of the original sample of 2,393. Individuals were found using information obtained in village censuses that focused on mortality and migratory status. Lists of missing sample members were produced and updated frequently and reviewed by relatives, peers, neighbors, and community leaders and other migrants. Flyers and invitation letters were left with migrants' relatives. A system was put in place to contact (and at times interview) migrants during visits to their home village. Once we had a phone number or address list a two-person team telephoned or visited the place of work or the potential home address until contacting them. These strategies required substantial dedication and financial support but allowed a high level of coverage.

The Human Capital Study (2002–04) complements and extends the data collected in previous studies with information on physical health and well-being, schooling and cognitive ability, wealth, consumption and economic productivity, and marriage and fertility histories. The data collection was organized in such a way that training, standardization, and supervision ensured data quality and comparability across previous studies. As an innovation a computer center was established close to the original villages, which allowed data entry and cleaning a few weeks after the interviews and physical measurements were performed and conducting descriptive analysis within 6 months of the completion of data collection.

The coverage varied among data areas, gender, and current place of residence. However, more than 80% of males and 89% of females in the original sample who are known to have been alive and in Guatemala completed at least one form. We conclude that the strategies implemented for tracking sample members and those to perform data collection were fairly successful, which affects the coverage and attrition levels and allow us better to test our hypotheses in future studies.

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Social and economic development and change in four Guatemalan villages: Demographics, schooling, occupation, and assets

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Abstract

This article uses census data and village histories to examine changes over the last 35 years in the four villages where the Institute of Nutrition of Central America and Panama (INCAP) Longitudinal Study (1969–77) was conducted and offers a rare picture of development and change in rural localities over a long period of time. In addition, by characterizing the environment in which the subjects of this study were raised, we provide context for and inputs into quantitative analyses of data collected at various points in time on these subjects. The villages have undergone massive demographic, social, and economic change. Initial differences have conditioned many of these changes, especially differences associated with agricultural potential and location. Originally these villages were rather isolated, but road and transportation access has improved substantially. The populations in the villages have more than doubled and also have aged. While marriage patterns have held steady, religious practice has changed a great deal. After many years of steady out-migration, three of the four villages are more recently experiencing net in-migration, a pattern associated with ease of access. Schooling access and outcomes also have improved, with average grades of schooling nearly tripling and literacy doubling to levels currently above national averages. Although agriculture remains an important component of individual livelihood strategies, non-agricultural sources of employment have become more important. Much of this change is associated with declining agricultural markets and increased access to non-agricultural jobs near the villages and in the capital. Accompanying these changes has been an improvement in living standards as measured by a number of indicators of household living conditions and consumer durable goods.

Key words: Guatemala, Institute of Nutrition of Central America and Panama (INCAP), Human Capital Study, demographics, schooling, occupation, assets

Introduction

In 1969–77 a multidisciplinary research team based at the Institute of Nutrition of Central America and Panama (INCAP) carried out a longitudinal nutrition and health intervention study in rural Guatemala. The goal of the INCAP Longitudinal Study (1969–77) was to determine the effects of undernutrition in utero and early childhood on subsequent physical and mental development of children [1]. In deciding where to situate the intervention, the original investigators sought study villages that were similar along certain dimensions, several of which were viewed as essential to the success of the study. For example, a decision to distribute the nutrition supplement at central feeding stations in each village meant that the settlements had to be relatively compact in order for all residents to have reasonable access. To facilitate psychometric testing, the population had to be Spanish-speaking. To allow frequent visits by the research team, access was necessary; therefore, distance to INCAP headquarters in Guatemala City was considered. Finally, investigators took into account population size and distribution, to ensure statistical power in the analyses [2]. After an exhaustive search in which 300 villages were investigated, two pairs of villages were chosen. Two smaller villages, San Juan and Espíritu Santo, had approximately 500 inhabitants each in 1967, and two larger ones, Santo Domingo and

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Conacaste, had 900 each. The investigators randomly assigned a nutrition supplement across village pairs: San Juan and Conacaste received *atole*, a high-calorie, high-protein drink; Espíritu Santo and Santo Domingo received *fresco*, a low-calorie, no-protein drink [2].

These villages have been the locus of several subsequent studies assessing the longer-term effects of exposure to this supplement. The 1988–89 follow-up study explored whether improved nutrition in early childhood enhances human capital in adolescence and adulthood [3]. In the late 1990s, there were a series of further longitudinal studies on subpopulations in the villages, assessing the role of early childhood nutrition on the prevalence of cardiovascular risk factors and on outcomes related to childbearing [4, 5]. In 2002–04, INCAP and collaborators again collected information on the INCAP Longitudinal Study (1969–77) sample, under the Human Capital Study (2002–04); the majority of that sample still lives in the original four villages [6].

The focus of much of the analytical work based on these data has been on the impact of the nutrition intervention on dimensions of individual well-being. However, each of the surveys has been accompanied by a census of all individuals and households in the four villages, conducted in 1967 (with data collection in one village spilling into 1968), 1975, 1987, 1996, and 2002, as well as a series of descriptive studies conducted in 1965–68, 1987–88, and 2002. In this paper, we use this information to examine changes in the four villages over the last 35 years. The study provides a rare picture of development and change in rural localities over a long period of time. In addition, by characterizing the environment in which most of the subjects of the original study were raised, we provide context for, and inputs into, quantitative analyses of data collected at various points on these subjects.

Methods

The principal sources of information for this article are the five censuses done in the study villages, as well as several village histories carried out over the same period.* The latter include Pivaral, Bergeron, and Murphy et al [7, 8, 9]. We also draw heavily on Engle et al., who analyze the first three rounds of census data considered in this article [10]. The census consisted of a single interview form administered to each "nuclear family" living in any of the four villages. A nuclear family was defined as any of the following: (1) a couple (including their children, if any), regardless of whether they lived on their own or with others, e.g., parents; (2) a single adult, with children and/or pregnant, regardless of whether s/he lived on their own or with others; and (3) a single adult living alone. A single woman without children (and not pregnant) living with her parents was considered a member of her parents' nuclear family. If she was pregnant and/or had had any children, she (and her children if present) would constitute a nuclear family apart from her parents. The same criteria applied to a single man. Thus, it was common for more than one nuclear family (hereafter referred to as family), as defined by the census, to live together. Families with a husband and wife (either in a consensual union or married) were defined to have a male and a female household head. In single-person or other family structures, only a single household head (either male or female) was defined.

Information collected at the family level included civil status and religion of the head(s), fertility of the female head, housing characteristics, and ownership of consumer durable goods. At the individual level, it included the following: gender, date of birth, whether alive or dead (and date of death), current location, self-reported literacy, education, and occupation. This information was collected for all persons who were resident during each census; after the initial census, the information was updated for individuals who had been interviewed in a previous census. The contents of the census questionnaires expanded over time, for example, to include additional household durable goods and productive assets as they became more widely available. Village boundaries have not changed and the census methodology was identical over time.

The descriptive studies, often referred to as village histories, employed quantitative and qualitative methods of data collection, to differing degrees. Pivaral and Bergeron are based mostly on quantitative data collected using standardized questionnaires, though they draw on observation and other qualitative methods. Pivaral uses quantitative social, economic, and cultural data collected between 1965 and 1968 from all families in all four villages to describe "baseline" conditions [7]. Bergeron uses the first three rounds of the same census data we use here, as well as two rounds of survey data on income and wealth collected in 1975 and 1988, to describe changes in the communities over two decades [8]. In contrast, Murphy et al. [9] summarize qualitative data that Estudio 1360 (a social and educational research firm based in Guatemala) collected in the four villages in 2002 using unstructured individual interviews, semi-structured individual interviews, and focus group discussions. In addition to the qualitative field methods, the anthropologists collected secondary information from school records in each village [9].

* This analysis is based on the April 2004 version of the INCAP Longitudinal Study censuses.

The four survey villages

The four survey villages are located in the Department of El Progreso, east of Guatemala City. The inhabitants are of *ladino* (mixed Spanish-Amerindian) heritage, and live in small, compact, rural settlements within about 100 km of Guatemala city [7]. These settlements, originally called *rancherías*, were formed around land loaned to *ladino* peasants in return for their labor on landowners' farms or *haciendas*. After the 1944 revolution, peasants gained rights to this land free of labor or rent obligations and gradually were granted legal ownership [8].

Due to the village selection procedure for the INCAP Longitudinal Study (1969–77), villages were similar at the outset, except for some small but statistically significant differences in socioeconomic indicators (e.g., male occupations, fertility rates, and literacy rates) [10]. Below we examine the two most salient initial conditions that were different across villages: agricultural potential and location (and transportation links).

Agricultural potential

The first difference among villages was, and remains, their agro-ecological environments. El Progreso is one of the hottest and driest departments in Guatemala. Its rainy season is from May to October, and this governs the agricultural production cycle [7]. El Progreso can be divided into two ecological areas that differ in temperature, patterns of rainfall, and quality of soil: the highlands of the Motagua valley, and the lowlands along the Motagua River [8].

Three of the study villages (Conacaste and San Juan in the municipality of Sanarate and Santo Domingo in San Antonio La Paz) are located in the cooler, wetter highlands, where the soil is shallow, less fertile, and more prone to erosion because of steep inclines. Historically, these lands have been used for subsistence production. The three highland villages also are distinct among themselves in terms of agricultural potential. Conacaste is on a plateau in the upper Motagua valley, giving it greater (commercial) agricultural potential than either Santo Domingo or San Juan—the latter two are nestled among steep hills, with shallow rocky soil prone to erosion [8].

The fourth village, Espíritu Santo (in the municipality of El Jícaro), is found in the warmer, drier lowlands where the soils are deep and rich, and the land is flat and amenable to mechanization and irrigation. In contrast to the highland villages, the high agricultural potential of the lowlands has long attracted capital investment in commercial farming and improvements to infrastructure. In the lower Motagua region, wealthier farmers have dominated the most productive alluvial lands leaving most villagers from Espíritu Santo to engage in subsistence production on marginal lands or engage in agricultural wage labor (and at times sharecrop) on wealthier farmers' lands. This separation between subsistence and commercial production is emblematic of the dual nature of agriculture elsewhere in Guatemala [8].

Location (and transportation links)

A second important difference among villages is location, in particular distance from the villages to their municipal capital and the Atlantic coast highway that leads to Guatemala City. The three mountain villages are 4–8 km from their municipal capitals (Conacaste and San Juan are 6 and 8 km from Sanarate and Santo Domingo is 4 km from San Antonio La Paz), whereas Espíritu Santo is only 1 km away from its municipal seat, El Jícaro. Proximity to the municipal capital has tended to provide people from Espíritu Santo with better access to municipal-level health and educational services. All four villages are along, but not on, the Atlantic coast highway. Santo Domingo is the closest to the highway, only 2 km away, while until 1998 Espíritu Santo was the farthest. Conacaste and San Juan are 4 and 9 km from the Atlantic coast highway, respectively. In addition to being closest to the highway, Santo Domingo also is closest to Guatemala City (36 km), a feature that has influenced its development; Espíritu Santo is the farthest away (102 km) and the others are around 60 km away (**fig. 1**) [8, 9, 10].

These initial differences in agricultural potential and location have been associated with different quality and timing of village infrastructure development (for example, roads and transportation), and therefore with villagers' mobility and access to livelihood opportunities. Differences in location and villager mobility are associated with differential access to health and schooling services and trends in migration and employment.

In the late 1960s, Espíritu Santo, having benefited from external investment by agribusiness and large landowners, was the only village with a longstanding, high-quality, all-weather access road. Santo Domingo's dirt access road also was reliable across all seasons. By contrast, the dirt access road connecting San Juan to the Sansare-Sanarate road (itself a dirt road at the time) had been constructed only recently and was of poor quality and not passable by four-wheel drive vehicles after a heavy rain. Likewise, the dirt access road connecting Conacaste to the Atlantic coast highway, constructed in the late 1960s, flooded easily [9].

Over time, improvements in their roads, and hence access to the Atlantic coast highway and to Guatemala City, have benefited all villages. In Santo Domingo, an all-weather road replaced the dirt road to the highway in the mid 1980s. In Conacaste, although the route to the highway remains a dirt road, the establishment of an agricultural horticulture cooperative in the village

FIG 1. Location of INCAP Longitudinal Study communities in Department of El Progreso, Guatemala

in 1978 motivated and financed regular maintenance. In 1994, governmental funds were used to widen and grade the road. By contrast, apart from intermittent maintenance, no improvements have been made to the access road between San Juan and the Sansare-Sanarate road; indeed, it still can become impassable during the rainy season. When the government paved the Sansare-Sanarate road in 1996, however, it enabled somewhat easier access from San Juan to Sanarate and the Atlantic coast highway. Lastly, villagers from Espíritu Santo gained more direct and regular access to the Atlantic coast highway only in 1998, when a bridge was constructed over the Motagua River, shortening the distance to the Atlantic coast highway from 20 km to 3 km [9].

Road improvements eventually led to better access to market towns, regional centers, and Guatemala City. During the 1980s in Espíritu Santo and Conacaste, small private vehicles known as *ruleteros* or *fleteros* began transporting people and goods. Improvement of the Conacaste access road in 1994 brought with it regular *ruletero* service between Conacaste and Sanarate every half hour, and direct bus service from Conacaste to Guatemala City. Daily bus service to Guatemala City began in Santo Domingo in the mid 1980s. In the 1990s, this became hourly service, and a *ruletero* began offering rides to the Atlantic coast highway where people could catch any one of numerous buses traveling to and from Guatemala City [9].

As with the development of roads, advances in transportation and mobility came later to San Juan than to the other three villages. Villagers did not often travel in motorized transport to the highway or to Sanarate until the 1990s, when microbuses started running between San Juan and Sanarate several times a day. With the paving of the Sansare-Sanarate highway in 1996, buses directly to Guatemala City began servicing that highway. Thus, residents could catch direct transport to Guatemala City after reaching the entrance of the access road [9].

Health services infrastructure

The INCAP project founded the first local health clinics in the four villages. Before the project, villagers treated ailments with home remedies, visited healers, or walked to the nearest health post in their municipal capital. For example, before 1969, nearly 80% of diarrheal diseases (and similar percentages for colds and parasites) were treated with home remedies [7]. With the exception of Espíritu Santo, where residents had access to (low-quality) governmental health services in nearby El Jícaro, the level of infant mortality was high, especially from vaccine-preventable diseases like tetanus [9, 11].

With the introduction of village health clinics, both the supply and demand for health care services increased dramatically in the four villages. INCAP medical staff offered free medical care and medicine to everyone, regardless of participation in the study. Transportation to the hospital was provided when necessary, and vaccinations were offered locally [9]. When the project closed, the INCAP-run health clinics were handed over to the government, with the Ministry of Health (MoH) sending nurse-aids to continue to provide health care in each village. The level of this care, however, was inferior. The nurse-aids were not as skilled as the INCAP physicians and nurses, no transportation to hospitals was provided, and medicines

were either unavailable or expensive. In the early 1980s, MoH built rural health posts in three of the four villages: Espíritu Santo in 1980; Conacaste in 1981; and a second one in San Juan in 1982. Neglected in the early 1980s, Santo Domingo was the last of the villages to get a health post in 1985. The MoH health clinics in all four villages encountered similar problems: lack of maintenance, old equipment, and inadequate access to medication [9]. The health posts in Espíritu Santo and Santo Domingo often have been short-staffed, whereas those in San Juan and Conacaste have been staffed relatively well, with the participation of final-year medical students (EPS) and rural health technicians (TSR), as well as community volunteers. The nurse-aids in these two villages served for more than 15 years, allowing a continuity of care unknown in the other two villages [9].

Currently, all four health posts provide birth control, prenatal check-ups and iron supplements, and immunizations. Although the mandate for health posts also includes provision of primary care, the village health posts are unable to provide these services; therefore, residents often turn to other providers, such as local traditional birth attendants and healers or more distant health clinics. Residents of all four villages seek care at larger, better staffed, and better equipped health care centers in municipal and departmental capitals if the local health post is closed, or they perceive it cannot or has not addressed their needs. If they visit governmental health care centers, the services are free. Villagers also occasionally use private physicians and clinics, for which they must pay. In this way, proximity to Guatemala City, municipal, and departmental capitals, and mobility provided by transportation services, influence the type of health care available to villagers [9].

Demographic trends

Changes in population composition: age and gender

Figure 2 shows population pyramids for residents in all four villages for each of the census rounds, with 5-year age groups on the vertical axis and the percentage of males and females on the left and right horizontal axes, respectively. The general shape of the population pyramids reflects the high fertility populations in these villages; the pyramid bases are relatively broad, with high proportions of the population less than age 15 years. The population in the villages, however, is aging over time as natural population growth falls, reflected in the thinning base and thickening middle portion of the pyramids. In 1967, 48% of villagers were younger than 15 years, and 12% were older than 50; by 2002, the former had decreased to 41% whereas the latter remained roughly constant, at 13%.

Consistent with an aging population, the child dependency ratio (the ratio of children less than 15 years to adults 15 to 64 years) was 97 in 1967, rose to 110 in 1975 but then declined to 75 in 2002 (not shown). The total age dependency ratio, which treats as dependents adults older than 64 years, as well as children less than 15 years, was 102 in 1967, and also rose during the 1970s. By 2002, however, it had declined to 85, nearly converging to the national average of 82 [12].

The pyramids show that the percentages of men and women tend to decrease relatively sharply when they are between 15 and 25, ages when they would typically gain economic independence, marry, and (often) migrate to other places. In all periods except 2002, the percentages of men in those age categories show large deficits relative to women. It may have been more common for young men rather than young women to leave the village for work, a theme elaborated upon below.

Components of population change

The census data permit estimation of various measures of overall growth across the rounds. In addition, starting from 1975 individuals can be matched across census rounds. For those years, we calculate in-village births by counting those born between two censuses, implicitly assuming that these young persons were living in the village at birth. Likewise, we calculate in-village deaths by counting those who were present in the village during the previous census but who died between the two censuses, implicitly assuming that the person did not migrate before dying (the census does not contain information on residence at death).

Determining in- and out-migration also requires certain assumptions. Individuals who appear in one round of the census, but who did not appear in the previous round and were not born during the interim, are counted as in-migrants. Similarly, individuals who were present in the village during the previous round, but who are marked as having left during the current round, are counted as out-migrants. In some cases, people "disappear" between census rounds, having been alive and present during one round and simply missing (no information) in the next. These are treated as out-migrants, though some of them could have died or simply been uncounted in the census. Thus, our measures of both in- and out-migration include population residuals of people unaccounted for in the 1987 or subsequent censuses. As a result, we may underestimate death rates, overestimate natural population growth, and overestimate out-migration. We also may overestimate in-migration if people are erroneously missing from census data in 1975; this scenario is unlikely, however, given that the study team had been in the villages for over 5 years and was familiar with the villages and their residents. Reassuringly,

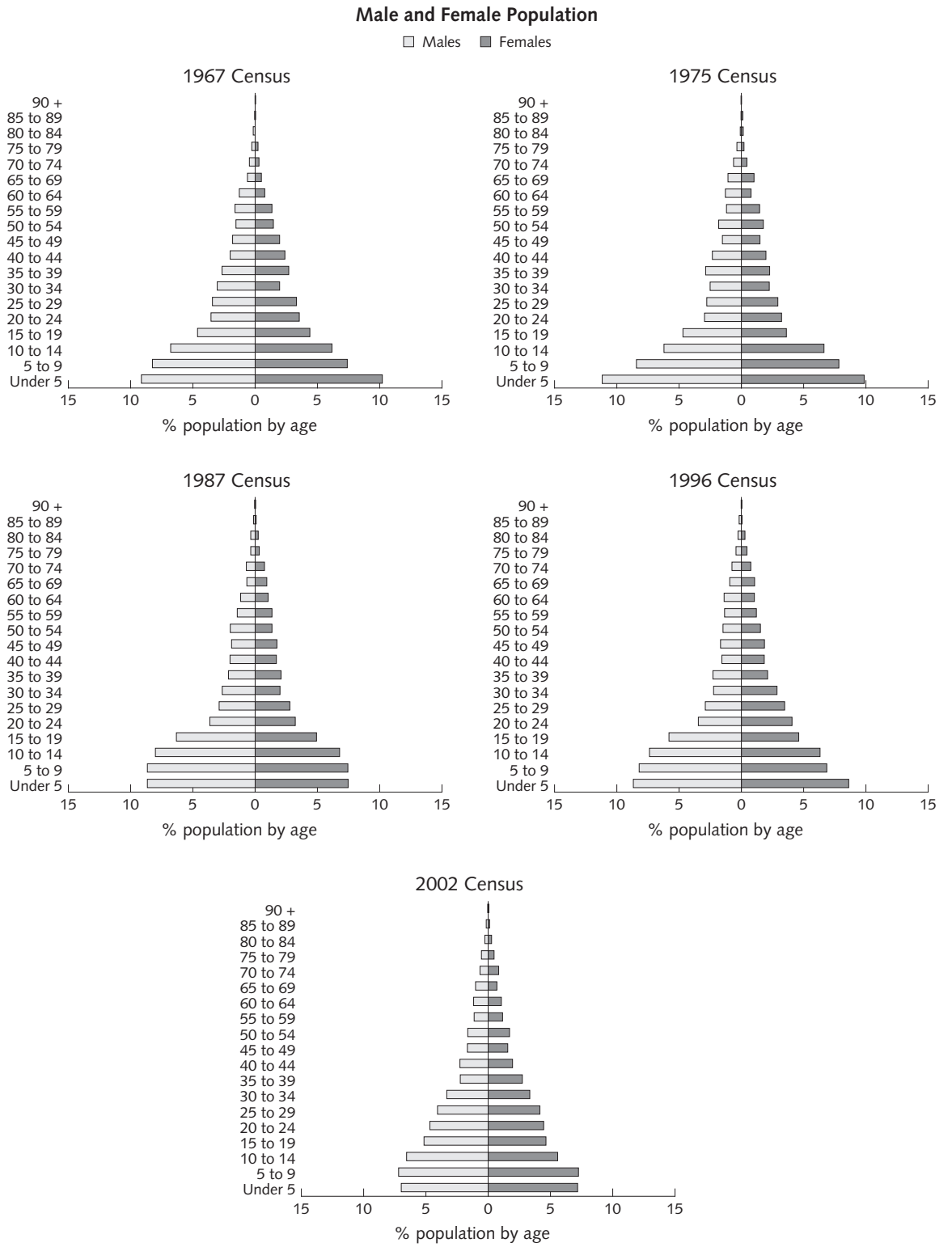

FIG 2. Population pyramids

the age distribution of in-migrants and out-migrants, from one census to the next, indicates more than 80% are 15–45 years. This observation, combined with the relatively small percentage (less than 10%) of persons who cannot be matched across census rounds, suggests that, while not perfect, the estimated growth rates are not severely biased. Moreover, because mortality rates are low for this age range, misclassifying deaths as out-migrants probably does not greatly over-estimate out-migration.

Since the original intervention in 1969, the population in each of the villages has more than doubled in size (**table 1**), as did the population of the country over this period [12]. Santo Domingo, the village closest to the capital, tripled in size. Total village population growth averaged 2.8% per annum. This growth was uneven over time, however, especially when disaggregated by natural growth (births minus deaths) and growth due to net migration (in-migration minus out-migration). Although natural growth rates have declined steadily over time both within and across all four villages, total growth declined markedly between 1987 and 1996, although there was some catch-up between 1996 and 2002.

Estimated rates of net migration suggest that the late 1980s and early 1990s may have been a period of substantial net migration *from* all of the villages, whereas the late 1990s was a period of net migration *to* three of the four villages. All four villages experienced net out-migration from 1975 to 1996, and the rate of out-migration was twice as fast in the 1987–96 period as in the 1975–87 period. Female out-migration rates were somewhat more stable over 1975–96, whereas male out-migration rates tripled from 1975–87 to 1987–96.

TABLE 1. Population growth by village (%)[a]

		1967–1975[b]	1975–1987	1987–1996	1996–2002	1975–2002
Santo Domingo	Total growth rate	3.0	3.2	2.5	4.6	3.3
	Natural growth rate	—	4.1	3.8	3.4	3.6
	Migration growth rate	—	–1.4	–1.8	1.4	–0.9
	Male migration rate	—	–1.0	–2.2	1.3	–1.0
	Female migration rate	—	–1.9	–1.4	1.5	–0.9
	Change in population	761–965	965–1,412	1,412–1,760	1,760–2,303	965–2,303
Conacaste	Total growth rate	2.5	2.8	1.5	3.9	2.6
	Natural growth rate	—	3.7	3.3	3.0	3.2
	Migration growth rate	—	–1.4	–2.5	1.0	–1.5
	Male migration rate	—	–0.9	–2.9	0.7	–1.7
	Female migration rate	—	–2.0	–2.0	1.3	–1.4
	Change in population	841–1,025	1,025–1,428	1,428–1,625	1,625–2,042	1,025–2,042
Espíritu Santo	Total growth rate	3.9	2.6	1.5	4.1	2.5
	Natural growth rate	—	3.5	3.6	2.5	3.1
	Migration growth rate	—	–1.5	–3.0	1.8	–1.4
	Male migration rate	—	–1.3	–3.2	2.0	–1.3
	Female migration rate	—	–1.7	–2.7	1.7	–1.4
	Change in population	542–733	733–993	993–1,130	1,130–1,439	733–1,439
San Juan	Total growth rate	5.3	3.5	0.7	3.3	2.5
	Natural growth rate	—	4.4	3.7	3.8	3.7
	Migration growth rate	—	–1.5	–4.2	–0.6	–4.4
	Male migration rate	—	–0.7	–5.8	0.0	–5.0
	Female migration rate	—	–2.3	–2.6	–1.2	–3.9
	Change in population	451–646	646–978	978–1,044	1,044–1,269	646–1,269
Total	Total growth rate	3.3	3.0	1.6	4.1	2.8
	Natural growth rate	—	3.9	3.6	3.2	3.4
	Migration growth rate	—	–1.6	–2.7	1.0	–1.7
	Male migration rate	—	–1.0	–3.3	1.1	–1.8
	Female migration rate	—	–2.0	–2.1	1.0	–1.6
	Change in population	2,595–3,369	3,369–4,811	4,811–5,559	5,559–7,053	3,369–7,053

a. Growth rates calculated using geometric formula.
b. Unable to match 1967 data with later census rounds, so cannot calculate natural or migration related growth rates.

During those latter years, net out-migration was largest in San Juan, followed by Espíritu Santo. Conacaste also saw a large increase in out-migration over 1987–96.

Diminished opportunity within villages (described below) and the increased availability of commuter transport likely influenced male migration rates through 1996. For example, men in Conacaste and Santo Domingo could live in the village and commute to work outside the village, whereas many men from San Juan and Espíritu Santo (which did not see substantially improved access to the outside until 1998 [9]) may have had to leave the village to make a living. By contrast, in all four villages during the final inter-censal period (1996–2002), net migration turned positive as transportation became more available, lessening the pattern seen for men 15–25 in the population pyramid for 2002. This changing pattern may reflect a "return" to the villages due to improved roads and transportation services, and thus increased opportunity to commute daily from the villages to jobs in or near the capital.

Civil status and religious affiliation

The percentages of household heads who are single (never married), separated or divorced, and widowed (about 20–25%) versus those who are in either a consensual union or formal marriage (around 75–80%) have remained relatively stable (**table 2**). Since 1967, however, there has been a seven percentage point increase in formal marriages and a similar decrease in consensual unions. Across villages, formal marriage has been consistently (and significantly, $p < .01$) more prevalent than consensual unions in San Juan and Santo Domingo, whereas the reverse is true in Conacaste and Espíritu Santo.

Although the distribution of marital status has changed little, change in religious affiliation has been substantial. Before the intervention, 97% of families were Roman Catholic, which reflects the prevailing situation in Guatemala at that time (**table 3**). A generation later in 2002, however, 57%–78% of female family heads (whether in a couple or not) were Catholic, and both substantial and significant ($p < .01$) differences in religious affiliation were apparent across villages. Nearly all of the decrease was a result of the rise in Evangelism, which grew from 3%–12% in 1975 to 13%–27% in 2002. The rise in Evangelism in Santo Domingo and Espíritu Santo was even greater, where over one-quarter of the family female heads were Evangelical in 2002.

Unsurprisingly, patterns were similar for male heads, though between 1975 and 2002 the percentage of family heads reporting a different religious affiliation from their spouse increased from 2% to 15%. About half of the 15% were cases in which one partner reported being Catholic and another Evangelical, and half involved one reporting a religion while the other reported none. There is no apparent relationship between marital status and religious affiliation across villages.

TABLE 2. Civil status of nuclear family heads by village (%)

	Santo Domingo	Conacaste	Espíritu Santo	San Juan	Total
Single, widowed, separated/divorced					
1967	24	24	35	19	25
1975	26	24	31	14	25
1987	26	21	26	16	23
1996	22	20	24	16	21
2002	23	21	26	21	23
Consensual union					
1967	25	55	52	17	40
1975	28	49	54	22	39
1987	33	54	42	27	40
1996	34	50	40	27	39
2002	33	44	37	20	35
Formally married					
1967	51	21	13	64	35
1975	46	27	15	64	36
1987	41	25	32	57	37
1996	44	30	36	57	40
2002	44	35	37	59	42

Schooling and literacy

The formal educational system in Guatemala is divided into primary and secondary education. Primary school comprises grades one through six. Secondary education consists of five to seven grades, divided into two parts. The first 3 years of lower secondary education are the basic grades (*básicos*), and instruction is expected to provide academic and technical skills necessary to join the labor force. The 2–4 years of upper secondary school are the diversified grades (*diversificados*) and students can choose among four specialized and career-oriented tracks:

» general (academic) high school education (*bachillerato en ciencias y letras*)
» teaching education (*magisterio*)
» commercial education, such as an accounting degree (*perito contador*)
» technical education, such as a secretarial degree (*secretariado*)

Typically, students who plan to go on to university education finish their general academic preparation (*bachillerato*) in 2 years at the secondary diversified level. More specialized (vocational), terminal diversified degrees, such as accounting, can take up to 4 years [9, 13].

Educational opportunities available to villagers

Public primary schools have been available in all four of the villages since the 1960s. At that time, public or private secondary schools were available only in larger towns, such as the municipal and departmental capitals, and Guatemala City. Only in the mid to late 1990s did basic secondary education become widely available in rural areas, through community-based schools and, beginning in 1998, via *telesecundarias*. The latter consist of at least one teacher with equipment and material support: television set, video player, videotaped lessons, and study guides to accompany them prepared by the Ministry of Education [9].

Although primary schooling was available in all villages at the time of the original intervention, the educational infrastructure has changed enormously since then. During the 1960s, the primary-school infrastructure in all four villages was so deficient that it barely met minimal needs for effective teaching [7]. None of the schools had water or electricity. After the INCAP study began (though not as a part of the intervention), all four schools were improved. In both Conacaste and Santo Domingo, adobe classrooms were added to relieve overcrowding. In Espíritu Santo and San Juan, new schools were built, and electricity was installed in San Juan's primary school in the mid 1970s [9].

Espíritu Santo and Santo Domingo were the first to build cement-block primary schools, around 1973. Santo Domingo's school survived the earthquake of 1976 with minor damage, and classes were suspended only for a few weeks. Espíritu Santo's school, on the other hand, was destroyed. Conacaste had an adobe primary school at the time of the earthquake that was destroyed as well. In the aftermath, modern classrooms were built in Conacaste, using donated materials. This structure, which also included two latrines and had electricity, was in full use by 1980. In 1985, the government built a new structure, replacing the one from 1980. This building remains the present primary school. San Juan waited until 1983 for a modern primary school structure with three classrooms (that are still standing), though the adobe structure in place during the earthquake suffered only minor damage. All of the modern primary schools have been improved

TABLE 3. Religion of female nuclear family head by village (%)[a]

	Santo Domingo	Conacaste	Espíritu Santo	San Juan	Total
Catholic					
1967[b]	100	95	99	93	97
1975	87	93	90	94	91
1987	81	92	79	88	85
1996	72	84	66	84	77
2002	66	78	57	75	69
Evangelical					
1967[b]	NA	NA	NA	NA	NA
1975	12	7	6	3	7
1987	18	8	19	11	14
1996	19	8	20	8	14
2002	26	16	27	13	21

NA, not available
a. Percentages do not (always) sum to 100% within census-years, as a small percentage of other religions and none are excluded.
b. In the 1967 survey, religion was asked only at the household level.

since their construction (Murphy et al. [9] provide a description of other changes in primary school infrastructure over the last 35 years).

Basic secondary education has become available recently within three of the four villages; only Espíritu Santo remains without its own basic secondary school, although it is only 1 km to the municipal seat where there has long been both basic and diversified secondary education. In 1997, San Juan was the first of the villages to establish its own basic secondary school. Both Conacaste and Santo Domingo have *telesecundaria* schools that offer basic secondary and were established in the late 1990s. The diversified grades are still unavailable within any of the four study villages. Access to diversified levels of schooling, then, varies with access outside the community [9].

Before and even after the establishment of local secondary schools in the three mountain villages, students wishing to study at the secondary level traveled to Sanarate, El Progreso, or Guatemala City. Some from Santo Domingo attended secondary school in their municipal capital. Sanarate has been the most common destination for secondary students from the three mountain villages and it has had secondary school offerings since the 1960s [9].

Primary enrollment, promotion, and student-teacher ratio

Enrollment

With improvements in primary schooling infrastructure came increases in the number of primary grades offered, the number of primary school teachers, and total enrollment. Enrollment data (collected from schooling records) is available for primary schools in the villages starting in 1979. Using the census data (and geometric growth rates), we project the number of school-age students (between 7 and 13 years) for the years for which we have school enrollment records. These predictions of the school-aged population allow us to calculate gross enrollment rates (all children in school, regardless of age, relative to the population of school-aged children between 7 and 13 years) for each of the villages at various points in time, since it was and is uncommon for children residing in the villages to go to primary school outside the village, or for children living in neighboring villages to attend primary school in these four villages. The only exception is Espíritu Santo, where a small proportion of resident children go to primary school in El Jícaro, a practice evident since the 1970s when 20% were enrolled in schools outside the village [7].

Overall, gross primary enrollment rates in the four villages increased steadily from 78% in 1979 to 93% in 1998–2001 (**table 4**). These rates were about 10 percentage points above the national average in the 1980s and early 1990s, but in the final period lag behind the year 2000 national average of over 102% (the gross enrollment rate can be greater than 100% because while the denominator includes all children between 7 and 13 years there may be both younger and older children in primary school, and therefore in the numerator) [12]. This is not surprising, however, given shifts in the distribution of the Guatemalan population to more urban areas where enrollment rates are higher on average.

The overall rates obscure across-village differences. Between 1979 and the present, the number of children enrolled in the two larger villages, Conacaste and Santo Domingo, more than doubled [9]. In Santo Domingo the increased enrollment was largely in step with population growth, while in Conacaste it meant a substantial increase in enrollment *rates*, as well. Only 45% of school-aged children were enrolled in Conacaste in 1979, by far the lowest enrollment rate across the four villages. The rate had doubled by 1998–2001. The

TABLE 4. Enrollment, first grade promotion, and student-teacher ratios by village

	Santo Domingo	Conacaste	Espíritu Santo	San Juan	Overall
% Enrollment					
1979	83	45	106	96	78
1991	95	75	101	91	90
1998–2001[a]	96	88	84	97	93
% 1st grade promotion					
1979	61	39	40	62	49
1991	60	58	38	49	52
1998–2001[a]	56	64	47	58	56
Student-teacher ratio					
1979	31	37	40	51	38
1991	38	33	43	43	39
1998–2001[a]	34	33	27	29	31

a. Data are from 2001 in Santo Domingo, 2000 in Conacaste and Espíritu Santo, and 1998 in San Juan.

number of children enrolling in San Juan's primary school increased over 50% between 1979 and the present [9], an amount sufficient to maintain a constant enrollment rate, at 96%–97%. Finally, the number of children enrolling in the primary school in Espíritu Santo increased only 30% over the period [9]. Accordingly, the enrollment rate dropped from 106% in 1979 to the lowest enrollment rate across all villages, only 84%, in 1998–2001. This likely understates the gross enrollment rates for the village, however, since Espíritu Santo is where children are more likely to attend primary school elsewhere (while still living in the village) and the percentage doing so may be increasing.

Promotion

Enrollment is only the beginning of the story, since not all those enrolled in a grade complete it. Overall promotion rates for primary school, the percentage of children graduating from one grade and eligible to continue to the next, have remained roughly constant over time (between 70% and 80%) in all villages except Conacaste, where they increased from 61% in 1979 to 80% in 1998–2001 (not shown). Concurrently, repetition and dropout rates were falling in Conacaste. Repetition and dropout rates have been significant in the other villages and show little signs of change over time, averaging around 20% and 10%, respectively, in each year.

Disaggregating promotion rates by grade helps identify the grades children are more likely to drop out of or repeat. Passing first grade presents the greatest challenge to advancing through primary school, with promotion rates across villages and over time ranging between 39% and 62% in 1979 and only slightly better, between 47% and 64% in 1998–2001 (**table 4**). Once children reach fifth or sixth grade, however, they are more likely to pass—promotion rates are between 80% and 100% (not shown).

In 1979, Santo Domingo and San Juan had first-grade promotion rates 20 percentage points higher than Espíritu Santo and Conacaste (60% versus 40%). However, if a child was able to pass first grade in one of the latter two villages, the likelihood of his or her passing second grade was much higher, so that the cumulative promotion rates to higher grades were more equal. Promotion rates dipped slightly for third grade in all villages (except Conacaste), after which advancement from fourth through sixth grade was almost guaranteed, with promotion rates between 92% and 100%. In more recent times, instruction, or promotion policy, appears to have changed such that a child now is somewhat more likely to pass the first grade (conditional on starting) than in 1979, but less likely to pass the fourth, fifth and sixth grades. Conacaste showed the largest improvement in first grade promotion rates, climbing from 39% to 64% over the 20-year period. Consistent with this, the census data show Conacaste also had the greatest improvement in the percentage of 10- to 19-year-olds who passed first grade (not shown), starting from the lowest among the villages in 1975 (56%) to the highest in 2002 (95%). By this same measure, the other villages also improved over time, with San Juan the last to reach 90%, only doing so in 2002.

The girl-boy ratios for enrollment and promotion rarely rise above one. In fact, only in Conacaste are the girl-boy promotion and/or enrollment ratios greater than or equal to one, whereas in Espíritu Santo in the mid 1990s, the girl-boy enrollment (0.6) and promotion (0.5) ratios are the lowest across villages and across years. That the ratios are consistently less than one suggests that more boys than girls are attending and advancing through school, a pattern confirmed in the schooling outcomes examined below [9].

Student-teacher ratio

Although the student-teacher ratio has varied little, it mirrors national trends and has recently declined [13] (**table 4**). However, the overall trend masks some differences across villages: in San Juan and Espíritu Santo, the student-teacher ratios have dropped 22 and 13 points, respectively, to the lowest ratios in 1998–2001. Meanwhile, the ratio increased slightly in Santo Domingo to the highest student-teacher ratio currently.

TABLE 5. Average schooling (number of grades passed) by 10-year age groups[a]

	Male				Female			
	1975	1987	1996	2002	1975	1987	1996	2002
10–19	2.2	3.4	4.1	**5.0**	2.1	3.2	3.9	**4.7**
20–29	**2.0**	3.6	**4.5**	**5.8**	**1.4**	3.3	**3.8**	**5.0**
30–39	1.4	**2.6**	3.6	**4.2**	1.1	**1.8**	3.2	**3.6**
40–49	1.2	**1.6**	**2.6**	**3.6**	1.0	**1.0**	**1.7**	**2.4**
50–59	**0.8**	1.4	1.3	**2.1**	**0.4**	1.1	1.2	**1.3**
60–69	0.7	0.9	1.4	**1.8**	0.4	0.9	1.4	**1.3**
70 +	0.5	**1.0**	1.2	1.1	0.3	**0.5**	1.1	1.4
Overall	**1.0**	**1.9**	**3.1**	**4.0**	**0.9**	**1.6**	**2.8**	**3.4**

a. Entries in boldface type are significantly different across males and females using a two-sided *t*-test and *p* value cutoff of .05.

Schooling grades passed

Table 5 shows average schooling (total number of grades passed) separately for men and women by 10-year age groups for all four villages in each census since 1975 (number of grades passed was not asked in 1967). Average schooling for individuals age 10 and above (bottom row) increases 3.0 grades for men and 2.5 for women. In 1975, the group with the most schooling is the 10- to 19-year-olds, consistent with rising enrollment rates and levels of schooling over time. In later censuses, however, this age group usually has fewer grades of schooling than those 20–29, reflecting the fact that some individuals continue to attend school in their teens and possibly into their 20s, for example adult education or, at times, university. This 20–29-year-old group, then, is the one we focus on when considering changes over time. The largest increases over time are for this cohort with an increase in average grades of schooling of 3.8 and 3.6 grades for men and women, respectively, between 1975 and 2002. Nearly all cohorts experienced monotonically increasing grades passed over time, and these differences are significant for all groups, except men over age 70 ($p < .01$, not shown).

In all periods and for all cohorts, male average schooling is higher than female average schooling and this gap is increasing. In 1975, given the relatively few average grades of schooling for both men and women, these gaps are at most 0.6 grades (for the 20–29 age group) and significantly different only for the 20–29 and 50–59 year age groups ($p < .01$). A generation later, after general increases in average grades of schooling, the gap has grown and is 0.8 years for 20–29-year-olds in 2002. In addition, in 2002, all gender gaps except for those over 70 for whom average grades of schooling is still very low, are significantly different, as indicated by bold figures in **table 5** ($p < .05$).

It is possible to follow a cohort (approximately) through time looking along the downward sloping diagonals of **table 5**. For example, individuals 20–29 in 1975 overlap substantially with those 30–39 in 1987 and 40–49 in 1996. Except for the 10–19 and 20–29 cohorts, who are more likely to be still in school or to migrate, average schooling for each age cohort remains relatively constant over time, despite migration in and out of the villages. The younger cohorts' average schooling tends to increase along the diagonal.

We also directly examine average grades of schooling for selected cohorts (20–29 and 15–64 year olds) over time and across village (**table 6**). The sharp increase in average schooling between 1975 and 1987, while in part reflecting the longer time period between those two censuses than between the later ones, is coincident with the most dramatic improvements in primary schooling in the villages. For example, 20–29-year-olds in 1987, who were of primary school age in the 1970s, had 1.6 and 1.9 grades for men and women respectively more than individuals the same age in 1975. Increases for this age group continued to 2002, reflecting the continued improvements in enrollment and access to schooling in the villages, at both the primary and secondary levels.

All villages show improvements, though currently San Juan has the lowest outcomes for men and second lowest for women 20–29 years old. The more muted improvement in schooling in San Juan may be associated with the later development of its transportation infrastructure; residents of San Juan historically have had the most limited options for secondary education. This "lower" position, however, may not persist given the recent introduction of a basic secondary school in San Juan.

Since the 1970s, male schooling outcomes for those 15–64 have been highest in Espíritu Santo and female outcomes have been highest or a close second. This pattern holds for 20–29-year-olds as well, except in 1975 when Espíritu Santo's women's schooling was

TABLE 6. Average schooling (number of grades passed) and by village[a]

	Men					Women				
	SD	CO	ES	SJ	Overall	SD	CO	ES	SJ	Overall
Individuals 20–29 years old										
1975	1.3	1.4	**3.5**	1.7	**2.0**	1.7	1.4	**1.3**	1.1	**1.4**
1987	3.8	2.5	**4.9**	3.9	3.6	3.6	2.8	**3.7**	3.3	3.3
1996	**5.4**	**3.4**	5.7	3.9	**4.5**	**4.0**	**2.8**	5.1	3.8	**3.8**
2002	**6.2**	**5.6**	6.3	4.8	**5.8**	**5.1**	**4.4**	5.6	4.8	**5.0**
Individuals 15–64 years old										
1975	1.5	1.2	**2.7**	1.3	**1.6**	1.5	1.1	**1.3**	1.2	**1.3**
1987	**3.1**	2.1	**4.2**	2.6	**2.9**	**2.6**	2.0	**2.8**	2.5	**2.4**
1996	**4.3**	**3.1**	**4.6**	3.0	**3.7**	**3.3**	**2.6**	**3.7**	3.1	**3.1**
2002	**5.0**	**4.2**	**5.5**	4.3	**4.7**	**4.3**	**3.4**	**4.1**	3.9	**3.9**

SD, Santo Domingo; CO, Conacaste; ES, Espíritu Santo; SJ, San Juan

a. Entries in bold-face type are significantly different across males and females using a two-sided *t*-test and *p* value cutoff of .05.

third highest. The higher levels of schooling in Espíritu Santo may reflect its proximity to the municipal seat where institutions of higher learning have long been available. It has had the highest average grades of schooling for men across the censuses; the 15–64 age group started at 2.7 in 1975 and increased to 5.5 a generation later (**table 6**), more than one-half a grade better than the other villages ($p < .01$). This advantage, however, has diminished for the younger generations. For example, 20–29-year-old men in Santo Domingo have nearly the same average grades of schooling as in Espíritu Santo. For the 20–29-year-old cohort, women in Espíritu Santo have had the highest average schooling since the 1987 census, though their dominance is also declining.

In tandem with the highest average years of men's schooling, Espíritu Santo has the largest gap between men's and women's schooling for individuals 15–64. This is largely because women's schooling, while among the highest across villages, is closer on average to the other villages. The gender gap in Espíritu Santo, however, is smaller for the 20–29-year-olds.

Literacy

The number of grades of schooling is a proxy measure for what is learned in school. Another indicator of educational achievement available in the census is literacy. As with most information in the census surveys, literacy is self-reported.

From the 1960s until 1985, virtually every successive national government promoted a literacy campaign and this has been reflected by various literacy programs (typically for people over 14 years) available in the villages over time. Some continuity in these programs was introduced after the founding of the National Committee for Literacy (CONALFA) in 1985. CONALFA is a national organization that provides training and educational materials for local literacy promoters who, in turn, teach in their own villages. Instruction is divided into phases that are equivalent to the six primary grades, such that graduating CONALFA is equivalent to finishing primary school. CONALFA has been active in all the villages since it was established. Two other programs have been in Conacaste and are likely to have been available to the other villages. The first is the graduation requirement that higher secondary students tutor illiterate people. The second is educational radio programming that allows students to complete primary school requirements [9].

Table 7 shows literacy rates over time across all four villages. With increased schooling has come increased literacy. In 1975, the villages were similar except for men in Espíritu Santo, who were by far the most literate. Between 1975 and 2002, literacy rates for individuals 15 years and older improved enormously. Men's literacy rates increased from 55% in 1975 to 84% in 2002, and women's literacy rates doubled, reaching 79% in 2002. The increases over time have led to far more equal literacy rates across villages in 2002 than in 1975, though they are still different ($p < .01$). For the more recent cohorts aged 10–19, we find that literacy rates for men and women in all villages are above 90%, indicating nearly universal literacy for the youngest generation (not shown).

Overall, women's literacy rates in the four villages have always exceeded the national average, by three percentage points in 1975, and by 16 in 2002. Although male literacy lagged behind the national average in all villages except Espíritu Santo in 1975, by 2002 male literacy in the four villages surpassed the national average by seven percentage points [12]. The gap between men and women's literacy is larger nationally than in the villages, indicating greater gender equality, at least in literacy, relative to the rest of Guatemala.

Livelihoods

Until the 1980s, subsistence agriculture was the most important component of livelihood strategies in the villages, though often it was combined with small-scale commodity production, as well as wage labor in both the agricultural and non-agricultural sectors [8]. An increasing rural population, however, has led to an increasing fragmentation of land holdings and

TABLE 7. Literacy rates for subjects age 15 years and older by village (%)[a]

	Men					Women				
	SD	CO	ES	SJ	Overall	SD	CO	ES	SJ	Overall
1967[b]	46	**38**	**65**	46	**48**	42	**29**	**33**	36	**35**
1975	54	**49**	**73**	49	**55**	51	**39**	**39**	44	**44**
1987	66	59	**80**	65	**66**	62	56	**58**	64	**60**
1996	**82**	**72**	**86**	69	**78**	**74**	**66**	**72**	73	**71**
2002	**87**	79	**88**	83	**84**	**83**	75	**76**	80	**79**

SD, Santo Domingo; CO, Conacaste; ES, Espíritu Santo; SJ, San Juan

a. Entries in bold-face type are significantly different across males and females using a two-sided *t*-test and *p* value cutoff of .05.

b. Literacy variable in 1967 represents "literate or some schooling" [9].

increased land degradation, limiting prospects for subsistence production. As a result of these trends as well as a series of adverse shocks, the importance of agriculture has diminished over time. By contrast, during the 1990s the tourism, service, and *maquila* sectors all grew, creating new opportunities for employment in the non-agricultural sector [13].

We categorize occupations based on two characteristics. The first is whether they are agricultural or non-agricultural. Agricultural activities include labor dedicated to the production of subsistence crops, commercial crops, and/or livestock. Examples of non-agricultural activities carried out by villagers include jobs in construction, manufacturing, and retailing, as well as self-employed businessmen apart from farmers. The second characteristic is whether or not the work is remunerative: wage versus non-wage. Using these two characteristics we categorize work into four broad groups: own (non-wage) agriculture, agricultural wage labor, non-agricultural wage labor, and non-agricultural self-employment (i.e., non-wage).

Own agriculture

As in other parts of El Progreso, before the intervention in the late 1960s, the economies of all four villages were based primarily on small-scale subsistence agriculture. The two most important crops were the staples of the local diet, corn and beans, although other crops such as tomatoes or sorghum were grown by many.

Until the 1980s, subsistence farmers in the villages relied heavily on (unpaid) family labor. As children increasingly have stayed in school longer, and as young people have left the village for non-agricultural wage work (or schooling), the supply of family labor has been restricted. These changes have left the subsistence farmer more dependent on hired help, especially during periods of heavy labor demand. Increased expenditure on chemical inputs, along with decreased availability of family labor and decreased plot size, have changed the economics of subsistence farming in the villages, leading subsistence farmers to scale back and in many cases exit from subsistence agriculture. Subsistence agriculture is now only a small part of livelihood strategies in the four villages; further, many of the subsistence farmers are of an older generation [9].

Commercial agriculture has played a large role in three of the four villages—and its absence from Santo Domingo has distinguished this village from the others. Since the late 1960s, three villages experienced periods of rapid economic growth and expansion of infrastructure that coincided with booms in local commercial agriculture: manioc (and starch from it) in San Juan, horticulture in Conacaste, and tobacco in Espíritu Santo. In the last 10–20 years, these same three villages have experienced the deterioration of livelihoods from commercial agriculture [9]. The development of less expensive, corn-based starch in Brazil destroyed the market for manioc-based starch from San Juan in the early 1980s. Fluctuating tomato prices and increasing costs of pest control and irrigation resulted in the folding of the horticultural agricultural cooperative in Conacaste in 1991. And, in 1998, hurricane Mitch washed away fertile tobacco fields along the lower Motagua River near Espíritu Santo. In two of these villages, San Juan and Conacaste, many villagers were landowners who were affected by these downturns in commercial agriculture. In Espíritu Santo, village farmers affected by the downturn were mostly sharecroppers (who carried out subsistence agriculture through sharecropping arrangements). In both Espíritu Santo and Conacaste, however, shocks to commercial agriculture affected not only landowners and sharecroppers, but also hundreds of others in the villages who lost wage work from tobacco and horticulture [9].

Despite these shifts, commercial agriculture remains part of the livelihood strategy of villagers in Espíritu Santo and Conacaste. Producers in Espíritu Santo have long participated in horticultural production, specifically tomatoes, chilies, and sweet peppers, on the flat riverbanks as well as in the irrigated plots of the piedmont. After 1998, these activities persisted only in the piedmont, on a much smaller scale. Villagers also harvest and sell limes and other fruits. A few farmers continue to produce vegetables and specialty crops in Conacaste [9].

Agricultural wage labor

Agricultural wage labor has been available locally in two of the four villages, Espíritu Santo and Conacaste. In Espíritu Santo, the tobacco and vegetable farms on the banks of the Motagua River provided a steady source of wage labor for villagers until 1998. In fact, during the tobacco harvest the demand for workers led to higher agricultural wages than in the other three villages. Currently, little agricultural wage labor is locally available in Espíritu Santo [9].

In Conacaste during the 1980s, the horticulture cooperative provided hundreds of permanent jobs to people in the village, including women and children. Women were in charge of tasks requiring more dexterity, such as setting twine, transplanting, fertilizing, and harvesting, whereas men were in charge of more technical jobs such as the application of pesticides and working the irrigation system. These jobs disappeared in 1991 with the collapse of the cooperative. However, women from Conacaste gained experience and earned a reputation for being good agricultural workers, and many now are employed in nearby agricultural operations [9].

All four villages have a history of seasonal migration for agricultural wage labor. When subsistence agriculture was the main source of livelihood, even men

from Santo Domingo would migrate to work on sugar and cotton plantations along the coast after harvesting their own subsistence crops. With its proximity to Guatemala City and increasing demands for non-agricultural wage labor, however, they no longer do so. With the exception of the period during the manioc boom, men from San Juan have migrated to the coast for agricultural jobs. Before the 1976 earthquake, men from Conacaste also regularly migrated to the coast, but afterward, local and regional demand for masons, and then the vegetable cooperative, led to local wage labor. Since the collapse of the cooperative in 1991, some have resumed seasonal migration. Finally, during the last 10 years, declining demand for tobacco and the hurricane of 1998 eliminated most of the locally available agricultural wage jobs in Espíritu Santo, and some men have taken up seasonal migration to agricultural wage jobs [9].

Non-agricultural wage labor

Since at least 1987, the main source of income for people from Santo Domingo has been non-agricultural wage labor. One of the most important employers has been a cement company, *Cementos Progreso*, with its major plant in Sinaca, Sanarate, on the Atlantic coast highway. Villagers from Santo Domingo have worked at *Cementos Progreso* since it opened in 1974. When it expanded in 1980, villagers from Conacaste began working there; it became even more important to them with the collapse of the cooperative in 1991. Both villages have convenient transportation to the plant, such that it is possible to live in the village and commute daily to work [9].

There also are many non-agricultural wage labor opportunities via the Atlantic coast highway on the way to, and in, Guatemala City. Since the 1960s, there have been employment opportunities for young women to work as domestic help in the capital. In the 1980s and 1990s, this type of work became less popular with the availability of better-paid work in the *maquilas*, or free-trade assembly and re-export factories. Finally, when demand for carpentry or masonry has been high in the capital, for example throughout the 1980s, many men have traveled to Guatemala City to work for wages in construction companies. When demand for small-scale construction work at home has been high, masonry also has been carried out as self-employment [9].

Non-agricultural self-employment

Masonry and petty trade are forms of self-employment common to all four villages. Whereas masonry involves only men, petty trade is the domain of women. In all four villages small retail shops selling basic foods and supplies have long existed. Many women also do domestic chores outside the home for pay. For example, some prepare food to sell at places of work, at the local schools, or house-to-house. Others have expanded their animal husbandry activities to include the slaughter and sale of meat. More recently, women have taken up selling other types of specialized retail products from their homes or door-to-door [9].

Espíritu Santo is the only village with a distinctive form of self-employment for which it is well known, the elaboration of artisan palm products. Palm weaving has been an important source of income since the 1960s, when approximately two-thirds of households in Espíritu Santo participated [7]. Bergeron found that in 1974 and 1987, the sale of palm products constituted the second most important source of income, next to agricultural wages [8]. Although earnings are low per unit time, this activity is a permanent source of income. The main changes during the last forty years are the diversification, marketing, and commercialization of products. Since the late 1970s, this form of self-employment has gradually become a home piecework industry, and in some cases wage labor, such that the occupation of palm weaver is no longer as easy to categorize [9].

Similar to palm weaving in Espíritu Santo, in San Juan work done previously in a cashew processing plant has shifted to piecework done in the home, usually by women. In two villages, Conacaste and Santo Domingo, outside industries have contracted local residents, mostly women, to work from their homes for pay by the piece. In all home piecework, the pay per unit time is especially low [9].

Male occupations

The last 35 years have seen massive changes in the occupations of village residents, and non-agricultural employment largely has displaced agricultural employment (**table 8**). In 1967, 99% of men aged 15–64 reported a primary occupation, and the vast majority of those (97%) worked in agriculture, most (86% of the 99%) as tenant or (small) landowning farmers, except in Espíritu Santo where only 72% of those men aged 15–64 who were working were own-account farmers (**table 8**). Agricultural wage employment as a primary occupation was evident to varying degrees in each village. It was highest (around 23% of those working) in Espíritu Santo where laborers worked on the large cash crop farms on the riverbanks and in the piedmont [9] but only some 5%–14% in the other villages.

By 2002, the percentage reporting a primary occupation had dropped to 86%; the percentage reporting no occupation increased slightly but those reporting schooling as their primary occupation increased more substantially as schooling opportunities and trajectories improved. Further, by 2002, the importance of agriculture had diminished markedly and less than half of those reporting a primary occupation were in agriculture. The percentage of those working as agri-

TABLE 8. Primary occupation of men ages 15 to 64 by village (%)

Community year	% employment	Agriculture wage	Agriculture non-wage	Non-agriculture wage	Non-agriculture non-wage	Total
Santo Domingo						
1967	100	7	86	6	1	100
1975	96	5	83	10	2	100
1987	95	5	60	32	3	100
1996	88	5	29	56	10	100
2002	84	5	27	56	12	100
Conacaste						
1967	100	5	93	1	1	100
1975	98	7	87	6	0	100
1987	95	7	79	11	3	100
1996	83	14	51	29	6	100
2002	85	13	38	38	11	100
Espíritu Santo						
1967	97	23	72	2	3	100
1975	94	30	55	6	9	100
1987	94	41	41	7	11	100
1996	84	34	37	13	16	100
2002	85	32	24	21	23	100
San Juan						
1967	99	14	84	1	1	100
1975	96	5	88	5	2	100
1987	93	1	80	15	4	100
1996	87	6	52	30	12	100
2002	89	4	32	50	14	100
Overall						
1967	99	11	86	2	1	100
1975	96	11	79	7	3	100
1987	95	12	66	18	4	100
1996	85	14	41	35	10	100
2002	86	13	31	42	14	100

cultural wage laborers remained about the same; hence, the bulk of the decline was due to declines in tenant and landowner farming, which now engage only about one-third of the active labor force. In its place, both non-agricultural wage labor and non-agricultural self-employment have increased, particularly the former, though agriculture remains important and constitutes more than half the primary employment in Conacaste and Espíritu Santo.

Examining these trends by village reveals that Santo Domingo was the first to make the transition to non-agricultural wage labor, between 1975 and 1987. Santo Domingo was a leader in access to Guatemala City, and also benefited from the opening of Cementos Progreso in 1974. Conacaste made this transition between 1987 and 1996 as the vegetable markets declined and more vegetable cooperative members left farming; they either migrated or increasingly became employed at Cementos Progreso, where employment possibilities in Conacaste began in 1984. San Juan made its main transition to non-agricultural wage work between 1996 and 2002; in 2002 half of the primary occupations were non-wage agriculture. This increase has also been in parallel with the increased access to San Juan, despite it being the only remaining village with a dirt access road, buses between the village and Sanarate began running in the mid 1990s.

Non-agricultural self-employment is about equally important in all villages except Espíritu Santo, where it was one-quarter of the male workforce in 2002, with many working in the elaboration of palm products. Espíritu Santo is the most diversified of all the villages in terms of its primary occupational distribution.

TABLE 9. Primary occupation of women ages 15 to 64 by village (%)

Community year	% employment	Agriculture wage	Agriculture non-wage	Non-agriculture wage	Non-agriculture non-wage	Total
Santo Domingo						
1967	3	20	40	20	20	100
1975	16	6	3	37	54	100
1987	15	0	4	53	43	100
1996	18	0	2	75	23	100
2002	24	0	1	62	37	100
Conacaste						
1967	6	58	8	17	17	100
1975	24	16	17	17	50	100
1987	16	6	16	16	62	100
1996	15	18	7	32	43	100
2002	23	8	4	43	45	100
Espíritu Santo						
1967	41	9	0	0	91	100
1975	75	4	3	4	88	100
1987	55	8	0	5	87	100
1996	32	8	1	21	70	100
2002	43	12	3	20	65	100
San Juan						
1967	8	13	0	37	50	100
1975	13	11	11	22	56	100
1987	16	0	6	60	34	100
1996	16	0	2	36	62	100
2002	29	0	0	56	44	100
Overall						
1967	13	18	4	8	70	100
1975	32	8	7	13	72	100
1987	24	5	5	23	67	100
1996	20	6	3	42	49	100
2002	28	6	2	44	48	100

Female occupations

In 1967, only 13% of women aged 15–64 years reported a primary occupation other than domestic duties, usually in non-agriculture (**table 9**). By 1975, participation in the labor market was substantially higher in all villages, averaging 32% (though there may have been some differences in how these questions were implemented between the first and later censuses). From 1975 to 2002, women aged 15–64 years living in all villages except Espíritu Santo have shown increasing rates of employment, especially in the non-agricultural sector, both wage and non-wage. Women in Espíritu Santo, who predominantly work in the elaboration of artisan palm products, have experienced the opposite trend, with 75% reporting a primary occupation in 1975 but only 43% doing so in 2002.

Housing characteristics and assets

When the villages were selected in 1967, less than 10% of the homes in each village had water in their homes (including wells in the yard) with nearly everyone collecting water from unprotected, open water sources, including springs or rivers. No homes had latrines or systems to drain sewage. There was no electricity and all the houses were made of modest materials readily available in the village. Most people owned their homes as well as the plot of land on which the home was built, although ownership of other assets was rare [2]. During the last 35 years, substantial improvements have occurred in the provision of services to the villages, as well as in the quality of housing and the types of assets owned.

Home tenure and quality

Home ownership has been a longstanding norm in all villages. Across all five censuses, the percentage of families who own their home is 78%–83% (**table 10**). Home ownership is more formalized in Espíritu Santo and San Juan, with more than half of families holding legal titles to their homes in 2002 (not shown). These were the two villages where residents were first given the opportunity and rights to own land during the liberal reforms of 1872. Slightly less than half have legal title in Conacaste where peasants gained the right to

TABLE 10. Tenure and housing characteristics by village (%)

		1967	1975	1987	1996	2002
Santo Domingo	Own their own home	90	85	83	83	80
	Reside with family	—	10	10	9	10
	Ranch style home	41	18	4	1	1
	Formal home	—	11	59	74	78
	Rooms per resident[a]	0.68	0.75	0.87	1.05	1.06
	Electricity	0	1	77	91	95
	In-home piped water	0	0	0	97	99
	Pit latrine or flush toilet	0	11	40	65	69
Conacaste	Own their own home	83	80	78	76	78
	Reside with family	—	12	15	17	17
	Ranch style home	61	55	14	2	3
	Formal home	—	11	25	48	59
	Rooms per resident[a]	0.42	0.50	0.72	0.96	0.96
	Electricity	0.6	1	63	90	95
	In-home piped water	0	0	63	80	90
	Pit latrine or flush toilet	0.6	14	63	82	91
Espíritu Santo	Own their own home	78	71	81	76	74
	Reside with family	—	19	13	16	18
	Ranch style home	81	77	48	25	15
	Formal home	—	3	24	34	60
	Rooms per resident[a]	0.56	0.62	0.75	0.92	0.97
	Electricity	0	43	57	85	89
	In-home piped water	0	0	58	94	99
	Pit latrine or flush toilet	0	6	50	71	67
San Juan	Own their own home	78	84	80	78	79
	Reside with family	—	11	13	17	17
	Ranch style home	26	18	17	3	3
	Formal home	—	8	22	65	77
	Rooms per resident[a]	0.60	0.54	0.62	0.92	0.87
	Electricity	0	2	75	90	96
	In-home piped water	0	0	1	88	95
	Pit latrine or flush toilet	1	8	65	74	72
Total	Own their own home	83	80	81	78	78
	Reside with family	—	13	13	14	15
	Ranch style home	—	43	19	6	5
	Formal home	46	29	34	56	69
	Rooms per resident[a]	0.56	0.61	0.75	0.97	0.98
	Electricity	0	11	68	89	94
	In-home piped water	0	0	31	89	96
	Pit latrine or flush toilet	0	10	54	73	75

a. Number of rooms per resident (not presented as a percentage).

land ownership in 1927 (on a former estate that was nationalized), and only 29% of families have legal title in Santo Domingo, the last of the villages in which residents gained land rights, which were communal in nature [8].

A substantial portion of families live with other family members, for example a newly married couple living with the groom's parents for the first years of marriage. This type of home tenure has been stable at 13%–15%. Other types of home tenure, including renting, mortgaging, inheritance, living with neighbors, or living as a domestic with an employer, were recorded in the census, but occur infrequently.

While home ownership and living arrangements may have changed little, the quality of housing has improved markedly over the years, with a decline in the percentage of ranch-style homes and an increase in the percentage of formal homes. Ranch-style homes are those constructed of materials that are available locally. Such homes typically have roofs made of straw or palm leaves; walls made of corn stalks, bamboo, or sticks and mud; and floors made of dirt. By contrast, the census defines formal homes as those constructed with synthetic materials: roofs made of tile, fiberglass, or concrete; walls made of adobe, brick, stone, wood (or otherwise reinforced); and floors made of brick, concrete, or tile.

Some important differences in housing quality also are apparent across villages. At the outset, San Juan had the lowest percentage of ranch style homes and Espíritu Santo the highest, where they persist as an important percentage of homes (15% in 2002). There was a sharp decline in the percentage of ranch homes in Conacaste between 1975 and 1987, and a doubling of the percentage of formal homes in Santo Domingo during the same time period, likely due to an influx of construction materials after the 1976 earthquake [9]. San Juan had a slightly delayed increase in the percentage of formal homes, between 1987 and 1996. The changes over time are not entirely associated with improvements in wealth, since the availability of local materials (and their relative prices) is an important consideration. For example, at the beginning of the study, homes in San Juan incorporated more formal materials such as roof tiles and adobe walls, simply because the materials were more easily obtained there. Families in Espíritu Santo, who on average were wealthier than their San Juan counterparts at the outset, built their homes of lower quality materials such as palm leaves not only because they were readily available, but also for comfort given the village's hotter, drier climate [7, 9].

Finally, the size of houses and their physical arrangement also have improved with time. The number of rooms per family member has increased in all villages from 0.6 in 1967 to 1.0 in 2002. While in 1967 more than 40% of families cooked in the same room where they slept and more than half of families cooked in make-shift kitchens away from their home, in 2002 only 6% of families shared their bedroom with the kitchen (not shown).

Household services

When services, such as electricity or within-household piped water, were introduced to villages, not all households within a village were able to access the newly introduced services at the same time, because access often required some household-level investment. For example, as seen in **table 10**, it is clear that the only community where electricity had been introduced

TABLE 11. Asset and durable good ownership (% families)

		1967	1975	1987	1996	2002
Communication	Radio	32	53	57	73	23
	Other audio	—	2	5	55	59
	Radio or other audio	32	53	57	73	73
	Television	0	1	21	61	70
	Video player	—	—	—	4	7
Housework	Stove	1	0	2	40	52
	Refrigerator	1	2	4	14	26
	Hand Mill	—	—	9	9	8
	Sewing machine	—	11	10	13	12
	Clothes iron	—	—	32	77	80
Animals	Fowl	—	—	62	63	56
	Pigs	—	—	46	28	25
Transportation	Bicycle	1	3	9	39	46
	Motorcycle	0	0	1	2	1
	Automobile	0	0	1	3	7

in 1975 was Espíritu Santo. By 1987, electricity was available in all four villages, though the percentage of families with service continued to rise through 2002. The same occurs for within-household piped water. Conacaste and Espíritu Santo were the only two villages with piped water in homes in 1987, and the percentage of families actually utilizing the service has increased in each census.

Another important service is wastewater disposal. There is little variation across villages or years in this variable until 2002 in Conacaste, as a result of installation of a public sewer system there after 2000. In 2002, 33% of families in Conacaste used the sewage system to dispose of wastewater. Otherwise, more than 99% of families have employed open-air disposal of their wastewater from cooking and cleaning in all villages and census years. Even with the lack of sewage systems, families have greatly improved the way in which they dispose of human waste. In 1975, the large majority of families (84%) had no access to pit latrines or other toilet facilities. By 2002, only 12% of families were in such a situation. Since 1987, the majority of families have used outdoor pit latrines. With the introduction of sewage in Conacaste, 23% of families there had modern flush toilets in 2002.

Finally, information on use and ownership of telephones was collected in 2002. As in the rest of Guatemala, an influx of personal cellular phones into the villages occurred during the late 1990s, partially displacing public telephone services that had been installed in three of the villages during the 1980s and early 1990s [9]. Still, 70% of families in all villages primarily use a community telephone. Personal cellular phones are the next most popular option, with 16% of families owning one.

Asset and durable good ownership

The type of household consumer durables available has changed substantially throughout the years, which has necessitated changes in the assets that are recorded in the census (**table 11**). The only assets that appear in all census forms are radios, televisions, refrigerators, stoves, bicycles, motorcycles, and automobiles. While in **table 11** it appears as if "other audio" is recorded in all censuses since 1975, this category actually combines different variables that appear on the census forms and then disappear, as new technologies replace the older ones: record player (1975, 1987, 1996), tape player (1996, 2002), and stereo system (2002). Other assets introduced to the census forms after 1975 include clothes irons and grinding mills (1987, 1996, 2002), video players (1996, 2002), and cable, typewriter, computer, blender, and microwave (2002). With the exception of clothes irons and blenders, ownership of the more recently included assets is uncommon, even in 2002, so they are not included in the analyses.

Few families owned consumer durable goods beyond a radio, and even radio ownership was uncommon before and during the intervention in the 1970s. Since then, the composition and level of asset ownership has changed markedly over time. Radio ownership increased from 32% in 1967 to more than 70% in 1996, only to drop to just over 20% in 2002. It seems to have been replaced by other types of audio equipment, the ownership of which rose from 2% in 1975 to nearly 60% in 2002. Now, about three-quarters of families own a radio or other audio equipment. Another striking increase has been in television ownership, from just a few in homes in Espíritu Santo in 1975 to 70% in 2002. These trends of course follow the increased availability of electricity.

Table 11 also shows the increasing ownership of consumer durable goods useful for domestic productive activities. The productive potential of these household assets should not be underestimated, as women can earn money in the informal economy by extending their domestic chores to productive activities, such as ironing others' clothes, preparing meals for sale, and selling ice and other frozen treats [9]. Starting in 1987, the census also collected information on other assets typically associated with women's household production: fowl and pigs. Raising domestic birds has consistently been a more popular activity than raising pigs and ownership of the latter declined dramatically by 2002.

Finally, ownership of transportation assets has increased with time, more markedly for bicycles than for automobiles. Bicycle ownership was under 1% in 1967, and in 2002 had reached 33%–57% across the villages. Automobile ownership has also increased, but was only 6%–9% in 2002.

Conclusions

Since the start of the INCAP Longitudinal Study (1969–77), the original four study villages, like their home country, have undergone massive demographic, social, and economic change. Many of these changes have been conditioned by initial differences, particularly those associated with agricultural potential and location. Originally rather isolated, the villages have become less isolated as road and transportation access has improved steadily and substantially. The populations in the villages have more than doubled and also aged. After seeing steady out-migration for a number of years, three of the four villages are more recently experiencing net in-migration, a pattern associated with ease of access. While marriage patterns have held steady, religious practice has changed a great deal. Schooling access and outcomes have also improved substantially over the last 35 years, with average grades of schooling nearly tripling and literacy doubling to levels currently above national averages. However, a

substantial schooling gap between men and women persists.

Occupations have also changed over the course of a generation. Early on, subsistence farming, and agriculture in general, were dominant. While to date they remain important components of individual livelihood strategies, they are much less common. Much of this change is associated with declining agricultural markets and increasing access to non-agricultural jobs near the villages and in the capital. With all these changes have come improvements in living standards, as measured by a number of indicators of household living situations and consumer durable goods. It is within this dynamic context that study subjects for the INCAP Longitudinal Study (1969–77) were born and raised.

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Schooling, educational achievement, and cognitive functioning among young Guatemalan adults

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Abstract

Quantity and quality of schooling obtained and the resulting skills and knowledge acquired are important components of human capital. We describe the distribution of selected measures of schooling, educational achievement, and cognitive functioning among individuals who participated as children in a nutrition supplementation trial in Guatemala and were followed up in 2002–04. Among 1,469 respondents (response rate 80%), who were 26–41 years of age in 2003, more than 90% of men and women had attended at least some school; more than half of men and more than one-third of women had completed sixth grade. Schooling attainment of both men and women has increased across birth cohorts but the schooling gap between men and women has increased. Parental socioeconomic status, as measured in 1975, is a strong predictor of schooling attainment. Basic literacy is high among those studied, with more than 80% able to read simple sentences. The gap in educational achievement favoring men narrowed across birth cohorts due to increases among younger women. The greater performance among men on the Raven's Progressive Matrices test persisted despite increased scores in the younger birth cohorts for both men and women. Migrants to Guatemala City have completed more years of school and scored higher on the tests of educational achievement and cognitive functioning than have cohort members who have remained in the study villages.

Key words: Guatemala, Institute of Nutrition of Central America and Panama (INCAP), Human Capital Study, cognitive functioning, educational achievement, gender, migration, schooling attainment, socioeconomic status

Introduction

Schooling is a key input to the development of human capital [1]. It is perhaps the most important mechanism by which knowledge, skills, and values are transmitted to children. Families and communities also influence the quantity and quality of schooling that children receive, through investment and encouragement. Throughout the world, heavy emphasis is placed on the development and dissemination of schooling as strategies for individual, family, community, and national development. Access to schooling and acquisition of benchmarks of schooling quantity are used as indicators of both societal and individual development. Indeed, the second of eight Millennium Development Goals, adopted by world leaders in 2000 with the intent of reducing poverty and improving lives, is to achieve universal primary education everywhere by 2015 [2, 3].

Education can be understood as the integration over time of innate potential; learning at home, at work, and in the community; time spent in school; the quality of the school environment (including teachers, resources, crowding, and so forth); and physical and mental health status. Thus, in addition to quantity of schooling, indicators of literacy, educational achievement, and cognitive functioning are important markers of human attainment. Indeed, it might be argued that education, as defined here, is an important outcome of schooling, and use of schooling attainment as a measure of human

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capital is inherently limited because it is an input into the process. However, comprehensive measures of educational achievement and cognitive functioning, which might include tests of functional literacy and of higher-order cognitive processing, are more difficult to measure cross culturally and in large-scale surveys and hence such data are not as widely available.

The present analysis reports on the schooling, educational achievement, and cognitive functioning of a cohort of individuals followed since childhood in Guatemala.

Methods

Individuals selected for this study were born between 1962 and 1977 and had participated in a longitudinal study of nutrition supplementation as children. Full details of the intervention trial and subsequent rounds of follow-up have been described elsewhere [4]. The present round of follow-up is called the Human Capital Study and was conducted between 2002 and 2004; the cohort was between 26 and 41 years of age in 2003. Full details of participant tracing and recruitment are presented elsewhere in this volume [5,6]. Briefly, of 2,393 individuals in the birth cohort, 2,019 were traceable; of these, 163 had left the country, resulting in 1,854 individuals within Guatemala eligible for follow up. All data were collected in face-to-face interviews.

Measures of schooling

In Guatemala, schooling is mandatory through the sixth grade (*Primaria*). Children are required to enroll in first grade on or before the year they attain 7 years of age. In recent years kindergarten and other early learning opportunities have become more available, but are not compulsory. Secondary school consists of two parts, *Básico* and *Diversificado*. *Básico* or middle school consists of 3 years (grades 7–9) whereas *Diversificado* or high school can be 2–4 years depending upon the choice of an academic or technical curriculum. Students can select a general, academic curriculum of two years if they intend to pursue university studies, and upon graduation receive a "*Bachillerato en Ciencias y Letras*." Alternatively, students can select specific, vocational programs of 3 years that will qualify them for professions such as primary school teacher, secretary, electrician, mechanic, agricultural technician or accountant. There are post-secondary, non-university advanced studies for technical fields, for example, a program of 3–4 years to become a registered nurse, as well as university studies offering both technical certificates following 2–3 years of study and degrees (Bachelor, Master, and Doctoral) in several fields.

The schooling questionnaire was administered by interview. Administration took 10–15 minutes. From this, we derived the following variables: *Ever attended preschool or kindergarten*, yes/no; *Ever attended school*, yes/no; *Age at entry into first grade*: Enrollment is expected to take place in the year in which the child turns 7 (enrollment prior to age 7 is a parental choice that can be seen as an additional investment in the child's schooling); *Completion of 6th grade*, yes/no; *Grade progression efficiency:* This is a measure of grade repetitions and skips, dropouts, and re-entries. It is calculated as the highest grade achieved through 12th grade divided by the total number of years between starting school and completing the highest grade attained. An individual who neither repeats a grade nor skips a grade nor drops-out and re-enters will have an efficiency of 1.00, regardless of the grade at which s/he leaves school. Grade progression efficiency cannot be calculated for those who never attend school, and these individuals have been excluded from analysis of this variable (see footnote to **table 1**). For the 43 individuals who attended university, the first year (corresponding to the 12th grade) is included in the measure of grade progression efficiency; *Grade at age 13 years:* This variable integrates age at school entry and grade progression efficiency and is an integer from 0 through 7. A child who starts school at age 7 years, and has a grade progression efficiency of 1.00 should complete primary school (6th grade) by age 13 years. *Highest grade attained* is an integer from 0 through 18. Parallel indices were constructed excluding and including the contribution of informal education (which includes a range of adult-education programs sponsored by employers and the government). University education was included, but attendance at university is low in this cohort and does not substantially affect the distributions except in the upper tails.

Educational achievement and cognitive functioning

We screened for literacy and administered two sets of instruments, the InterAmerican Reading Series (Serie Inter-Americana, SIA) modules related to Comprehension and Vocabulary [7], and the Raven's Progressive Matrices test [8].

Our literacy screen consisted of a graded set of reading tests, from sounding of single letters to full sentences. Failure to complete the screen (which occurred when the respondent committed five consecutive errors), or completion with more than a specified number of errors overall, was considered failure. Individuals who reported completing sixth grade or higher were considered to be literate and were not administered the screening test.

The SIA was originally developed to assess reading abilities of Spanish-speaking children in Texas [7]. It tests for basic and advanced vocabulary, and for level and speed of comprehension of written sentences. Several levels of the tests have been developed to

account for differences in schooling level. The tests have demonstrated adequate test-retest reliability (correlation coefficients = 0.85 and 0.87 for reading and vocabulary, respectively), internal consistency (alphas = 0.79–0.98), and validity in previous studies in this population [9].

The SIA was only administered to those individuals who passed the literacy screening. Based on pilot studies in nearby villages, we decided to use level 2 of SIA for reading comprehension and level 3 for vocabulary. Only the level of comprehension and vocabulary sections were included, but not the speed of comprehension based on the pilot study and the need to keep the testing time less than one hour. The SIA was administered in writing in a quiet environment. The interviewer was present and was instructed not to assist the respondent with specific questions, but only to explain the process. Administration took 40–50 minutes. The results are presented as scores for the Vocabulary and Comprehension modules separately, and for the SIA as a whole. Higher scores denote better performance.

All individuals, regardless of literacy, were administered the Raven's Progressive Matrices, a nonverbal assessment of cognitive ability [8]. The Raven's Progressive Matrices are considered tests of observation and clear thinking ability—of a person's capacity for coherent perception and orderly judgment [10]. The test consists of a series of pattern-matching exercises, with the patterns getting progressively more complex and hence harder to match correctly. We administered only three of the five scales (A–C, 12 items each), as our pilot data suggested that respondents would be unlikely to be able to progress beyond the third scale. Respondents could take as long as they needed, with a typical test being completed in 40 minutes. Results are presented as the number of correct answers summed across the three scales, with higher numbers denoting better performance. The Raven's has also exhibited adequate test retest reliability (r = 0.87) and internal consistency, as well as construct validity in this population [9].

Results

A total of 1,469 individuals completed the schooling questionnaire, for an overall response rate of 80%. Completion rates were highest among residents of the study villages (89.8%), as compared with 57.5%–61.5% among migrants. Overt refusal rates were low; the primary reason for non-completion among migrants was a failure to establish contact. Two men and two women who completed the schooling questionnaire declined to participate in the literacy screen, and a few additional individuals declined to participate in the SIA or the Raven's tests. The SIA was completed by 1,196 respondents (as 255 individuals failed the literacy screen) and the Raven's test was completed by 1,450 respondents.

We tabulated the schooling, educational achievement and cognitive functioning measures by birth cohorts (categorized as 1962–68 and 1969–77), current residence of the respondent (in or near each of the original four study villages, in Guatemala City, or elsewhere in Guatemala), and socioeconomic status of the respondent's parental household in 1975 (a wealth index derived from ownership of durable consumer goods [11], categorized into tertiles with an additional category for missing). Within each table we tested for heterogeneity of the stratum values within males and females separately through analysis of variance (for continuous variables) or chi-square test (for categorical variables).

Schooling attendance and attainment

Men and women did not differ with respect to the prevalence of ever-attending school (95%); 105 respondents did not attend school at all, while another 117 attended but did not complete first grade. Of 1,363 respondents who reported attending school, the modal age at school entry was 7 years (906 respondents; 66.5%), with 173 (12.7%) starting school prior to age 7, 179 (13.1%) starting at age 8, and 105 (7.7%) starting after age 8. Age at school entry was similar for men and women ($p > 0.1$). Men attained higher grades than women and were more likely to complete sixth grade (**table 1**), but grade progression efficiency (0.8) was similar for men and women. Among the 155 respondents who attended *Diversificado*, 37 obtained a *Bachillerato en Ciencias y Letras* and 99 obtained a vocational diploma, 48 of which were in accounting. Among the 136 high school graduates, 43 (31.6%) have attended university.

One hundred and eleven respondents (7.6%, 40 men and 71 women, $p < .05$ for sex difference) reported attending kindergarten. The proportion attending kindergarten increased strongly over time, from 8 of 521 (1.5%) respondents born 1962–68 to 53 of 365 (14.5%) respondents born in 1974–77 ($p < .01$ for birth cohort differences). Notably, almost all those who reported attending kindergarten were from Conacaste (**table 2**), where a kindergarten program was established in the late 1970s [12].

Seventy-one (5%) individuals reported any nonformal adult education. Most of these had completed one additional year over and above their formal schooling. The analyses presented here exclude informal schooling, as inclusion of the contribution of informal schooling did not change the estimates (data not shown).

While most of the cohort has completed their formal schooling, 75 individuals reported currently attending adult education or other programs. Of these, 31 (18 of whom reported never attending or not complet-

TABLE 1. Schooling attainment, educational achievement, and cognitive functioning in the Human Capital Study 2002–04, by birth cohort and sex

	Men				Women			
Birth cohort	Total	1962–68	1969–77	p^a	Total	1962–68	1969–77	p
Sample size[b]	683	230	453		786	291	495	
Attended kindergarten (%)	5.9	0.9	8.5	< .01	9.2	2.1	13.4	< .01
Ever attended school (%)	95.9	95.2	96.3	.5	95.0	94.5	95.4	.6
Started school at or prior to age 7 (%)	73.4	71.6	74.2	.5	76.1	73.1	77.9	.1
Completed 6th grade (%)	52.4	42.6	57.4	< .01	36.1	29.6	40.0	< .01
Grade at age 13 y (mean ± SD)	3.8 ± 2.2	3.3 ± 2.3	4.1 ± 2.1	< .01	3.4 ± 2.1	3.0 ± 2.2	3.6±2.1	< .01
Highest formal grade achieved (mean ± SD)	5.0 ± 3.4	4.2 ± 3.4	5.4 ± 3.4	< .01	4.2 ± 3.2	3.5 ± 2.9	4.5±3.3	< .01
Grade progression efficiency (mean ± SD)	0.8 ± 0.2	0.8 ± 0.3	0.8 ± 0.2	.3	0.8 ± 0.3	0.8 ± 0.3	0.8±0.3	.2
Literate (%)	83.9	77.4	87.1	.01	81.5	75.2	85.2	< .01
SIA comprehension (mean ± SD)[c]	23.7 ± 6.8	23.4 ± 6.4	23.8 ± 6.9	.6	23.6 ± 6.7	22.5 ± 6.3	24.2±6.8	< .01
SIA vocabulary (mean ± SD)	21.7 ± 10.6	22.1 ± 10.4	21.5 ± 10.6	.5	18.7 ± 9.8	17.2 ± 9.7	19.4±9.8	< .01
SIA total (mean ± SD)	45.3 ± 16.8	45.5 ± 16.3	45.2 ± 17.0	.9	42.3 ± 15.9	39.8 ± 15.4	43.6±16.1	< .01
Raven's score (mean ± SD)	19.4 ± 6.5	18.1 ± 6.2	20.1 ± 6.6	< .01	16.3 ± 5.4	15.5 ± 5.2	16.7±5.5	< .01

a. p value for test of heterogeneity within sex by one-way analysis of variance or chi-square test (two-tailed) as appropriate.
b. Sample sizes for individual modules: Schooling: men n = 681, women n = 786; Grade efficiency (not calculated if respondent never attended school): men n = 614, women n = 708; Literacy: men n = 679, women n = 784; SIA (not administered if respondent failed literacy screen): men n = 563, women n = 632; Raven's Progressive Matrices: men n = 669, women n = 779.
c. Serie Inter-Americana.

ing primary school) were in adult education programs, 15 were attending university, and the remaining 29 were in technical or vocational training. There was no association between respondent sex or birth cohort and the proportion of respondents currently attending school ($p > .5$).

Most measures of schooling attainment have improved over time (**table 1, fig. 1**). Large differences between men and women in the prevalence of completion of sixth grade persisted, and may have increased. Men and women in the younger birth cohorts obtained, on average, 1.2 and 1.0 grades additional schooling, respectively, compared to the older birth cohorts. There was no difference across birth year groups in either the probability of ever attending school or in grade progression efficiency.

There were large differences by current residence in schooling attainment (**table 2**). Individuals living in Guatemala City and in Espíritu Santo reported the highest schooling attainment, and those living elsewhere in Guatemala or in Conacaste the lowest. Differences across place of residence were apparent for both men and for women, but within each category the male advantage persisted.

Educational achievement and cognitive functioning

A total of 255 individuals (16.9%) failed the literacy screen and were therefore not eligible to complete the SIA. Illiteracy was more prevalent among older respondents (**table 1**), respondents living in Conacaste, migrants to areas other than Guatemala City (**table 2**), and those in the lower parental SES tertile in 1975 (**table 3**). Among migrants to Guatemala City literacy was 98% for men and 94% for women.

Among those completing the SIA there was no difference in the mean comprehension score between men and women (**table 1**), but men scored better on the vocabulary component, resulting in an overall difference of 3.5 points in favor of men. In general, scores

TABLE 2. Schooling attainment, educational achievement, and cognitive functioning in the Human Capital Study 2002–04, by current residence and sex

Current residence	Men							Women						
	Living in or near birth village				Guatemala City	Elsewhere in Guatemala	p^a	Living in or near birth village				Guatemala City	Elsewhere in Guatemala	p
	Conacaste	San Juan	Santo Domingo	Espíritu Santo				Conacaste	San Juan	Santo Domingo	Espíritu Santo			
Sample size[b]	173	118	148	101	100	43		181	132	159	111	141	**62**	
Attended kindergarten (%)	17.5	0.0	1.4	1.0	6.0	2.3	< .01	25.1	2.3	0.6	4.5	7.9	9.7	< .01
Ever attended school (%)	91.9	96.6	98.6	97.0	99.0	90.7	< .01	93.4	92.4	95.6	96.4	98.6	93.5	.2
Started school at or prior to age 7 (%)	52.3	76.3	81.4	83.7	82.1	67.6	< .01	69.8	76.5	81.6	76.6	81.8	64.3	.03
Completed 6th grade (%)	32.9	40.7	58.8	76.2	74.0	34.9	< .01	21.5	26.5	40.3	46.8	57.4	21.0	< .01
Grade at age 13 y	2.6 ± 2.2	3.5 ± 2.1	4.3 ± 2.0	4.5 ± 1.9	4.8 ± 1.8	3.1 ± 2.1	< .01	2.4 ± 2.1	3.3 ± 1.9	3.8 ± 2.0	3.7 ± 2.1	4.4 ± 1.9	2.7 ± 2.2	< .01
Highest formal grade achieved	3.6 ± 3.5	4.4 ± 3.2	5.2 ± 2.9	6.2 ± 3.1	7.1 ± 3.5	3.8 ± 3.0	< .01	2.9 ± 2.8	3.7 ± 2.5	4.3 ± 2.7	4.7 ± 3.4	6.2 ± 3.8	3.2 ± 2.7	< .01
Grade progression efficiency	0.8 ± 0.3	0.8 ± 0.3	0.9 ± 0.2	0.9 ± 0.2	0.9 ± 0.1	0.9 ± 0.2	< .01	0.8 ± 0.3	0.9 ± 0.2	0.9 ± 0.2	0.8 ± 0.3	0.9 ± 0.2	0.7 ± 0.4	< .01
Literate (%)	70.5	85.6	88.4	87.1	98.0	76.7	< .01	75.1	82.6	82.9	76.6	94.3	73.8	< .01
SIA comprehension[c]	22.4 ± 7.1	23.0 ± 6.4	23.2 ± 6.8	23.7 ± 6.3	26.9 ± 6.3	22.3 ± 6.5	< .01	23.1 ± 6.3	23.3 ± 6.8	23.7 ± 6.5	22.1 ± 6.4	25.9 ± 6.9	21.6 ± 6.4	< .01
SIA vocabulary	19.8 ± 10.6	20.1 ± 10.5	21.0 ± 10.4	21.1 ± 9.3	27.1 ± 10.4	20.7 ± 10.4	< .01	16.7 ± 8.7	17.7 ± 9.5	18.2 ± 8.8	16.3 ± 9.6	23.7 ± 10.6	18.1 ± 9.9	< .01
SIA total	42.2 ± 17.1	43.1 ± 16.3	44.2 ± 16.6	44.8 ± 14.8	54.0 ± 16.2	43.0 ± 16.3	< .01	39.7 ± 14.4	41.1 ± 15.7	41.8 ± 14.8	38.4 ± 15.5	49.6 ± 17.0	39.7 ± 15.8	< .01
Raven's score	19.3 ± 6.6	19.9 ± 6.9	18.3 ± 6.2	18.6 ± 6.1	22.1 ± 6.3	17.3 ± 5.7	< .01	16. 3 ± 5.0	16.3 ± 4.8	14.9 ± 5.3	15.4 ± 5.3	18.9 ± 6.2	15.3 ± 4.1	< .01

a. p value for test of heterogeneity across categories of current residence within sex by one-way analysis of variance or chi square (two-tailed) as appropriate after exclusion of individuals with missing SES.

b. Sample sizes for selected analyses may differ due to item non-response or ineligibility. Grade efficiency not calculated if respondent did not attend school; SIA only administered to individuals who passed the literacy screen.

c. Serie Inter-Americana.

FIG. 1. Distribution of schooling attainment in the Human Capital Study 2002–04, by gender and birth cohort

on the SIA closely paralleled trends in schooling attainment, with most of the effect attributable to variation in scores on the vocabulary module. For men, scores on the SIA were considerably higher among those living in Guatemala city or in Espíritu Santo than in Conacaste, with the other villages somewhat intermediate (the pattern was less consistent among women) (**table 2**). Finally, the SIA score was strongly related to schooling attainment in both men and women (**table 4**).

The mean score on the Raven's was 19.4 for men and 16.3 for women ($p < .01$). This gender difference persisted within all strata of the other variables used for classification. The Raven's score improved over time in both men and women (**table 1**), was considerably higher among migrants to Guatemala City than among any other residential categories (**table 2**) and was highest among respondents in the highest parental SES tertile in 1975 ($p < .01$ for men; $p = .2$ for women). The Raven's score was strongly associated with respondent schooling attainment in both men and women (**table 4**).

Discussion

Our schooling measures provide a comprehensive set of attainment indices. Schooling attainment in the study sample is similar to that of rural respondents aged 25–42 years in the northeast region (which includes the Department of El Progreso) from the 2000 Guatemalan *Encuesta Nacional Sobre Condiciones de Vida* (ENCOVI) [13]. Specifically, completion rates for primary school were 49% (men) and 37% (women), respectively, in the rural ENCOVI sub-sample. Among ENCOVI respondents 25–42 years in the metropolitan region (which includes Guatemala City), completion rates for primary school were 84% (men) and 78% (women), respectively (our analysis), much like our sample.

Our data suggest large and meaningful differences in schooling attainments across major sub-groups of our cohort. The women in our study have obtained fewer years of school than have men, and there is some suggestion that the schooling gap between men and women has widened over time. This result is unexpected, particularly in light of the general closing and reversal of gender gaps in schooling attainment for recent birth cohorts on average in almost all countries in Latin America [14]. In sub-national studies, local conditions are likely to contribute to departures from the larger aggregate patterns—in a slum population of Guatemala City households there are strong male-female differentials in schooling attainment that decrease only slightly with later age at marriage of the couple [15]. In future studies we will explore the determinants of this persistent gender gap in the study population.

As described elsewhere in this special volume, the availability of schooling has changed over time in our study villages [12]. In the early 1960s, schools consisted of single rooms with multiple ages and grades being taught simultaneously by a single teacher. Over time the infrastructure has improved, and access to kindergarten and to schooling beyond primary became increasingly feasible. Time trends, therefore, capture not only increased intentions on the part of parents, but also removal of barriers to entry. Nevertheless, between-village differences persisted over the 15 years

TABLE 3. Schooling attainment, educational achievement, and cognitive functioning in the Human Capital Study 2002–04, by parental socioeconomic tertile and sex in 1975

	Men					Women				
Parental socioeconomic tertile	Low	Medium	High	Missing	p^a	Low	Medium	High	Missing	p
Sample size[b]	217	223	200	43		259	229	229	69	
Attended kindergarten(%)	6.0	4.1	7.0	9.3	.4	9.3	8.9	9.7	7.4	.95
Ever attended school (%)	93.5	97.3	98.0	90.7	.03	93.1	95.6	98.7	88.4	.01
Started school at or prior to age 7 (%)	64.1	72.6	84.5	67.6	< .01	69.5	76.9	85.7	62.5	< .01
Completed 6th grade (%)	42.9	47.1	71.5	39.5	< .01	26.6	35.8	48.0	33.3	< .01
Grade at age 13 y (mean ± SD)	3.2 ± 2.2	3.6 ± 2.2	4.7 ± 1.8	3.2 ± 2.4	< .01	2.8 ± 2.1	3.5 ± 2.1	4.1 ± 2.0	2.8 ± 2.4	< .01
Highest formal grade achieved (mean ± SD)	4.1 ± 3.2	4.7 ± 3.4	6.5 ± 3.3	4.3 ± 3.6	< .01	3.4 ± 3.0	4.1 ± 2.9	5.3 ± 3.4	3.6 ± 3.4	< .01
Grade progression efficiency (mean ± SD)	0.8 ± 0.3	0.8 ± 0.3	0.9 ± 0.2	0.8 ± 0.3	.02	0.8 ± 0.3	0.9 ± 0.3	0.9 ± 0.2	0.8 ± 0.3	.1
Literate (%)	77.4	81.1	93.0	88.4	< .01	76.1	84.1	89.5	66.7	< .01
SIA Comprehension (mean ± SD)[c]	22.2 ± 6.2	22.9 ± 6.3	25.5 ± 7.1	25.1 ± 7.6	< .01	21.7 ± 6.4	24.4 ± 6.3	24.5 ± 6.9	24.4 ± 7.0	< .01
SIA vocabulary (mean ± SD)	18.8 ± 9.7	20.4 ± 9.9	25.4 ± 10.5	22.4 ± 12.0	< .01	15.9 ± 9.2	19.2 ± 9.4	20.4 ± 10.1	21.3 ± 10.3	< .01
SIA total (mean ± SD)	41.0 ± 15.3	43.3 ± 15.7	50.9 ± 17.0	47.5 ± 19.1	< .01	37.6 ± 14.9	43.6 ± 15.1	44.8 ± 16.5	45.7 ± 16.9	< .01
Raven's score (mean ± SD)	18.4 ± 5.8	18.8 ± 6.5	21.1 ± 6.9	19.1 ± 6.9	< .01	15.8 ± 4.7	16.4 ± 5.6	16.7 ± 5.9	16.3 ± 5.6	.2

a. p value for test of heterogeneity across levels of SES by one-way analysis of variance or chi square (two-tailed) as appropriate after exclusion of individuals with missing SES.
b. Sample sizes for selected analyses may differ due to item non-response or ineligibility. Grade efficiency not calculated if respondent did not attend school; Serie Inter-Americana only administered to individuals who passed the literacy screen.
c. Serie Inter-Americana.

TABLE 4. Performance on the Serie Inter-Americana and Raven's Progressive Matrices tests[a] in the Human Capital Study 2002–04, by sex[a]

	Men		Women	
	Serie Inter-Americana	Raven's Progressive Matrices	Serie Inter-Americana	Raven's Progressive Matrices
No formal schooling	23.2 ± 9.0 (24)	14.9 ± 5.4 (98)	27.2 ± 10.7 (17)	13.2 ± 3.1 (123)
Some primary school (*Primaria*)	36.0 ± 13.1 (187)	17.9 ± 5.4 (221)	35.5 ± 13.3 (334)	15.4 ± 4.4 (375)
Completed primary school (*Primaria*)	45.3 ± 12.5 (211)	19.7 ± 5.7 (211)	46.0 ± 13.6 (172)	16.5 ± 5.1 (172)
Some middle school (*Básico*)	51.8 ± 13.2 (37)	19.6 ± 6.1 (37)	55.1 ± 11.4 (23)	19.9 ± 7.3 (23)
Completed middle school (*Básico*)	61.8 ± 14.0 (24)	23.7 ± 5.7 (24)	56.9 ± 12.8 (22)	21.6 ± 6.6 (23)
Attended high school (*Diversificado*)	64.0 ± 12.8 (62)	26.3 ± 6.2 (61)	60.3 ± 11.0 (51)	23.0 ± 5.6 (50)
Attended University or other post-secondary education	70.6 ± 6.5 (19)	27.4 ± 6.9 (19)	68.2 ± 7.4 (13)	24.0 ± 6.7 (13)

a. Values are means ± SD, with sample sizes in parentheses. Individuals who had not completed 6th grade and who failed a literacy screen were not administered the SIA. For both SIA and Ravens Progressive Matrices for both men and women, $p < .01$ for test of heterogeneity across levels of schooling within sex by analysis of variance, adjusting for birth cohort (1962–65; 1966–68; 1969–73; 1974–77), SES (low, medium, high, missing), community of birth (Conacaste, Espíritu Santo, Santo Domingo, San Juan)

covered by this birth cohort. Indeed, these differences reflect long-standing village-level attributes, insofar as the same differentials were noted among the parents of this cohort [16]. Higher education remains unavailable in the villages, and the strong association between migration to Guatemala City and schooling attainment needs to be interpreted cautiously as individuals must migrate to obtain post-intermediate schooling.

Only about half of men and one-third of women met the Millennium Development Goal of universal completion of primary school education [2]. However, there was progress over time. Men and women born in 1962–65, around 40 years of age in 2004, had primary school completion rates of 39% and 29%, respectively, compared with rates of 61% and 43% for men and women, respectively, born between 1974 and 1977 and who are around 28 years old in 2004.

These improvements in schooling were related to parallel improvements in both the SIA and the Raven's. Highest grade of school attained was consistently and strongly associated with both the SIA and the Raven's scores, and within levels of schooling attainment there were few differences between men and women in SIA scores, although the male advantage persisted for the Raven's score. Whether schooling quantity, per se, is causally related to performance on the Raven's test, or whether the quantity of schooling obtained and subsequent performance on the Raven's test are both dependent on innate endowments and the recognition of these endowments very early in life by parents and others in the community is beyond the scope of this paper.

Schooling and education do not occur in a vacuum. Decisions about schooling are made by parents in accordance with their analysis of the child's potential, the costs and expected returns to schooling and societal values. The child's innate potential (intelligence) thus influences both the quantity of schooling that might be obtained and the resulting educational attainments. Similarly, one needs to interpret associations between migration status, educational achievement, and cognitive functioning cautiously, in light of the strong association of all three with schooling. Indeed, it is possible that schooling, migration status and cognitive functioning are all dependent and causally related to innate potential. Separating out the effects of innate potential from nutrition supplementation in early life, parental investments prior to school entry, and the quality and quantity of schooling obtained will be the focus of future analyses and papers. Not only will such analyses enable us to understand better what determines different components of education in the population being studied, but they will make possible better estimates of the causal effects of education on various subsequent outcomes such as labor productivity, occupational choice, marriage, migration, fertility, and child-rearing.

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Levels, correlates, and differences in human, physical, and financial assets brought into marriages by young Guatemalan adults

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Abstract

This article examines marriage patterns among individuals who participated as children in a nutrition supplementation trial in Guatemala and were followed up in 2002–04, at ages 25–42 years. Of all 1,062 known and alive couples, 735, or 69%, responded fully to the marriage assets questionnaire. Focus of the analysis is on the birth cohorts born prior to 1974, a total of 1,058 intervention participants, among whom four-fifths of men (82%) and of women (78%) were married at the time of the 2002–04 survey. Basic patterns are examined in current marital status, age at first marriage and related milestones, human capital assets brought to marriage (e.g., schooling attainment, cognitive ability, literacy, and pre-marital work experience), and physical assets and savings accounts brought to marriage. Measures of husbands' human capital at marriage are positively correlated with wives' human capital, but are consistently higher. Husbands also bring substantially more physical and financial assets than wives. A number of interesting patterns emerge, including (1) changes in the composition of assets that women bring to marriage from physical to human assets, (2) declining gaps in age and premarital work experience between husbands and wives, and (3) increasing gaps in schooling attainment and cognitive ability between husbands and wives. Given conflicting directions of change in spousal gaps in human, physical and financial assets, their net effect on changes over time in the bargaining power of husbands and wives is uncertain and deserves further investigation.

Key words: Guatemala, Institute of Nutrition of Central America and Panama (INCAP), Human Capital Study, marriage patterns, assortative matching, gender gap

Introduction

As in much of the world, marriage is a major transition in the lives of most young adults in Guatemala. By "marriage," we mean joining in a union, usually involving cohabitation, whether or not the union is church- or state-sanctioned. The age at first marriage, in particular, often is related to other important transitions for young adults, including the termination of formal schooling, entrance into the labor market, separation from the parental household, and parenthood [1].

The nature of the marriage match—its timing and the characteristics of one's marriage partner and their parental family—has important implications for the welfare of individuals and of their families. Having a spouse with greater human, physical, and financial resources, all else being equal, tends to increase one's options and one's welfare to the extent that one shares in those resources or acquires prestige because of them. Some partially offsetting effects arise if there is (perhaps implicit) intra-household bargaining, and spouses with greater resources or from families with greater resources have greater bargaining strength (see, for example, the studies synthesized in Quisumbing [2] and Behrman and Rosenzweig [3]). The type of marriage union, whether or not sanctioned by church and state, also may be associated with the extent to which resources are shared within marriage.

The nature of marriage matches also has important

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implications for the next generation by affecting the number of children born and investments in and transfers to those children. Fertility tends to increase somewhat with increased resources, including those from both partners, but declines markedly with increased schooling attainment of the partners, particularly of women. Interpretations of the latter effect include the following: more educated people have preferences for fewer but higher quality children, are more effective in producing high-quality children so they choose to have fewer but higher quality children, have tastes that favor material consumption over consumption of so-called "child services," and have higher opportunity costs of time (e.g., in terms of labor market alternatives) for child care, with the last of these interpretations especially relevant for women. The number of children and the extent of investment in child quality also are thought to depend on differences in the resources between husbands and wives because such differences, again, affect bargaining, and women are perceived to tend to prefer fewer but higher quality children. The type of marriage union, whether or not sanctioned by church and state, also may be associated with decisions to have children and the resources to invest in them.

The present analysis reports on a cohort of individuals followed since childhood in rural villages in Guatemala and their spouses (if any).

Methods

The data used in this study come from the 2002–04 round of a well-known longitudinal data set that originated in an experimental nutrition intervention in 1969–77. Full details of the intervention trial and subsequent rounds of follow-up are described elsewhere [4, 5]. Individuals selected for this study include the original subjects of that study, all of whom were born between 1962 and 1977 and participated in the longitudinal study of nutrition supplementation as children. Also included are the spouses of these individuals, who were born over a somewhat wider range of years (1940–87). Because the original study included all children born in the four study villages over a 15-year period, we find that about 20% of participants in the original study married other participants.

The present round of follow-up was conducted during 2002–04, when the study participants were between 25 and 42 years of age. Full details of participant tracing and recruitment are presented in Grajeda et al. [6]. Briefly, of 2,393 individuals in the original study, 2,019 were traceable, i.e., determined to be alive; of these, 163 had left the country, resulting in 1,856 individuals who were in Guatemala and eligible for follow-up. The data presented in this paper come primarily from the Marriage History module, similar to that used in Quisumbing and Maluccio [7], and from the schooling and employment modules. Also, data presented in this paper pertaining to reading performance, cognitive ability, and anthropometry come from these respective modules. The Marriage History module consisted of a series of questions on (a) age at first marriage, duration of first marriage, age at subsequent marriages and at marital dissolutions, co-residence with parents or in-laws; (b) information on 16 types of physical and financial assets brought to marriage, including mode of acquisition, and value at the time of acquisition (or at the time of interview); and (c) family background, including literacy and schooling of parents and in-laws, landownership, residence in the community, and relative socioeconomic status (SES). These modules were administered separately to each husband and wife, yielding self- and spousal reports of relevant variables. The modules were administered during the latter part of 2002 among residents in the original study villages. For migrants, data were collected in a single session in 2003 or early 2004.

Below, we focus on patterns in the following aspects of marriage:

- **Marital status in 2002–04 and number of marriages**: currently in a cohabiting informal marriage (hereafter also called 'informal union'); in a formal (church- or state-sanctioned) marriage or union; separated; widowed; or single (never-married)
- **Age of economic independence**: age at which people considered themselves to be economically independent of their parents, which could be before or after their first marriage
- **Age at first marriage, residence with parents/in-laws during the first/most recent marriage, duration of first marriage, number of marriages**
- **Human capital brought to the most recent marriage** in the form of adult height, cognitive ability, educational achievement (literacy, schooling attainment), and pre-marital work experience
- **Physical and financial capital (assets and savings accounts) brought to the most recent marriage**

In the analysis, we stratify each of these aspects of marriage by the following:

- **Sex or gender**: biologic differences between females and males, or social differences between women and men (here, the terms 'sex' and 'gender' are used interchangeably)
- **Birth cohorts**: pre-1969, 1969–73, 1974–77, the first of which is before the *intervention* and the last of which appears only in **table 1a** for reasons described below
- **Parental family background** as measured by a derived score for parental SES in 1975: bottom, middle, or top tertile on the score for SES, or missing [8]
- **Place of current residence**: original village or

TABLE 1a. Civil status in the Human Capital Study 2002–04, by birth cohort and sex[a]

	Men				Women			
Birth cohort	Pre-1969 $n = 219$	1969–73 $n = 265$	1974–77 $n = 152$	p^b	Pre-1969 $n = 287$	1969–73 $n = 287$	1974–77 $n = 196$	p^b
	%				%			
United	37.0	32.5	32.9	.54	31.0	34.8	40.3	.11
Married	46.6	47.9	39.5	.23	45.6	44.9	37.8	.18
Separated	5.5	4.2	0.7	.052	8.0	8.4	7.1	.89
Widowed	0.0	0.0	0.0	NA	4.2	1.0	0.5	< .01
Single	11.0	15.5	27.0	< .01	11.1	10.8	14.3	.46

NA, not applicable

a. The table was based on all subjects living in Guatemala (n = 1,406).

b. The test of significance across cohorts is one-way ANOVA.

elsewhere in *El Progreso* (the Department in which the four study villages are situated), Guatemala City, and elsewhere in Guatemala.

Of all 1,062 known and alive couples, 735, or 69%, responded fully to the marriage assets questionnaire. Response rates varied between spouses for specific questions and by migration status. Where data are missing from the self-report but are available from the spousal report, we have used the spousal report. In the assets module, for example, substitution of the spousal report where the own report was missing or the median asset value where both own and spousal reports were missing resulted in a total of 9% of individuals and 16% of couples for whom one or more substitutions were made.

Results

A significance level of .05 is used as the cutpoint defining "significant" differences in aspects of marriage across these strata, and a significance level of .10 is used as the cutpoint defining "marginally significant" differences across these strata; however, some caution is recommended in the interpretation of estimated differences that have *p* values *around* .05 [9]. All references to the relative ranking of estimates across strata are qualitative and are not based on multiple comparisons tests.

Marital status of master subjects in 2002–04

Although differences across birth cohorts in marital status are generally insignificant at the .05 significance level (**table 1a**), two exceptions that are consistent with typical life-cycle patterns are notable: (1) younger men are more often single so a significantly higher percentage of males born after 1974 is single and (2) older women are more often widowed so a significantly higher percentage of females born in or before 1969 is currently widowed. The tendency for males to remain single until older ages creates right-censoring of variables related to union formation and marriage. Thus, the remainder of this paper focuses on the birth cohorts born prior to 1974, a total of 1,058 individuals.

Four-fifths of men (82%) and of women (78%) born before 1974 were married at the time of the 2002–04 survey, with no significant difference between men and women; 58% of husbands and 58% of wives were in formal unions, but large minorities of men and women across birth cohorts were in informal unions (**table 1b**). Those not married were primarily single (74% of currently unmarried men, 51% of women) and secondarily separated (26% of currently unmarried men, 38% of women), with some women also widowed (12% of currently unmarried women). The percentages of men and women who were separated or widowed differ significantly, with higher percentages of women in both categories. These differences are consistent with the tendency for women in Guatemala, as in many parts of the world, to marry older men [10] and to live longer [11].

Another important aspect of background pertains to parental (family of origin) SES (**table 1c**). Among women, the frequency of formal marriage differs significantly by parental SES, with the lowest percentage in formal marriages coming from families in the bottom parental SES stratum. The percentage of women in informal unions also differs significantly by parental SES, with the lowest percentage coming from parental families with the highest SES. Among men, marital status does not differ significantly by parental

TABLE 1b. Civil status in the Human Capital Study 2002–04, by sex, in participants born before 1974 (%)

	Men $n = 484$	Women $n = 574$	p^a
United	34.5	32.9	.59
Married	47.3	45.3	.51
Separated	4.8	8.2	.03
Widowed	0.0	2.6	< .01
Single	13.4	11.0	.22

a. Test of significance across sexes is two-sample test of proportions.

TABLE 1c. Civil status in the Human Capital Study 2002–04, by parental socioeconomic tertile in 1975 and sex, in participants born before 1974

Parental socio-econonomic tertile	Men					Women				
	Low $n = 154$	Middle $n = 154$	High $n = 137$	Missing $n = 39$		Low $n = 191$	Middle $n = 164$	High $n = 160$	Missing $n = 59$	
	%				p^a	%				p^a
United	38.3	35.1	27.7	41.0	.15	39.3	32.9	23.8	37.3	< .01
Married	44.8	44.2	56.2	38.5	.07	38.7	48.8	51.9	39.0	.03
Separated	2.6	3.9	6.6	10.3	.24	5.8	8.5	9.4	11.9	.41
Widowed	0.0	0.0	0.0	0.0	NA	1.6	3.0	3.1	3.4	.57
Single	14.3	16.9	9.5	10.3	.18	14.7	6.7	11.9	8.5	.06

NA, not applicable
a. Test of significance across cohorts is one-way ANOVA.

TABLE 1d. Civil status in the Human Capital Study 2002–04, by current residence and sex, in participants born before 1974

Place of residence:	Men				Women			
	Original village $n = 360$	Guatemala City $n = 84$	Elsewhere in Guatemala $n = 40$		Original village $n = 416$	Guatemala City $n = 109$	Elsewhere in Guatemala $n = 49$	
	%			p^a	%			p^a
United	35.0	31.0	37.5	.72	31.7	31.2	46.9	.09
Married	44.2	58.3	52.5	.05	44.5	52.3	36.7	.16
Separated	4.7	4.8	5.0	.99	7.9	10.1	6.1	.668
Widowed	0.0	0.0	0.0	NA	2.6	1.8	4.1	.71
Single	16.1	6.0	5.0	.02	13.2	4.6	6.1	.02

NA, not applicable
a. Test of significance across cohorts is one-way ANOVA across three categories (original village, Guatemala City, and other Guatemala).

SES. When stratifying by current residence in 2002–04 (**table 1d**), only the percentages for those who are single differ significantly across strata for women and men. Among men, marginally higher percentages of migrants to Guatemala City and to elsewhere in Guatemala are formally married, and lower percentages are single. Among women, a significantly higher percentage in the original villages is single.

When the category of current residence "original village" is disaggregated into the four study villages (not shown; available upon request), some significant differences in the percentages in an informal union, formal marriage, and single are apparent among women, with markedly lower percentages of women in an informal union in San Juan (19%), and higher percentages in an informal union in Espiritu Santo (41%) and Conacaste (38%). By contrast, the highest percentage of formally married women is in San Juan (63%), and the lowest is in Espiritu Santo (32%), reflecting marriage patterns seen in the census data for the same villages [12].

Characteristics of husbands and wives

Marriage transitions

We now examine the characteristics of husbands and wives, where the unit of analysis is a couple in which at least one member participated in the original study, excluding couples with a study participant born after 1974 as well as non-study participant husbands born after 1974, or 521 couples out of the 735 who answered the marriage history module. Out of the 521 couples, 18% consist of marriages between participants. Couples are stratified according to the husbands' characteristics (birth cohort, parental [origin family] SES, and current residence), again because right-censoring is most apparent among husbands. Pairwise correlations between husbands' and wives' stratifying variables indicate, as expected, a high correlation between current places of residence ($r = .96$, $p < .01$) but lower, albeit significant, correlations between birth years ($r = .33$, $p = .01$) and parental SES tertiles ($r = .22$; $p = .03$). Therefore, all references to "birth cohort," "parental SES," and "place of current residence" hereafter refer to those characteristics of the husband. **Table 2a** presents overall comparisons between husbands and wives in marriage transitions, human capital, and assets brought

TABLE 2a. Husband and wife characteristics in the Human Capital Study 2002–04: For all birth cohorts, means and correlations

	Husbands			Wives			Difference[a]	p^b	Correlation	p^b
	N	Mean	SD	N	Mean	SD				
Marriage transitions										
Age of economic independence (y)	521	22.2	5.2	521	19.1	4.2	3.1	< .01	.18	< .01
Age at first marriage (y)	521	22.9	4.6	521	19.4	3.9	3.5	< .01	.26	< .01
Duration of first marriage (y)	87	4.5	5.5	69	3.8	3.5	0.7	.33	—	—
Interval between first and second marriages (y)	87	3.5	3.2	70	4.6	3.9	–1.1	.06	—	—
Times married	521	1.22	.57	521	1.15	0.38	.07	.01	.18	< .01
Lived with parents at time of most recent marriage (%)	521	33.0	—	521	4.6	—	28.4	< .01	—	—
Lived with parents at time of first marriage (%)	434	36.2	—	434	3.9	—	32.3	< .01	—	—
Human capital										
Highest grade attained	520	4.8	3.6	521	4.3	3.3	0.5	.03	.46	< .01
Attained height (cm)	509	162.8	5.8	474	150.7	5.3	12.1	< .01	.21	< .01
Raven's Score	503	18.9	6.3	512	16.1	5.3	2.8	< .01	.26	< .01
Serie Inter-Americana Score	504	38.5	23.2	510	35.1	21.5	3.4	.02	.34	< .01
Potential work experience prior to first marriage[c]	493	6.4	4.9	513	2.9	3.6	3.5	< .01	.14	< .01
Assets at current marriage										
Present value of assets (QQ)	521	21,325	40,721	521	5,946	22,282	15,379	< .01	.15	< .01
Had household assets (%)	521	34.6	—	521	13.8	—	20.8	< .01	.09	.05
Had productive assets (%)	521	31.7	—	521	1.3	—	30.4	< .01	.01	.79
Had savings accounts (%)	521	16.3	—	521	9.0	—	7.3	< .01	.12	< .01
Had land (%)	521	5.2	—-	521	1.0	—	4.2	< .01	.07	.13

QQ, quetzals

a. Difference is husband–wife.

b. Test of significance for all variables in Table 2a is unpaired unequal variance *t*-test.

c. Potential work experience = age at first marriage – age at first waged job (0 if never worked before time of marriage).

to their current marriage, as well as pairwise correlations between husbands' and wives' characteristics.

The average age of economic independence (not shown)—the age at which people either consider themselves to be economically independent of their parents, whether before or after first marriage—was 22.2 years for husbands and 19.1 years for wives, and this difference is significant. The average ages of independence among husbands and wives do not differ significantly by parental SES or by birth cohort, but differ significantly by place of residence in 2002–04 (with the highest ages of independence for husbands among those in their original village and for wives among those in Guatemala City).

The age of first marriage for those ever married (84% of men and 78% of women) is slightly higher than the age at economic independence, averaging 22.9 years for husbands and 19.4 years for women, a significant difference of 3.5 years. The age of first marriage for husbands (but not for wives) differs significantly by birth cohort, with a decline in the mean from 23.5 years among husbands born before 1969 to 21.9 years among those born after 1969. This decline does not seem to reflect greater right-censoring for younger cohorts because the proportions married do not change by birth cohorts (**table 1a**). This result is striking and contradicts a fairly broad tendency for the age of first marriage to increase over time in the developing world [1, 13], an increase that has been attributed by some [14] to more years spent in formal schooling though relatively small percentages of females (and even smaller percentages of males) marry immediately upon termination of their schooling [1]. This result also is surprising, given the increase in schooling attainment among younger males [15]. The decline in average age at first marriage for husbands, but not for wives, implies a decline in the age difference between husbands and wives. Because the age difference often is interpreted to reflect a difference in marital power to determine intrahousehold allocations, this change, taken in isolation, suggests

TABLE 2b. Husband and wife characteristics in the Human Capital Study 2002–04, by birth cohort

Birth cohort[a]:	Husbands							Wives						
	Before 1969			1969–73				Before 1969			1969–73			
	N	Mean	SD	N	Mean	SD	p^b	N	Mean	SD	N	Mean	SD	p^b
Marriage transitions														
Age at first marriage (y)	323	23.5	5.0	198	21.9	3.7	< .01	323	19.4	4.0	198	19.5	3.9	.70
Duration of first marriage (y)	68	5.0	6.0	19	2.7	2.9	.11	45	4.1	3.8	24	3.2	2.6	.29
Interval between first and second marriages (y)	68	3.4	3.5	19	3.8	2.3	.62	45	4.3	3.9	25	5.1	3.9	.42
Times married	323	1.28	.65	198	1.12	.38	< .01	323	1.15	.40	198	1.13	.35	.50
Lived with parents at time of most recent marriage (%)	323	30.7	—	198	36.9	—	.14	323	4.3	—	198	5.1	—	.71
Lived with parents at time of first marriage (%)	255	34.1	—	179	39.1	—	.29	255	2.7	—	179	5.6	—	.13
Human capital														
Highest grade attained	322	4.3	3.6	198	5.6	3.4	< .01	323	4.0	3.2	198	4.7	3.3	.02
Attained height (cm)	316	162.7	5.7	193	163.1	5.9	.43	300	150.7	5.3	174	150.7	5.4	.97
Raven's Score	312	18.0	6.1	191	20.5	6.4	< .01	319	15.8	5.0	193	16.6	5.7	.08
Serie Inter-Americana Score	311	36.0	24.2	193	42.6	20.8	< .01	319	33.8	21.3	191	37.3	21.7	.08
Potential work experience prior to 1st marriage[c]	303	6.9	5.4	190	5.5	3.8	< .01	320	2.8	3.6	193	3.1	3.5	< .01
Assets at current marriage														
Present value of assets (QQ)	323	25,452	48,214	198	14,592	22,444	.02	323	7,656	27,686	198	3,156	6,712	.92
Had household assets (%)	323	34.0	—	198	35.6	—	.31	323	13.3	—	198	14.7	—	.31
Had productive assets (%)	323	32.0	—	198	31.3	—	.77	323	1.5	—	198	0.8	—	.27
Had savings accounts (%)	323	16.4	—	198	16.2	—	.94	323	8.0	—	198	10.6	—	.32
Had land (%)	323	5.9	—	198	4.0	—	.36	323	1.2	—	198	0.5	—	.41

QQ, quetzals

a. Husbands and wives are stratified by husband's birth cohort.

b. Test of significance across stratifying variables for total present value of assets at time of current marriage is Kruskal-Wallis test of equality of populations. Test of significance across stratifying variables for all other variables is one-way ANOVA.

c. Potential work experience = age at first marriage □age at first waged job (0 if never worked before time of marriage).

TABLE 2c. Husband and wife characteristics in the Human Capital Study 2002–04, by parental socioeconomic tertile in 1975

Parental socioeconomic tertile:	Husbands									Wives								
	Low		Middle		High		Missing			Low		Middle		High		Missing		
	N	Mean	N	Mean	N	Mean	N	Mean	p^a	N	Mean	N	Mean	N	Mean	N	Mean	p^a
Marriage transitions																		
Age at first marriage (y)	165	23.1	154	23.0	149	22.7	53	22.5	.80	165	19.8	154	18.8	149	19.9	53	18.7	.03
Duration of first marriage (y)	24	4.6	28	4.1	27	2.8	8	11.6	.35	20	3.4	24	3.1	14	3.9	11	6.1	.75
Interval between first and second marriages (y)	24	2.8	28	3.9	27	3.7	8	3.1	.37	20	3.6	25	4.9	14	6.4	11	3.4	.14
Times married	165	1.23	154	1.20	149	1.22	53	1.25	.89	165	1.14	154	1.18	149	1.09	53	1.21	.13
Lived with parents at time of most recent marriage (%)	165	33.9	154	35.1	149	27.5	53	39.6	.32	165	4.2	154	5.2	149	3.4	53	7.5	.73
Lived with parents at time of first marriage (%)	141	37.6	126	38.9	122	28.7	45	44.4	.19	141	3.5	126	4.8	122	1.6	45	8.9	.39
Human capital																		
Highest grade attained	164	3.8	154	4.2	149	6.4	53	4.6	< .01	165	3.3	154	4.1	149	5.6	53	4.0	< .01
Attained height (cm)	161	162.0	151	162.8	146	164.1	51	161.9	< .01	144	150.5	136	150.9	144	151.2	50	149.1	.48
Raven's Score	156	17.6	152	18.4	143	20.9	52	18.9	< .01	162	15.6	151	15.6	147	17.4	52	15.7	< .01
Serie Inter-Americana Score	157	31.5	152	35.6	143	48.2	52	41.9	< .01	160	30.0	151	33.3	147	43.6	52	32.5	< .01
Potential work experience prior to first marriage[b]	153	6.8	148	6.4	141	5.8	51	6.5	.19	161	3.3	152	2.6	148	3.1	52	2.3	.17
Assets at current marriage																		
Present value of assets (QQ)	165	16,429	154	20,513	149	30,752	53	12,421	< .01	165	2,398	154	7,812	149	7,881	53	6,129	.07
Had household assets (%)	165	31.8	154	34.1	149	39.2	53	31.4	< .01	165	12.0	154	14.5	149	14.7	53	14.9	.22
Had productive assets (%)	165	32.3	154	32.7	149	30.4	53	30.8	.71	165	0.6	154	1.7	149	1.6	53	1.3	.31
Had savings accounts (%)	165	21.8	154	13.0	149	16.1	53	9.4	.10	165	7.9	154	10.4	149	10.1	53	5.7	.71
Had land (%)	165	4.2	154	5.8	149	6.0	53	3.8	.74	165	0.6	154	1.3	149	0.7	53	1.9	.76

QQ, quetzals

a. *p* value is across low, middle, and high groups, and husbands and wives are in the husband's SES group except where missing, in which case both are categorized according to wife's SES score. Test of significance across stratifying variables for total present value of assets at time of current marriage is Kruskal-Wallis test of equality of populations. Test of significance across stratifying variables for all other variables is one-way ANOVA.

b. Potential work experience = age at first marriage □age at first waged job (0 if never worked before time of marriage).

TABLE 2d. Husband and wife characteristics in the Human Capital Study 2002–04, by place of current residence

Current residence:	Husbands							Wives						
	Original village		Guatemala City		Elsewhere in Guatemala			Original village		Guatemala City		Elsewhere in Guatemala		
	N	Mean	N	Mean	N	Mean	p^a	N	Mean	N	Mean	N	Mean	p^a
Marriage transitions														
Age at first marriage (y)	364	22.9	90	22.9	67	22.6	.89	364	19.0	90	21.4	67	19.1	< .01
Duration of first marriage (y)	42	3.3	28	6.0	17	5.2	.11	41	3.4	13	4.5	15	4.4	.48
Interval between first and second marriages (y)	42	3.8	28	3.3	17	2.9	.55	41	4.2	14	6.9	15	3.3	.03
Times married	364	1.16	90	1.37	67	1.33	< .01	364	1.12	90	1.16	67	1.25	.04
Lived with parents at time of most recent marriage (%)	364	37.9	90	15.6	67	29.9	< .01	364	4.1	90	7.8	67	3.0	.27
Lived with parents at time of first marriage (%)	322	40.1	62	17.7	50	34.0	< .01	322	3.1	62	8.1	50	4.0	.18
Human capital														
Highest grade attained	363	4.2	90	7.3	67	4.2	< .01	364	3.8	90	6.4	67	4.0	< .01
Attained height (cm)	353	162.4	89	164.7	67	162.5	< .01	327	150.7	83	151.1	64	149.8	.34
Raven's Score	349	18.4	87	22.0	67	17.8	< .01	357	15.6	88	18.5	67	15.8	< .01
Serie Inter-Americana Score	350	36.1	87	51.7	67	34.1	< .01	356	32.6	88	47.3	66	32.6	< .01
Potential work experience prior to first marriage[b]	343	6.4	83	6.2	67	6.6	.89	358	2.5	88	4.8	67	2.8	< .01
Assets at current marriage														
Present value of assets (QQ)	364	21,939	90	26,197	67	11,443	.05	364	5,242	90	10,154	67	4,119	< .01
Had household assets (%)	364	34.0	90	38.8	67	32.2	.03	364	12.2	90	20.9	67	12.8	< .01
Had productive assets (%)	364	34.9	90	20.7	67	29.4	< .01	364	1.3	90	0.7	67	2.0	.55
Had savings accounts (%)	364	14.0	90	26.7	67	14.9	.01	364	8.5	90	12.2	67	7.5	.49
Had land (%)	364	4.9	90	4.4	67	7.5	.66	364	1.1	90	0.0	67	1.5	.57

QQ, quetzals

a. Test of significance across stratifying variables for total present value of assets at time of current marriage is Kruskal-Wallis test of equality of populations. Test of significance across stratifying variables for all other variables is one-way ANOVA.

b. Potential work experience = age at first marriage □age at first waged job (0 if never worked before time of marriage).

a decline in the marital power of husbands relative to wives. Husbands' age at first marriage does not differ significantly by either parental SES or current residence, but wives' age at first marriage does differ significantly by both variables (with the highest average age at first marriage, like the average age of independence, in Guatemala City).

Almost 17% of husbands and 13% of wives experienced marital or union dissolution. Among those whose first marriages dissolved, these marriages lasted 5.5 years for husbands and 3.8 years for wives. Conditional on remarrying, wives also tended to take significantly longer to remarry than husbands (4.6 years versus 3.2 years). For husbands and wives, neither the duration of first marriage nor the interval between first and second marriages differs significantly by birth cohort or parental SES. The interval between marriages is significantly different, however, for wives by place of current residence, with a longer interval (6.9 years) for wives in Guatemala City compared with elsewhere in Guatemala (3.3 years) or the original village (4.2 years). All in all, husbands averaged 1.22 marriages, and wives significantly fewer (1.15) marriages. For husbands, but not for wives, there are significant differences across birth cohorts in the number of marriages, with more marriages on average among the earlier birth cohorts, presumably reflecting in part the increased right-censoring for younger cohorts. For neither husbands nor wives are there significant differences in the average number of marriages across parental SES strata. But for both husbands and wives there are significant differences in the average number of marriages across place of residence in 2002–04. In both cases, higher numbers of marriages are apparent among those living in Guatemala City or elsewhere in Guatemala.

More than one-third of married couples report living with their parents or in-laws at the time of their most recent marriage, though the exact percentages differ depending on whose report we consider. Husbands reported that at the time of their most recent marriage, 33% of the newlyweds lived with husbands' parents, 6% with their in-laws, and 61% lived in separate households. Reports from wives are broadly consistent, though not identical: 40% report living with the husbands' parents, 5% with the wives' parents, and 55% with neither. These discrepancies arise from reporting error, since, for couples whose marriages have not dissolved, husbands who report living with their parents at the time of marriage would always, by definition, be married to wives who report living with their in-laws, and vice-versa. A significantly higher percentage of husbands (33%) reports living with their parents, as compared with wives (5%), at the time of their most recent marriage (**table 2a**). Using the most recent marriage as a point of reference, however, may lead to comparisons of couples at different life-cycle stages, if some (possibly older) couples are in their second or third marriages while younger couples are in their first. To control for this, we examine co-residence patterns of couples at the time of their first marriage, for the subset of couples whose first marriages have not dissolved. The percentage of husbands living with their parents increases to 36%, whereas the percentage of wives living with parents decreases to 4%—and the difference between husbands and wives is significant, consistent with patrilocal patterns of co-residence.

Although parental co-residential patterns do not differ significantly across birth cohorts for either husbands or wives at the time of the most recent marriage, they do differ for *current* co-residence with parents, and are significantly higher for younger couples (not shown). This difference could be due to life-cycle patterns in which young married couples more often live for a while with their parents/in-laws before establishing their own residence (or due to the deaths of their parents/in-laws). Such a pattern would be consistent with patterns of co-residence in Mesoamerica and elsewhere, in which newlyweds first live with the husbands' parents, and then become economically independent after a few years, even if they continue to share the family dwelling [16, 17]. Indeed, most couples in our sample end up living independently, with only 8% of husbands and 4% of wives living with their parents at the time of the survey (not shown), a statistically significant difference. Patterns of parental co-residence also could shift over the life-cycle, with parents supporting children at the time of marriage, and the reverse later in life [17].

There is no significant association between couples living with parents/in-laws and parental SES status, regardless of whether the most recent marriage or first marriage is used as a point of reference (**table 2c**). There is a significant association between couples living with husbands' parents and place of residence, with a smaller percentage of couples in Guatemala City living with the husbands' parents at the time of their most recent marriage, and also at the time of first marriage for those couples whose first marriages have not dissolved (**table 2d**). At the time of the survey, however, there is no significant association between residence with parents/in-laws and current place of residence (not shown; available upon request). Moreover, percentages of couples living with parents at present are much lower than percentages at the time of the first or most recent marriage, and do not differ significantly across current location.

Human capital at marriage

The human capital that spouses bring to marriage takes several forms, including education, health, nutrition status, and work experience. Human capital, more so than physical capital, is associated with assortative matching in the marriage market, with sorting along human capital attributes increasing over time [10]. This

sample is no exception—unlike correlations with assets (see below), all correlations among the human capital components of husbands and wives are significant. These correlations are consistent with those reported in the literature [10, 18]. At the same time, men also consistently bring higher human capital attributes to the union.

One important form of human capital that is widely emphasized is schooling. As emphasized in the paper on schooling and education in this volume [15], the most widely used measure is schooling attainment, which should be considered an input into education rather than a measure of education itself. For comparison with the literature, we begin with schooling attainment. Husbands bring to marriage significantly greater mean schooling attainment (4.8 grades) than do wives (4.3 grades), with the correlation of schooling attainment between husband and wife positive and significant (0.46). Differences in schooling attainment across the two birth cohorts are significant for husbands and wives, with increases of 1.3 years for husbands and 0.7 years for wives. As a result, the average extent to which schooling of husbands exceeds that of wives increases marginally from 0.3 grades (this difference rounds to 0.2 grades in **table 3**) for the cohort born before 1969 to 0.9 grades for the cohort born in 1969 or after. In isolation, this marginal change suggests an increase in the bargaining power of husbands relative to wives if differences in schooling are associated with relative bargaining power. This increase in the male-female gender gap in schooling contradicts declines or even reversals of the gender gap in schooling in most of Latin America, where women not only have caught up with men, but also have surpassed men in some cases [19] (but see also [15]). For husbands and wives, associations between schooling attainment and parental SES are positive and significant, and schooling attainments are higher for those who are resident in Guatemala City in 2002–04.

An important contribution of this study is the availability of measures of human capital beyond schooling attainment—namely attained height, cognitive ability (as measured by Raven's scores), literacy (as indicated by the Serie Inter-Americana Score Score), and work experience. On average, husbands are taller than their wives (162.8 cm vs. 150.7 cm), and the correlation between husbands' and wives' heights is positive and significant ($r = .21$). Attained height does not vary by birth cohort for either husbands or wives, but is positively associated with parental SES among husbands (not wives). Height also varies significantly by place of residence, with the tallest husbands (but not wives)

TABLE 3. Differences between husband and wife in the Human Capital Study 2002–04 in marriage transitions, human capital, and assets at current marriage, by husband's birth cohort

Differences between husband and wife in:	Difference[a]	p^b	Before 1969			1969–73			p^b
			N	Mean	SD	N	Mean	SD	
Marriage transitions									
Age at first marriage (y)	3.5	< .01	323	4.1	5.5	198	2.4	4.6	< .01
Times married	.07	.01	323	0.13	0.70	198	–0.02	0.49	.01
Human capital									
Highest grade attained	.5	.03	322	0.2	3.8	198	0.9	3.2	.06
Attained height (cm)	12.1	< .01	294	12.0	6.9	169	12.6	7.2	.36
Raven's Score	2.8	< .01	309	2.3	7.0	189	3.8	7.2	.02
Serie Inter-Americana Score	3.4	.02	308	2.4	27.0	189	5.2	23.4	.24
Potential work experience prior to first marriage[c]	3.5	< .01	300	4.0	6.1	188	2.5	4.7	< .01
Assets at current marriage									
Present value of assets (QQ)	15,379	< .01	323	17,796	51,963	198	11,436	23,321	.09
Had household assets (%)	20.8	< .01	323	20.7	—	198	20.9	—	.93
Had productive assets (%)	30.4	< .01	323	30.4	—	198	30.5	—	.99
Had savings accounts (%)	7.3	< .01	323	8.4	—	198	5.6	—	.48
Had land (%)	4.2	< .01	323	4.6	—	198	3.5	—	.60

QQ, quetzals

a. All differences are husband □wife.

b. Test of significance across stratifying variables in total present value of assets at time of current marriage is Kruskal-Wallis test of equality of populations. Test of significance across stratifying variables for all other variables is one-way ANOVA.

c. Potential work experience = age at first marriage □age at first waged job.

living in Guatemala City.

Husbands score better than wives on tests of cognitive ability and literacy, although husbands' and wives' scores are positively correlated (r = .34). Husbands' Raven's scores are significantly higher among younger than older birth cohorts, whereas wives' scores do not vary by (husbands') birth cohort. Raven's scores are positively associated with parental SES and vary significantly by place of residence, with migrants to Guatemala City having higher-scoring husbands and wives. Finally, husbands score higher than wives on the Serie Inter-American (SIA) score, with the difference being driven by scores on the vocabulary component (husbands = 18.7, wives = 15.6, p= < .01) rather than scores on the comprehension component (husbands = 19.8, wives = 19.5, p= .68). SIA scores are significantly higher among younger than older cohorts of husbands, but only marginally so among wives. When the SIA score is broken down into the components of comprehension and vocabulary, scores still are significantly different across birth cohorts for husbands, but less so for vocabulary (p = 0.02) than for comprehension (p < .01). The reverse is true for wives—scores for the comprehension component are not significantly different across birth cohorts (p = .14), whereas scores for vocabulary are marginally different (p = .06). SIA scores also vary significantly across parental SES tertiles, with significantly higher scores for better-off tertiles in both vocabulary and comprehension for both husbands and wives.

Finally, another important form of human capital that individuals bring to marriage is work experience, which is associated with higher economic productivity and earnings in many studies. On average, husbands bring to their first marriage significantly more work experience (6.4 years) than do wives (2.9 years). This difference primarily reflects the older age at first marriage for husbands than for wives, but also may reflect differential labor force participation rates between spouses as well as an early age at entry into the labor force among men. For husbands and wives, there are significant differences in work experience prior to first marriage across birth cohorts, but differences across parental SES are insignificant. For wives, but not for husbands, pre-marital work experience differs significantly by current location of residence, which may indicate migration in search of better work opportunities for women.

Physical and financial assets brought to marriage

On average, husbands bring to marriage physical and financial assets (savings accounts) worth approximately Q21,000 (valued in 2002–04 with Q7 = 1$ US), and wives bring significantly less (Q6,000, or 28% as much); however, the present value of physical assets and savings accounts varies considerably for husbands and wives. We aggregated the 16 asset categories into household assets (house, furniture, consumer durables, animals for consumption), productive assets (working animals, motor vehicles, equipment), financial assets (savings accounts), and land. All types of assets were those held independently by each spouse at the time of marriage. A greater percentage of husbands than wives bring any household assets (35% vs. 14%), productive assets (32% vs. 1%), financial assets (16% vs. 9%), and land (5% vs. 1%) to their marriages. Although correlations of the present value of husbands' and wives' total physical and financial assets are positive and significant (r = .15), they are not large and more finely disaggregated results indicate significant positive correlations only for savings accounts (r = .12) and marginally significant correlations for household assets (r = .09) (not shown; available upon request). Differences in the total value of assets by husbands' birth cohorts are significant, whereas for wives, these differences by husbands' birth cohort are insignificant. The average value of assets brought to marriage by husbands, but not by wives, increases significantly with husbands' parental SES. By contrast, there are significant differences by current residence in total assets and the percentages of a number of the individual assets brought to marriage by both husbands and wives, with the highest averages for total assets among those residing in Guatemala City. Among couples in Guatemala City, having higher values of assets also may be associated with later marriage and the ability to accumulate more over the life course.

Differences between husbands and wives in human, physical, and financial assets at marriage

Table 3 presents pairwise differences between husbands' and wives' human capital and assets at marriage, overall, and by husbands' birth cohort (pre-1969, 1969–73). In this section, we also discuss significant differences in husband-wife gaps in human capital and assets by parental SES and place of current residence (not shown; available upon request).

The asset gap has not changed significantly through time, and continues to favor husbands. If asset gaps are constant through time, but some human capital gaps are increasing while at least one other and the age gap are decreasing, the balance of bargaining power within households may shift in either direction. The schooling gap does not vary significantly across SES tertiles, but the husband-wife gap in the present value of assets decreases for the middle tercile, and almost doubles for the highest. This observation contradicts the hypothesis of an intrahousehold Kuznets curve, in which intrahousehold inequality first increases, then declines with wealth [20]. Finally, although the husband-wife schooling gap is greatest among migrants to Guatemala City, differences across place of current residence are insignificant. In fact, the only husband-

wife differences in human capital that are significant across place of current residence are height (with the greatest gap in Guatemala City) and potential work experience (with the smallest gap in Guatemala City). Regarding husband-wife differences in assets, the gap in present value of assets is greatest among couples remaining in the original villages, and smallest for those in other parts of Guatemala, but the differences are only marginally significant; this result probably is driven by the significant difference in productive assets, where the gap is greatest among those who remained in the original villages.

Discussion

Marriage is a major life-cycle transition for most people in most societies, including rural Guatemala. The nature of the marital match often affects the welfare of not only each partner in a marriage, but also their parental families and the quantity and quality of their children. This paper describes basic patterns in current marital status, age at first marriage and related milestones, human capital assets brought to marriage (e.g., schooling attainment, cognitive ability, literacy, and pre-marital work experience), and physical assets and savings accounts brought to marriages for the longitudinal sample originally from four villages in Guatemala that are the focus of this special issue. A number of interesting patterns emerge, including (1) changes in the composition of assets that women bring to marriage from physical to human assets, (2) declining gaps in age and premarital work experience between husbands and wives, and (3) increasing gaps in schooling attainment and cognitive ability between husbands and wives. Given conflicting directions of change in spousal gaps in human, physical and financial assets, their net effect on changes over time in the bargaining power of husbands and wives is uncertain. These net effects on marital dynamics are interesting questions for future research. Moreover, the increasing gap in schooling between husbands and wives contradicts trends elsewhere in Latin America. Whether this result is due to specific circumstances in the study villages, attrition bias, or other factors deserves further investigation. The larger project to which this special issue is an introduction will go beyond the descriptive analyses presented here to investigate in detail whether early childhood nutrition and other events during childhood affect the timing and matches made in marriage and the number and quality of children.

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Fertility behavior and reproductive outcomes among young Guatemalan adults

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Abstract

Fertility rates have declined in many developing countries and this has implications for health and development of subsequent generations. Guatemala has the highest fertility rates in Central America. Reproductive histories were obtained by interview in 2002–04, in a cohort of 779 women and 647 men who had participated as young children in a nutrition supplementation trial in Guatemala conducted between 1969 and 1977. Most women (77%) and men (79%) are currently married. Among the 700 women and 524 men reporting at least one birth, mean age at first birth was 20.7 ± 3.8 years and 23.1 ± 3.9 years respectively. Knowledge (> 80%) and use (~70%) of modern contraceptive methods is fairly high; knowledge increases with parental socioeconomic status (SES) as measured in 1975. Younger respondents have experienced fewer pregnancies and live births compared with older respondents; age-specific fertility rates between 20 and 24 years were 294, 249, 236, and 261 births per 1,000 women, respectively, for women born from 1962–65, 1966–69, 1969–73, and 1974–77. Women in the top tertile of parental SES have had significantly fewer pregnancies (3.3) compared with those in the middle (3.7) and lower (3.8) tertiles. Migrants to Guatemala City reported greater knowledge of contraceptive methods, fewer pregnancies and living children, higher age at first birth, and more pregnancy and newborn complications as compared with cohort members who remained in the original villages ($p < .05$ for each comparison). Fertility rates, especially between 20 and 24 years, have declined over time. Differences in reproductive behaviors by parental SES and current residence suggest the role of social transitions in determining family formation in Guatemala.

Key words: Guatemala, Institute of Nutrition of Central America and Panama (INCAP), Human Capital Study, fertility, contraceptive use

Introduction

The age at which men and women begin to have children, the spacing of their births, and the number of children that are dependent on them affect their constraints and incentives to engage in productive activities and expenditure patterns. Child-bearing is especially salient for women, as it has direct implications for their physical and mental well-being, as well as their time use. The number of children, moreover, tends to be associated inversely with investments in children [1–3], with important implications for the productivity and options of the next generation.

Broadly speaking, socioeconomic changes, such as improvements in schooling, the increased availability of and access to modern contraceptives and increased economic opportunities—especially for women—have played key roles in fertility change by changing the desired number of children and allowing individuals and couples to limit the number of children that they have [4–9]. Similarly, expanded programs of immunization, increased access to and use of health services during pregnancy and early childhood, and

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improved nutrition, have played key roles in enhancing the survival of children who are born, which in turn may influence fertility [10–12]. Finally, the diffusion of 'modern' ideas about family and child-bearing—through migration, schooling, mass media, and expanded systems of transportation—may independently affect the fertility-related behavior of women and men [13, 14].

Rates of fertility have declined worldwide, although regional differences prevail. The total fertility rate (TFR) in most Western industrialized countries is at or below replacement (2.1 births per woman of reproductive age), whereas it is higher in developing countries, especially parts of sub-Saharan Africa [15]. Although nationally representative data from Latin America and the Caribbean (LAC) show substantial declines in fertility, TFRs since the late 1990s still vary considerably and range from 5.0 in Guatemala in 1998/1999 to 2.5 in Brazil in 1996 [16]. Other concerns include persistently low rates of prenatal care in some countries in the LAC region: In Bolivia in 1998 and in Haiti in 2000, respectively, 30% and 20% of children born 3 years before the survey received no prenatal care [16].

Results from the Encuesta Nacional Salud Materno-Infantil (ENSMI) in Guatemala indicate that total fertility rates have declined steadily from 5.6 to 4.4 between 1987 and 2002 [17]. Although total fertility rates remained higher in rural areas (5.2) and among uneducated women (6.4) in 2002, declines have also been seen in these subgroups. Substantial increases in the use of family planning, and especially modern contraceptive methods, have accompanied these changes [17]. By contrast, there has been no improvement in prenatal care. At the national level, non-use of prenatal care reportedly occurred among 14% and 16% of births in the 3 years before the survey in 1998/1999 and 2002, respectively. Similarly, rates of complications at delivery in the same samples of births were 11% and 18%, respectively, for prolonged labor and 8% and 12%, respectively, for excessive bleeding [16, 17].

The main objective of this paper is to describe the levels and correlates of a range of measures for the reproductive histories of women and men in a cohort of individuals who participated as young children in a nutrition supplementation trial that was conducted in eastern Guatemala in 1969–77 [18, 19].

Methods

A cohort of 2,393 individuals who had participated as children in a nutrition intervention trial between 1969 and 1977 formed the study base. Of these, 165 (5%) were not traceable; the 1,856 who were not known to have died or to have left Guatemala were eligible for the Human Capital Study of 2002–04. The subjects were 26 to 41 years of age in 2003. Details about the criteria for eligibility and selection of the sample are described elsewhere [19, 20].

The reproductive history questionnaire was based on instruments used in previous studies in this population [21] and was adapted for use with both men and women. Men and women were asked about their marital history, number of live births, number of children who died, pregnancy intentions, and knowledge and use of a range of contraceptive methods. Women also were asked about their menstrual history and provided a detailed pregnancy history. For each pregnancy, women provided information on their own age at delivery, type and place of delivery, and complications during pregnancy and delivery. Men were administered questions about the number of pregnancies and their outcomes with each spouse or partner.

The main reproductive events and behaviors of men and women (unless otherwise indicated) that are examined in this paper include:

1. Age at menarche in years and menstrual history (for women only).
2. Percentage currently married, including informal unions, common-law marriage, and/or legal marriage.
3. Percentage who have children.
4. Contraceptive methods: knowledge of, ever-use (overall and by type of method), or use in the last 12 months. The type of method was classified either as modern or traditional and female- (FC) or male-controlled (MC). Modern methods included the use of contraceptive pills (FC), injection (FC), condoms (MC), foam/jellies (FC), intra-uterine devices (FC), Norplant or implants (FC), and male and female sterilization. Traditional methods included rhythm or calendar (FC), method of necklace (FC), breast-feeding (FC), and coitus interruptus or withdrawal (MC).
5. Percentage who planned and/or desired the last pregnancy.
6. Age of the respondent when his/her first child was born, in years.
7. Total number of pregnancies.
8. Total number of children (living and dependent).
9. Percentage who ever had an abortion, stillbirth, and/or child death.
10. Percentage who ever experienced pregnancy, delivery and newborn complications.

For women and men separately, we examine differences in the reproductive variables across strata for the following covariates: birth cohort (1962–68, 1969–77), parental SES in 1975 (Low, Middle, High, and Missing) [22], and current place of residence (original village or surrounding area, Guatemala City, or elsewhere in Guatemala). Equally spaced birth cohorts (1962–65, 1966–69, 1970–73, 1974–77) that differed slightly from

the birth cohorts in the original intervention trial were used for the comparison of age-specific fertility patterns to ensure an equal number of years of exposure. We test for differences across strata using one-way analysis of variance (ANOVA) for continuous variables and the chi-square test of independence for dichotomous variables. We report as significant differences across strata at p-value < .05. For comparison of fertility-related behavior across parental SES tertiles, *p*-values are computed only for differences across Low, Middle, and High strata (those with "Missing" information on parental SES are excluded). Discussion of differences in reproductive variables by gender or within stratifying variables for women and men considered separately are not based on statistical tests. We note also that differences in measures of the reproductive variables across age cohorts may not necessarily indicate true cohort change over time, but instead may reflect censoring due to the earlier stage of the younger cohorts in their reproductive lifecycle.

Results

A total of 647 men and 779 women completed the reproductive history questionnaire, for an overall response rate of 77%. A higher response rate was achieved among those still residing in the study villages (85%) compared with migrants, especially those living in Guatemala City (60%). As with other modules administered in this round of follow-up, the primary reason for lower response rate among migrants was failure to establish contact rather than overt refusal [20].

The mean age at menarche was 13.5 ± 1.6 years and was reported to have occurred earlier in the younger women (**table 1**). The mean (SD) interval and duration of the menstrual cycle in days were 31.6 (13.1) and 3.8 (2.0), respectively, and 52% and 25% of women reported moderate and heavy bleeding with no differences by birth cohort, parental SES, or current place of residence. Almost one-third of women reported at least moderate to severe discomfort during their menstrual cycles, and migrants more often (4.4%) reported greater discomfort and an inability to perform normal chores when compared with those living in the study villages (< 1%).

Most women (77%) and men (79%) are currently married and have at least one living child (81% and 89%, respectively). The percentage of women and men reporting that they (or a current or previous partner for men) had at least one pregnancy is 90% ($n = 700$) and 82% ($n = 528$), respectively. As expected, older women and men report these statuses more often than do younger women and men. The percentage of respondents who know about or have ever-used any contraceptive method (regardless of type) does not vary by birth cohort among women; however, compared with older men, younger men less often report knowledge about (74% vs 82%) and ever-use of female-controlled methods (63% vs. 73%) but more often report ever-use of a male-controlled method (condom, vasectomy, withdrawal) (58% vs. 45%). A larger percentage of men than women report knowing about and having ever-used contraceptive methods, regardless of the birth cohort or type of contraceptive method. Regarding use of contraceptive methods in the past year, a larger percentage of younger than older women reports recent use of any contraceptive methods (64% vs 56%), especially modern (54% vs. 48%) and female-controlled methods (54% vs. 47%). Compared with older men, younger men report significantly more often recent use of male-controlled methods and less often recent use of female-controlled methods. With the exception of female-controlled methods in the younger birth cohort, men tend to report recent use of contraception more often than do women, regardless of age cohort and type of method. A larger percentage of men (56%) than women (46%) say they planned the last pregnancy, but the vast majority (> 95%) of men and women reportedly desired this last pregnancy.

For subjects reporting at least one pregnancy, the mean age at first birth is earlier among women (20.7 ± 3.8 y) than among men (23.1 ± 3.9 y) and is lower among younger than older men. The number of reported pregnancies and living children is lower among younger men and women; however, comparison of estimated age-specific fertility rates (ASFR) by more disaggregated birth cohorts suggests that the probability of child-bearing at least at ages 20–24 years is lower among the 1966–69, 1970–73, and 1974–77 cohorts compared with the 1962–65 cohort (**fig. 1**). The percentages of women and men who report that they (or their current or previous partner, for men) experienced at least one child death, stillbirth, or abortion also is lower among younger than older cohorts, but this difference again could simply be a result of the

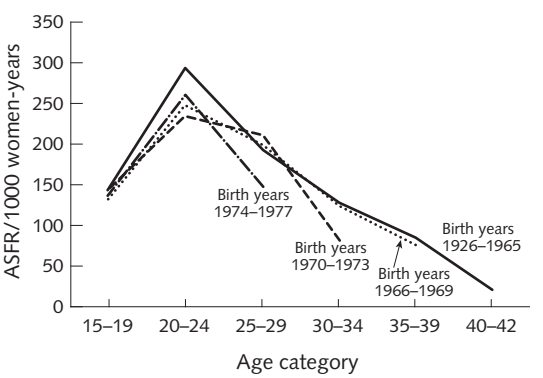

FIG. 1. Distribution of schooling attainment in the Human Capital Study 2002–04, by gender and birth cohort; ASFR, age-specific fertility rate

TABLE 1. Reproductive history in the Human Capital Study 2002–04, by birth cohort and sex

	Women				Men			
Birth Cohort:	All $n = 779$	1962–68 $n = 292$	1969–77 $n = 487$	p^a	All $n = 647$	1962–68 $n = 223$	1969–77 $n = 424$	p^a
Age at menarche (y, mean ± SD)	13.5 ± 1.6	13.8 ± 1.4	13.5 ± 1.7	.01	—	—	—	—
Currently married/in union (%)	77	75	78	.09	79	83	76	.04
Has any living children (%)	89	94	86	< .01	81	88	77	< .01
Know any contraceptive method (%)[b]	87	87	87	.9	94	93	94	.6
Modern method (%)	85	85	84	.7	92	92	93	.7
Traditional method (%)	35	34	36	.7	50	50	50	1.0
Male-controlled methods (%)	59	60	59	.6	85	85	86	.8
Female-controlled methods (%)	84	84	84	.9	77	82	74	.04
Self or partner ever-used any contraceptive method (%)[b]	74	71	76	.2	88	86	86	.9
Modern method (%)	69	65	70	.14	78	78	78	1.0
Traditional method (%)	19	18	19	.6	27	28	27	.7
Male-controlled methods (%)	27	24	28	.2	54	45	58	< .01
Female-controlled methods (%)	67	64	69	.2	66	73	63	< .01
Self or partner used contraceptive methods within last 12 mo(%)	61	56	64	.04	72	72	71	.8
Modern method (%)	52	48	54	.07	60	62	59	.5
Traditional method (%)	9	9	9	.8	13	11	14	.4
Male-controlled methods (%)	10	9	11	.5	20	15	22	.04
Female-controlled methods (%)	51	47	54	.07	53	59	50	.04
Reported at least one pregnancy	700	279	421		528	196	332	
Planned last pregnancy (%)	46	41	49	.2	56	52	58	.2
Desired last child (%)	96	95	96	.3	99	99	99	.8
Age when first child born (y, mean ± SD)[c]	20.7 ± 3.8	20.9 ± 4.1	20.6 ± 3.6	.2	23.1 ± 3.9	24.0 ± 4.7	22.7 ± 3.2	< .01
Self or spouse currently pregnant (%)	6	3	9	< .01	6	6	6	.7
Number of pregnancies for self or spouse(s) (mean ± SD)	3.7 ± 2.0	4.3 ± 2.2	3.3 ± 1.7	< .01	3.4 ± 1.8	4.3 ± 2.1	2.9 ± 1.4	< .01
Number of children living (mean ± SD)	3.1 ± 1.7	3.7 ± 1.9	2.7 ± 1.5	< .01	2.9 ± 1.5	3.5 ± 1.6	2.5 ± 1.2	< .01
At least one child died (%)	20	24	17	.01	16	24	11	< .01
At least one still birth (%)	6	8	5	.08	4	6	3	.13
At least one abortion (%)	19	23	16	.03	20	27	17	< .01

a. *p* value for test of heterogeneity between birth year groups by one-way ANOVA for continuous variables or chi-square test for categorical variables.

b. Contraceptive methods are classified as (1) modern or traditional and (2) female- (FC) or male-controlled (MC). Modern methods included the use of contraceptive pills (FC), injection (FC), condoms (MC), foam/jellies (FC), intra-uterine devices (FC), Norplant or implants (FC), and male and female sterilization. Traditional methods included rhythm or calendar (FC), method of necklace (FC), breastfeeding (FC), and coitus interruptus or withdrawal (MC).

c. Data are missing for 42 women and 10 men due to non-response; 9 additional women experienced one pregnancy that did not result in a live birth.

longer exposure time of older women and men to the risk of these reproductive events.

Comparisons of women's and men's reproductive behavior by parental SES tertile in 1975 (**table 2**) shows that although level of knowledge about contraception is high (> 80% for women and 90% for men), it does vary by tertile of parental SES among women and men, with knowledge generally being highest among those in the highest parental SES tertile. For women, this increase is apparent for all classifications of contraception, whereas for men, the increase is most apparent for all but female-controlled methods.

TABLE 2. Reproductive history in the Human Capital Study 2002–04, by parental socioeconomic tertile in 1975 and sex

Parental socioeconomic tertile:	Women					Men				
	Low $n = 247$	Middle $n = 247$	High $n = 217$	Missing $n = 68$	p^a	Low $n = 212$	Middle $n = 219$	High $n = 172$	Missing $n = 44$	p^a
Age at menarche (y, mean ± SD)	13.7 ± 1.3	13.6 ± 1.4	13.4 ± 1.3	13.5 ± 3.5	.07	—	—	—	—	—
Currently married/in union (%)	74	82	76	71	.6	76	81	79	80	.1
Has any living children (%)	86	91	88	93	.4	76	83	81	87	.2
Know any contraceptive methods (%)[b]	83	87	91	90	.05	92	94	96	100	.2
Modern methods(%)	80	85	88	88	.04	88	93	95	96	.07
Traditional methods (%)	32	32	41	38	.08	47	43	62	52	< .01
Male-controlled methods (%)	53	56	69	62	< .01	83	81	93	89	< .01
Female-controlled methods (%)	78	86	89	87	< .01	72	79	81	75	.1
Ever-used any contraceptive method (%)[b]	71	77	77	66	.3	84	85	89	89	.4
Modern methods(%)	64	73	71	62	.1	73	80	80	84	.1
Traditional methods (%)	19	18	20	13	.8	27	21	36	25	< .01
Male-controlled methods (%)	26	23	33	21	.04	52	48	62	52	.02
Female-controlled methods (%)	63	73	68	60	.07	60	69	70	66	.06
Used contraceptive methods within last 12 months (%)[b]	56	64	63	56	.2	66	71	79	73	.02
Modern methods (%)	50	57	50	47	.2	55	63	62	66	.3
Traditional methods (%)	7	7	13	7	.05	11	10	19	11	.04
Male-controlled methods (%)	10	9	12	8	.5	18	16	27	16	.02
Female-controlled methods (%)	47	56	53	46	.2	48	57	53	59	.14
Reported at least one pregnancy	215	229	193	63		165	183	142	38	
Planned last pregnancy (%)	45	49	45	38	.7	53	62	56	40	.2
Desired last child (%)	94	97	95	98	.3	99	99	100.0	97	.3
Age when first child born (y, mean ± SD)[c]	21.0 ± 4.2	20.4 ± 3.4	21.0 ± 3.8	20.4 ± 3.4	.2	23.4 ± 3.8	22.9 ± 3.9	23.3 ± 4.0	23.0 ± 3.9	.4
Self or spouse currently pregnant (%)	8	6	7	3	.6	10	4	4	8	.04
Total number of pregnancies for self or spouse(s) (mean ± SD)	3.7 ± 2.0	3.8 ± 1.9	3.3 ± 1.9	4.3 ± 2.5	.04	3.3 ± 1.6	3.6 ± 2.0	3.3 ± 1.8	3.9 ± 2.1	.3
Number of children living (mean ± SD)	3.1 ± 1.7	3.2 ± 1.7	2.8 ± 1.6	3.7 ± 2.0	.06	2.8 ± 1.4	2.9 ± 1.5	2.8 ± 1.5	3.2 ± 1.6	.6
At least one child died (%)	21	25	13	21	.02	13	19	13	24	.2
At least one still birth (%)	4	7	7	10	.4	4	4	5	8	.8
At least one abortion (%)	17	18	22	21	.4	18	24	18	24	.3

a. *p* value for test of heterogeneity across parental socioeconomic status in 1975 by one-way ANOVA for continuous variables or chi-square test for categorical variables. Missing subjects not included in calculating *p*-value.

b. Contraceptive methods are classified as (1) modern or traditional and (2) female- (FC) or male-controlled (MC). Modern methods included the use of contraceptive pills (FC), injection (FC), condoms (MC), foam/jellies (FC), intra-uterine devices (FC), Norplant or implants (FC), and male and female sterilization. Traditional methods included rhythm or calendar (FC), method of necklace (FC), breastfeeding (FC), and coitus interruptus or withdrawal (MC).

c. Missing data for 42 women and 10 men due to non-response; 9 additional women experienced one pregnancy that did not result in a live birth.

Despite higher knowledge of contraception among women with higher parental SES, no clear pattern of use of contraception (whether overall or by type) is apparent across parental SES strata. The frequency of ever-use of male-controlled methods does, however, differ significantly by parental SES among women and men, with the highest level of ever-use of these types of methods observed among those from the highest parental SES tertile (33% and 62%, respectively). The frequency of ever-use of traditional methods also increases significantly by parental SES among men. The frequency of using contraception in the 12 months before the interview (whether any method or by type) also does not differ significantly across parental SES strata among women; the prevalence of recent use does vary by parental SES strata among men; however, the prevalence of using any method (79%), traditional methods (19%), and male-controlled methods (27%) tends to be highest among men with the highest parental SES. Overall, except for female-controlled methods, both knowledge about and ever- and recent-use of all other types of contraception tends to be higher among men than women.

Age at menarche for women is fairly constant across all parental SES groups (13.4–13.7 years). The proportion of most recent pregnancies that were planned/desired and the mean age at first birth also do not vary significantly by parental SES strata. However, men tend to report more often than women that they planned and desired their last pregnancy, and mean age at first birth tends to be higher among men than women, regardless of the level of parental SES. Although the total number of pregnancies (by any partner in the case of men) does not differ by parental SES tertile among men, total number of pregnancies does differ across parental SES strata among women, with the lowest number of pregnancies reported among women with the highest parental SES tertile (3.3 vs. 3.7 and 3.8). Among women, the percentage reporting that at least one child died differs significantly across parental SES strata, with the lowest percentage apparent among the women from the highest parental SES (13% vs. 21% for the lowest tertile and 25% for the middle tertile). There were no differences among men.

Comparison of women's and men's reproductive behavior by place of current residence (**table 3**) shows that higher percentages of men who left the study villages had any living children (93% in Guatemala City and 88% elsewhere in Guatemala) compared with those who remained (78%). With few exceptions, knowledge about contraception overall and by type varies significantly by current residence among women and men. For women and men, levels of knowledge about contraception, regardless of type, tend to be highest among migrants to Guatemala City (e.g., 96% for women and 98% for men overall), although levels of contraceptive knowledge among men tend to be more similar among migrants to Guatemala City and elsewhere in Guatemala. Except for female-controlled methods, levels of knowledge about contraception tend to be consistently higher among men than women in both the original study villages and elsewhere in Guatemala.

Among women and men, neither overall levels of ever-use nor overall levels of recent use of contraception vary by current place of residence. Among women, however, the relative frequencies of ever-using and recently using male-controlled methods do vary by residence (with the highest levels of ever- and recent use of these methods being 36% and 17%, respectively, in Guatemala City). Among men, only the relative frequency of ever using female-controlled methods varies by residence (with the lowest level of ever-use of these methods being 64% among residents in the original villages).

Regarding reproductive histories of women and men, mean age at first birth, number of pregnancies, and number of living children all vary significantly by place of current residence. Both female and male migrants to Guatemala City, respectively, tend to be older at first birth (21.7 and 24.1 years), to have experienced (or to have had a partner experience) fewer pregnancies (3 and 3), and to have fewer living children (3 and 2). In addition, the percentage of respondents who experienced a child death differs significantly by place of residence among women, with the lowest percentage having experienced this event in Guatemala City (15%).

Although not shown, some differences in patterns of fertility were apparent by study village, especially among women. The percentage of women who are currently married is higher in Espíritu Santo and San Juan (see Quisumbing, et al. [23] for extensive discussion of marriage patterns), and women who were born in Espíritu Santo had their first child later, had fewer pregnancies and less often had living children when compared with the other three study villages. Interestingly, age at menarche was earlier among women from Espíritu Santo. There also are significant village-level differences in the percentage of women who had at least one stillbirth or child death, the least being in Espíritu Santo (22%) and highest in San Juan (35%).

Data on complications during pregnancy, during delivery, and with the newborn were collected as part of the pregnancy history in women only; using pregnancies as the denominator ($n = 2{,}612$), the prevalences of complications were 21%, 11%, and 6%, respectively. The most common reported complications were threat of abortion, preeclampsia, urinary tract infection, impaired circulation to the neck, poor fetal presentation, and long delivery. In newborns, the most common complication was low birthweight (5%). **Table 4** shows the prevalence of reporting complications by place of current residence. As shown, the relative frequency of reporting complications during delivery differs signifi-

TABLE 3. Reproductive history in the Human Capital Study 2002–04, by current residence and sex

	Women				Men			
Current residence:	Original village or surrounding areas $n = 569$	Guatemala City $n = 149$	Other areas of Guatemala $n = 61$	p^a	Original village or surrounding areas $n = 503$	Guatemala City $n = 101$	Other areas of Guatemala $n = 43$	p^a
Age at menarche (y, mean ± SD)	13.6 ± 1.7	13.5 ± 1.3	13.3 ± 1.5	.3	—	—	—	—
Currently married/in union (%)	75	81	16	.02	75	90	91	< .01
Has any living children (%)	88	88	95	.3	78	93	88	< .01
Know any contraceptive method (%)[b]	84	96	89	< .01	93	98	98	.08
Modern methods (%)	81	95	89	< .01	91	98	98	.01
Traditional methods (%)	33	44	34	.03	50	56	40	.2
Male-controlled methods (%)	55	78	56	< .01	83	96	86	< .01
Female-controlled methods (%)	82	95	85	< .01	75	85	84	.04
Self or partner ever-used any contraceptive method (%)[b]	73	81	72	.13	85	89	86	.6
Modern methods (%)	49	75	67	.2	76	87	77	.06
Traditional methods (%)	17	25	15	.08	27	30	23	.7
Male-controlled methods (%)	25	36	18	< .01	53	62	44	.09
Female-controlled methods (%)	67	20	66	.09	64	76	72	.04
Self or partner used contraceptive methods in last 12 months (%)[b]	59	67	56	.2	71	73	72	.9
Modern method (%)	51	54	51	.8	60	61	58	.9
Traditional method (%)	8	13	3	.07	12	14	16	.7
Male-controlled methods (%)	9	17	3	< .01	21	17	19	.7
Female-controlled methods (%)	51	52	51	1.0	51	60	58	.2
Reported at least one pregnancy	508	135	57		395	95	38	
Planned last pregnancy (%)	48	48	22	< .01	58	50	53	.3
Desired last child (%)	97	93	93	.3	99	99	97	.7
Age when first child born (y, mean ± SD)[c]	20.6 ± 3.7	21.7 ± 4.2	19.7 ± 2.9	< .01	22.9 ± 3.9	24.1 ± 4.1	23.0 ± 3.4	.03
Self or spouse currently pregnant (%)	7	7	2	.3	6	6	3	.7
Number of pregnancies for self or spouse(s) (mean ± SD)	3.7 ± 2.0	3.2 ± 1.9	4.5 ± 2.2	< .01	3.5 ± 1.8	3.0 ± 1.8	4.1 ± 1.9	< .01
Number of children living (mean ± SD)	3.2 ± 1.7	2.6 ± 1.6	3.7 ± 1.8	< .01	2.9 ± 1.5	2.4 ± 1.2	3.6 ± 1.5	< .01
At least one child died (%)	20	15	33	.01	16	13	21	.5
At least one still birth (%)	6	6	9	.7	4	4	5	.9
At least one abortion (%)	18	19	25	.5	21	17	18	.9

a. *p* value for test of heterogeneity between birth interval by one-way ANOVA for continuous variables or chi-square test for categorical variables.

b. Contraceptive methods are classified as (1) modern or traditional and (2) female- (FC) or male-controlled (MC). Modern methods included the use of contraceptive pills (FC), injection (FC), condoms (MC), foam/jellies (FC), intra-uterine devices (FC), Norplant or implants (FC), and male and female sterilization. Traditional methods included rhythm or calendar (FC), method of necklace (FC), breastfeeding (FC), and coitus interruptus or withdrawal (MC).

c. Missing data for 42 women and 10 men due to non-response; 9 additional women experienced one pregnancy that did not result in a live birth.

TABLE 4. Complications of pregnancy, delivery, and in newborn infants of 2,612 pregnancies in 700 women included in the Human Capital Study 2002–04, by current residence

Current residence:	All $n = 2,612$	Original village or surrounding area $n = 1,919$	Guatemala City $n = 433$	Other areas in Guatemala $n = 260$	p^a
Complications during pregnancy (%)					.15
At least one complication	21	20	25	19	
Two or more complications	6	6	8	7	
Complications during delivery (%)					< .01
At least one complication	11	10	13	11	
Two or more complications	1	1	3	2	
Complications of newborns (%)					.04
At least one complication	6	5	7	9	
Two or more complications	2	2	3	1	

a. *p* value for test of heterogeneity across villages of birth or treatment group by one-way ANOVA for continuous variables or Fisher's exact test for categorical variables.

cantly by residence, with both one and two or more complications reported more often in Guatemala City (13% and 3%, respectively). Whether this difference is due to a higher underlying rate of complications with delivery or to a higher rate of *reporting* such complications in Guatemala City is uncertain. The prevalence of complications among newborns also varies by place of residence; fewer women (7%) who are currently residing in the study villages reported at least one newborn complication compared with migrants to Guatemala City (11%).

Discussion

Having children is a major life-cycle event. Most adults desire to have at least one child [24]. National data from many developing countries suggest that, despite increases in the use of contraception and declines in fertility, many people (and perhaps more women than men) continue to bear more children than they desire [25]. For example, in Guatemala the percentage of women of reproductive age who do not desire any more children increased from 47% to 58% between 1987 and 1998/1999 and then declined to 53% in 2002 [17]. As expected, the percentage of women who stated that they had more children than they desired also increased with age, and although there were no differences between urban and rural areas, almost one-third (29%) of women without schooling stated that they had more children than they desired compared with only 7% of women with at least secondary schooling. Although we do not examine some of these issues in this paper, it is notable that whether or not all live-born children are wanted, the birth of each child constrains parental choices, including the extent to which parents are willing and able to invest in each child. These constraints have important implications for the productivity of current parents as well as of their children when they become adults.

Our data have several important similarities and differences as compared with data collected in ENSMI-2002, especially for contraceptive use and age at first birth. For example, reported knowledge of any method of contraception is lower than the national average (93%) or that reported for the northeast region (92%), which includes the department (El Progreso) in which the study villages are located [17]. By contrast, the prevalence of both ever- and recent use of contraception are much higher in the study villages than in the ENSMI–2000 sample. Nearly two-thirds of all women in our study sample reported ever-using any modern method, compared with only 34% and 41% of women aged 15–49 years nationally and in the northeast region, respectively. Age at first birth also was more than a year later for women in our study. Data from ENSMI–2002 show the median age at first birth among women to be 20.3 and 19.4 years in the national and northeast regional samples, respectively [17]. The differences described above could be real, or could simply be a function of the different age ranges of the cohort in the study villages (25–42 years) and ENSMI-2002 samples (15–49 years).

Patterns of age-specific fertility in our sample are comparable to those seen in the nationally representative samples from Guatemala and other countries in Central America, which reveal that fertility remains highest among women aged 20–24 years and declines thereafter. We cannot ascertain whether a real decline in total fertility has occurred across age cohorts in our sample because none of the age cohorts has completed its reproductive lifespan. However, data for Guatemala suggest that rates of fertility in the 25–34-year age range are declining over time. For example, from 1987–92 to 1997–2002, age-specific fertility rates declined from 263 to 216 at ages 25–29 years and from

201 to 158 at ages 30–34 years, respectively. Notably, declines in age-specific fertility rates are *not* seen in the first few years following union, but instead after 5 years of being in union [17].

In conclusion, we have presented in this paper associations between measures of human fertility and a set of stratifying variables including birth cohort, level of parental SES in 1975, and current place of residence. Several associations identified in this paper raise interesting questions for future research; however, the associations presented here may not be causal and likely reflect related changes in several other important dimensions of life such as schooling, marriage, labor markets, and migration that are summarized elsewhere in this issue [23, 26, 27]. For example, the association between current residence and percentage of men with living children (**table 3**) could be due to the higher average age among migrants compared with non-migrants. The challenge in future analysis is to go beyond these associations to elucidate causal paths and investigate how human fertility, as well as other important life-cycle events, fit into the complex web of human behaviors that determine the welfare of people such as the subjects who lived in the study villages in 1969–77 and their children.

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Physical activity level, dietary habits, and alcohol and tobacco use among young Guatemalan adults

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Abstract

Physical activity, diet, and alcohol and tobacco use are all related to the development of obesity, diabetes, coronary heart disease, osteoporosis, and cancer. We examined the distribution of measures of these behaviors in a cohort of individuals born in four villages in Guatemala between 1962 and 1977 and who were 26–41 years old in 2003. Response rates to the instruments averaged 80% of cohort members known to be living in Guatemala. Physical activity levels were moderate, and were lowest among migrants to Guatemala City. Dietary habits reflect early phases of the nutrition transition, with high carbohydrate and moderate fat intakes. Migrants to Guatemala City reported higher intakes of meat and of dairy products, while those remaining in or near the original study villages reported higher consumption of tortillas and of vegetables and fruits. One-third of men reported consuming alcohol and 42% were current smokers. Very few women reported alcohol or tobacco use.

Key words: Guatemala, Institute of Nutrition of Central America and Panama (INCAP), Human Capital Study, alcohol, behavioral risk factors, diet, nutrition transition, physical activity, gender, tobacco

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Introduction

It is increasingly recognized that many developing countries are in the midst of an epidemiologic transition from a situation in which communicable diseases are a leading cause of morbidity and mortality to one where non-communicable diseases dominate [1]. In fact, non-communicable diseases now account for most deaths that occur in the developing world [2]. The simultaneous nutrition, epidemiologic, and demographic transitions have led to worldwide increases in the prevalence of overweight and obesity [3], diabetes [4], and cardiovascular disease [5].

Four sets of behaviors (physical activity, diet, alcohol consumption, and tobacco use) have been closely related to the development of several chronic diseases [6, 7]. Of these, the strongest evidence exists for tobacco use, which is related to several cancers and to coronary heart disease [7]. Energy balance is the major determinant of overweight and obesity, which are related to risk of diabetes, coronary heart disease, and some cancers [6]. Sedentary lifestyle is also an independent risk factor for cardiovascular diseases, diabetes mellitus, osteoporosis, and a few types of cancer [8]. Individual components of the diet have been related to a wide range of outcomes [9]. Moderate alcohol intake, while likely protective for coronary heart disease is nevertheless of concern due to the potential for abuse and intoxication and probable associations with liver and other cancers [9].

Surveillance of the distribution of behaviors that affect risk of disease across populations and over time is a key step in predicting the emergence and impact of future disease, especially in populations as yet too young to manifest clinical symptomatology. Understanding the descriptive characterization and determinants of such behaviors will aid program planners in developing appropriate policies and interventions. In this paper we present the relationship of demographic characteristics, parental socioeconomic status (SES) in childhood and current residential status to the prevalence of four behaviors—physical activity, diet, alcohol consump-

tion, and smoking—among members of a cohort of Guatemalan men and women originally born in one of four villages and studied between 1969 and 1977. A parallel paper in this volume considers the prevalence of biomarkers of risk in this same population [10].

Methods

Individuals selected for this study were born in one of four villages in El Progreso Department, Guatemala, between 1962 and 1977 and had participated between 1969 and 1977 as children in a longitudinal study of nutrition supplementation. Full details of the intervention trial and subsequent rounds of follow-up have been described elsewhere [11]. The present round of follow-up, called the Human Capital Study, was conducted between 2002 and 2004; the cohort was between 26 and 41 years of age in 2003. Full details of participant tracing and recruitment are presented in Grajeda et al [12]. Briefly, of 2,393 individuals in the cohort, 272 (11.4%) had died, 102 (4.3%) were lost to follow-up, and 163 (6.6%) had left the country, resulting in 1,856 individuals living within Guatemala eligible for follow-up. Eligible individuals were contacted at their homes and invited to participate in a series of interviews and physical examinations. In the study villages these were administered over multiple sessions spread over 1 year, while for individuals living outside the study villages all data collection was completed in one or two sessions.

Physical activity

Respondents were asked to complete an activity recall for a typical workday, including periods of sleeping, transition to work, work, and leisure. The respondent was asked for the type and duration of any primary and secondary occupations, which might occur on the same day or on different days. The questionnaire was based on one developed for a previous follow-up of these subjects [13], modified to include greater emphasis on the child-care and domestic duties of women. The questionnaire took 20–30 minutes to administer.

All forms of activity were converted to metabolic equivalents (METS), which are multiples of the basal metabolic rate (BMR), an estimate of baseline minimal energy expenditure [14, 15]. Overall 24-hour physical activity level (PAL-24) of a typical workday was calculated by integrating these metabolic equivalents over the durations of activity. We note that the algorithm we used is modified from that used in prior publications. Differences occur owing to changes in the way leisure-time activity is accounted for, the metabolic equivalent values assigned to specific activities, and the assumptions regarding the relative PAL contribution of the primary and secondary occupation. We defined low physical activity as PAL-24 levels less than 1.66 (men) and 1.60 (women) METS [14].

The reproducibility of the physical activity questionnaire has been ascertained by repeat administration to 17 men and 16 women living in the study villages (mean interval between administrations 4 weeks) who had not changed primary occupation. Mean PAL-24 (calculated using the original algorithm) did not differ across administrations (first: 1.64 ± 0.21 METS, range 1.23–2.05; second: 1.61 ± 0.22 METS, range 1.25–2.12) [16]. The linear correlation between administrations was 0.91($p < .01$). The reproducibility of the instrument has not been assessed in urban populations, and the validity of the questionnaire against an objective measure of physical activity has not been assessed.

Dietary habits

Dietary intakes of 52 foods commonly eaten in Guatemala were ascertained using a food frequency questionnaire developed as part of an earlier study in this population [13, 17]. Respondents were asked to report how often they consumed a given food in terms of occasions per day, week, month, or year, and how many servings they consumed per occasion. Open-ended questions allowed for inclusion of seasonal foods (especially fruits and vegetables) and foods that might not be widely consumed. The time reference was the past 3 months. We converted the frequency of consumption of each food to servings per day. We summed these frequencies across foods within selected food groups, namely vegetables and fruits, dairy products, and meats. Given our interest in the nutrition and epidemiologic transition, an additional category called "transitional" foods was created and included foods likely to be markers of a diet undergoing the nutrition transition, including hamburgers, cake, ice cream, candies or chocolates, pizza, hot dog or other sausage, and potato chips and other snacks. Intakes of foods and food groups were represented as servings per 1000 kilocalories (kcal). By normalizing intakes in terms of servings per 1000 kcal, we take into account any systematic tendencies to over or under-report food intakes, though not differential misreporting by food type [18, 19].

To estimate nutrient intakes we multiplied the servings per day of each food by the weight of a standard serving size (as ascertained in previous studies using 24-hour dietary recalls in this population), and obtained the contribution of the food to total nutrient intake by matching individual line items to food items in the INCAP nutrient composition database. This table is based on direct analysis of foods commonly consumed in Guatemala [20], supplemented with data from the US Department of Agriculture databases [21]. We then summed the nutrient intakes over all foods to derive total daily intakes. In this approach, missing data for a nutrient are converted to zero. We compared

energy intakes to the expected energy requirements given the respondents' age, sex, weight, and PAL using published equations [22]. We computed the contribution of the macronutrients (protein, carbohydrate, and total, saturated, monounsaturated, and polyunsaturated fat) to total energy.

We note that nutrient intakes from the food frequency questionnaire used in this study have been validated against three 24-hour dietary recalls in a group of men and women living in the same four villages [17]. That study showed correlations between the food frequency and the mean of the three dietary recall estimates of intakes of absolute macronutrient intakes to be in the range 0.63–0.71, with the food frequency estimates for total energy being higher by 361 kcal (17.4%) than those for the dietary recalls. Correlation coefficients for energy-adjusted macronutrient intakes were 0.22 for protein, 0.66 for carbohydrate, and 0.70 for fat. The two methods provided substantial agreement with respect to the contribution to total energy intake of a wide range of foods and food groups, with tortillas and bread being the major sources of energy. The instrument has not been validated in urban populations.

Alcohol

Alcohol intake was estimated from responses to two items on the food frequency questionnaire relating to beer and to liquor consumption. Individuals were classified as consumers if they reported any consumption in the past three months. Servings per day were estimated separately for beer and for liquor. Wine consumption was not ascertained as it is not widely consumed in Guatemala.

Smoking

Tobacco use was ascertained during the clinical examination using a standardized questionnaire. We characterized individuals as current smokers or non-smokers (the latter includes also former smokers), and for current smokers the number of cigarettes smoked per day was calculated from answers to questions concerning the number of smoking days per week and the number of cigarettes per smoking day.

Statistical analyses

Means and SDs were calculated by sex, birth year, current residence of the respondent (categorized as living in or near the original village, in Guatemala City, or elsewhere in Guatemala), and SES of the respondent's parental household in 1975 (categorized as tertiles of the distribution of the first component of a principal components analysis model incorporating measures of household assets [23]). All analyses were stratified by respondent sex. For each analysis, we tested for heterogeneity of the distributions through analysis of variance (for continuous variables) or the chi-square test (2-tailed) for categorical variables ($p < 0.01$ was used to assess significance).

Results

The response rate for this component of the survey was 80% with 1,486 individuals completing the food frequency questionnaire and 1,487 respondents completing the physical activity questionnaire. The clinical examination including the tobacco module was completed by 1,349 individuals (73%). As with all modules, completion rates were highest among residents of the study villages (close to 90% response rate), and were lower (~ 60%) among migrants. Overt refusal rates were low, the primary reason for non-completion among migrants being a failure to establish contact [12].

Physical activity and energy intake

The PAL-24 of the men (mean 1.67 ± 0.27 METS) was higher than that of the women (1.44 ± 0.09 METS; $p < .01$; **table 1**). This difference was also apparent when waking-time physical activity level was considered (men: 2.51 ± 0.46 METS; women: 2.21 ± 0.17 METS; $p < .01$). In men, physical activity level was more variable compared with women (test for heterogeneity of variances $p < .01$ for both 24-hour and waking time). In men, PAL-24 did not vary by period of birth (births 1962–68 as compared with births 1969–77; $p > .5$) while women born from 1962–68 reported higher PAL-24

TABLE 1. Energy intakes and physical activity level in the Human Capital Study 2002–04, by sex[a]

Physical activity level[c]	Men (mean ± SD)	Women (mean ± SD)	p[b]
Over 24 hours	1.67 ± 0.27	1.44 ± 0.09	< .01
During waking hours only	2.51 ± 0.46	2.21 ± 0.17	< .01
Energy intake (kcal reported on FFQ)	3,182 ± 981	2,256 ± 712	< .01
Estimated energy requirement based on weight and physical activity[d]	2,742 ± 444	1,970 ± 221	< .01

a. Sample sizes for selected analyses may differ due to item non-response. Estimated energy requirement only calculated for respondents who also underwent the anthropometric assessment (men, $n = 603$; women, $n = 702$).
b. p-value for test of heterogeneity by t-test.
c. Average daily metabolic equivalents expressed as multiples of resting metabolic rate.
d. Estimated from respondent sex, age, PAL, and weight [22].

(1.45 ± 0.10 METS) as compared with women born from 1969–77 (1.43 ± 0.09 METS; $p < .01$); there was no difference in waking-hours physical activity level in men or women ($p > .3$). In men, physical activity level was higher in those resident in the study villages and was lowest among those resident in Guatemala City; men whose parents were in the upper SES tertile in 1975 reported lower physical activity levels than other men. There were no differences by residence or parental SES among women (**table 2**). Just over one half of men (53.6%), and almost all women (94.3%) had a PAL-24 equivalent to very light or light activity. The prevalence of low physical activity was highest among men from households in the upper tertile of parental SES in 1975 (67%) and those living in Guatemala City (82%). Year of birth was not associated with prevalence of low physical activity level in men. Conversely, in women the prevalence of low physical activity level increased from 92% among births in 1962–1965 to 98% among women born in 1974–1977. Among women there was no variation in prevalence of low physical activity level by village of birth, place of residence, or parental SES in 1975.

The higher total physical activity of men as compared with women was attributable in part to both the activity level of the primary occupation and time spent walking. Men had a wider range of primary occupations, many of which entail exertion of over 2 METS. The main occupation of the women in this cohort was household chores and child care (76%), with an assigned value of 1.7 metabolic equivalents. Just over two-thirds of men reported engaging in their primary occupation on 6 or more days per week, whereas 88% of women reported engaging in their primary occupation on 7 days per week. Men currently living in the village of their birth or in nearby villages and men with low or median parental SES in 1975 tended to have more physically demanding primary occupations (see also Hoddinott et al. [24]), while no association of activity level of the primary occupation was found with village of birth or year of birth (not shown).

Men also reported spending more time walking (16.6 ± 24.5 minutes per day) than did women (6.7 ± 13.0, minutes per day; $p < .0001$). For men, reported walking time was primarily time spent commuting to and from their primary and secondary occupations. Relative to men, women were less likely to be engaged in wage employment and more likely to operate their own home-based businesses; hence, commuting time is, on average, less for women. Men living in the study villages spent more time walking than did men living elsewhere, and men born in Santo Domingo reported more walking than men born elsewhere, while year of birth and parental SES in 1975 were not related to time spent walking. In women, time spent walking was not related to village of birth, year of birth, current residence, or parental SES in 1975.

Overall reported energy intakes were 41% higher for men (mean 3,182 ± 981 kcal/day) than for women (2,256 ± 712 kcal/day; $p < .01$ by t-test; **table 1**). Much of this difference was attributable to differences in body weight and PAL. Men reported 440 (13.8%) kcal/day and women reported 286 (12.7%) kcal/day over and above energy requirements as estimated from weight and PAL. Reported energy intakes did not vary by birth year group ($p > .5$ for men and for women) or by parental SES in 1975 (**table 2**). Energy intakes tended to be lower among residents of Guatemala City and higher among residents of the study villages ($p = .04$ and $p = .09$ for heterogeneity across current residence status for men and for women, respectively; **table 2**).

Nutrients and foods

Parallel to the larger absolute intakes of energy, absolute intakes of individuals foods were considerably higher in men compared with women (not shown), contributing also to an overall reported higher absolute intake of macronutrients and of energy among men. A more complex pattern emerges once intakes are expressed as servings per 1000 kcal (**table 3**), with much smaller differences between men and women. As a proportion of their total intake, men report consuming less bread but more tortillas, more "transitional" foods and soda, but less dairy products, meat, and fruits and vegetables (all $p < .01$).

The macronutrient composition of the diet is characterized by moderate protein intakes (12% of energy), a heavy reliance on carbohydrates (69%–70% of energy), and moderate intakes of fat (18%–19% of energy). The differences in macronutrient composition between men and women were small ($p < .01$ for carbohydrate and protein, $p > .1$ for fat). The fat intake is approximately equally distributed among saturated, monounsaturated, and polyunsaturated fats.

Food consumption and nutrient density of the diet did not vary across year of birth among either men or women, except for consumption of "transitional" foods, which were more frequently consumed by men born from 1969–77 (0.4 ± 0.5 servings per 1000 kcal per day) as compared with men born from 1962–68 (0.3 ± 0.4 servings per 1000 kcal per day; $p < .01$)

There was greater heterogeneity of food consumption patterns by current residence for men as compared with women (**table 3**). Male residents of Guatemala City reported higher consumption of meat and soda compared with those remaining in the original study villages, and female residents of Guatemala City reported higher consumption of bread, milk products, and meat. Intakes of "transitional" foods did not vary by current residence status.

In men, higher parental SES in 1975 was associated with lower consumption of tortillas, and higher consumption of milk products and meat in adulthood; in

TABLE 2. Energy intakes and physical activity level[a] in the Human Capital Study 2002–04, by current residence and parental socioeconomic tertile in 1975 and by sex (mean ± SD)

	Men				Women			
Current residence:	In or near original village	In Guatemala City	Elsewhere in Guatemala	p^b	In or near original village	In Guatemala City	Elsewhere in Guatemala	p^b
Sample size[a]	552	101	44		583	145	61	
Physical activity level[c]								
Over 24 hours	1.70 ± .27	1.53 ± .23	1.62 ± .24	< .01	1.43 ± .09	1.46 ± .10	1.45 ± .09	.02
During waking hours only	2.56 ± .45	2.26 ± .37	2.42 ± .50	< .01	2.21 ± .18	2.21 ± .17	2.22 ± .16	.9
Energy intake (kcal)	3,228 ± 979	2,970 ± 1,008	3,086 ± 891	.04	2286 ± 703	2,141 ± 641	2,239 ± 917	.09
Estimated energy requirement[d]	2,775 ± 448 (464)	2,592 ± 397 (95)	2,715 ± 448 (43)	< .01	1961 ± 231 (511)	2,002 ± 191 (132)	1,978 ± 190 (59)	.2
Parental socioeconomic tertile:	Low	Median	High	Missing	Low	Median	High	Missing
Sample size[a]	216	234	201	46	254	233	233	69
Physical activity level[c]								
Over 24 hours	1.72 ± .26	1.69 ± .27	1.60 ± .27	1.68 ± .27	< .01	1.44 ± .09	1.43 ± .08	1.44 ± .11	1.46 ± .11	0.5
During waking hours only	2.57 ± .45	2.57 ± .47	2.37 ± .42	2.50 ± .48	< .01	2.21 ± .17	2.21 ± .15	2.21 ± .20	2.23 ± .17	0.99
Energy intake (kcal)	3,179 ± 1,032	3,135 ± 935	3,285 ± 1011	2,981 ± 802	.3	2,287 ± 744	2,205 ± 668	2,302 ± 727	2,160 ± 678	0.3
Estimated energy requirement[d]	2,802 ± 440 (190)	2,756 ± 445 (198)	2,661 ± 429 (172)	2,733 ± 487 (43)	< .01	1,955 ± 207 (227)	1,975 ± 199 (206)	1,987 ± 262 (202)	1,957 ± 196 (67)	0.3

a. Sample sizes for selected analyses may differ due to item non-response. Estimated energy requirements only calculated for respondents who also underwent the anthropometric assessment (sample sizes in parentheses).
b. p-value for test of heterogeneity by one-way ANOVA; p-value for parental SES in 1975 calculated after exclusion of individuals with missing values.
c. Average daily metabolic equivalents expressed as multiples of resting metabolic rate.
d. Estimated from respondent sex, age, PAL, and weight [22].

TABLE 3. Intakes of selected nutrients and foods in the preceding three months[a], as assessed by food frequency in the Human Capital Study 2002–04, by current residence and sex[b]

	Men					Women				
Current residence:	All men $n = 697$	In or near original village $n = 552$	In Guatemala City $n = 101$	Elsewhere in Guatemala $n = 44$	p^c	All women $n = 789$	In or near original village $n = 583$	In Guatemala City $n = 145$	Elsewhere in Guatemala $n = 61$	p^c
Foods and food groups (servings per 1000 kcal per day)										
Bread	1.3 ± .9	1.3 ± .9	1.2 ± .9	1.0 ± .9	.1	1.5 ± 1.0	1.4 ± 1.0	1.8 ± 1.2	1.2 ± .8	< .01
Tortillas	3.9 ± 1.3	3.9 ± 1.2	3.9 ± 1.4	4.7 ± 1.5	< .01	3.6 ± 1.4	3.6 ± 1.3	3.6 ± 1.6	4.0 ± 1.8	.07
Nutrition transition foods[d]	.4 ± .4	.4 ± .5	.3 ± .4	.4 ± .4	.7	.3 ± .4	.3 ± .4	.2 ± .3	.2 ± .4	.2
Milk products	.4 ± .4	.4 ± .4	.5 ± .4	.4 ± .5	.05	.5 ± .4	.5 ± .4	.6 ± .5	.6 ± .5	.04
Vegetable & Fruit	1.4 ± 1.2	1.4 ± 1.2	1.4 ± 1.0	1.0±1.2	.05	1.5±1.3	1.6 ± 1.2	1.5±1.3	1.3 ± 1.2	.4
Meat	. 5± .3	.5 ± .3	.6 ± .5	0.4±0.4	< .01	.6 ± .4	.5 ± .4	0.7±0.5	.6 ± .5	< .01
Soda	.8 ± .5	.8 ± .5	.9 ± .5	0.9±0.5	< .01	.7 ± .5	.7 ± .5	0.7±0.5	.7± .5	.6
Nutrient density (% of energy)										
Protein	11.9 ± 1.6	11.8 ± 1.6	12.2 ± 1.8	12.1 ± 1.8	.06	12.3 ± 1.7	12.2 ± 1.6	12.5±2.1	12.5 ± 1.9	.2
Carbohydrate	69.7 ± 5.3	69.8 ± 5.1	68.6 ± 5.7	71.1 ± 6.4	.03	69 ± 5.8	69.1 ± 5.4	68.3±6.2	69.3 ± 7.5	.3
Fat	18.3 ± 4.5	18.3 ± 4.4	19.1 ± 4.5	16.8 ± 5.3	.02	18.7 ± 5	18.7 ± 4.8	19.2±4.9	18.1 ± 6.5	.3
Saturated fat	4.8 ± 2.1	4.8 ± 2.2	5.4 ± 1.9	4.3 ± 2.1	.01	5 ± 2	5 ± 2	5.3±2.2	5.1 ± 2.5	.2
Monounsaturated fat	5. 6± 1.6	5.6 ± 1.6	6.1 ± 1.7	5.1 ± 1.8	< .01	5.7 ± 1.8	5.7 ± 1.7	5.8±1.9	5.7 ± 2.2	.8
Polyunsaturated fat	3.9 ± 1.0	3.8 ± 1.0	3.8 ± 1.0	4.1 ± 1.4	.3	3.7 ± 1	3.7 ± 1	3.6±1.0	3.7 ± 1	.3

a. All data presented as mean ± SD.
b. Sample sizes for individual variables may differ slightly due to item non-response.
c. *p*-value for test of heterogeneity within males and females separately, by one way analysis of variance.
d. Nutrition transition foods include: hamburger, cake, ice cream, candies or chocolates, pizza, hot dog or other sausage, and potato chips and other snacks

women, higher parental SES in 1975 was associated with higher consumption of bread and fruits and vegetables, and with lower consumption of tortillas (**table 4**). There was no difference by parental SES in 1975 with respect to consumption of transitional foods in adulthood. In men but not women, saturated fat, expressed as a percentage of energy, was correspondingly higher among respondents from households with higher parental SES in 1975, with similar but weaker trends noted for total fat and monounsaturated fats, and an inverse trend observed for polyunsaturated fat.

Alcohol

Alcohol consumption was reported by 33% of men and by 2% of women (**table 5**). Among the 218 men who reported consuming beer in the three months prior to the survey, mean consumption was 0.9 servings per day. For liquor, mean consumption was 1.5 servings per day among 45 men who reported any consumption. No women reported consumption of liquor. Among men, alcohol consumption varied little by birth year group ($p > .8$) or parental SES in 1975 ($p > .2$), but was lowest (13.6%) among respondents living elsewhere in Guatemala, as compared with those living in or near the villages (34.6%) or in Guatemala City (30.7%; $p < .02$ for test of heterogeneity). Too few women reported consuming alcohol to permit meaningful comparisons across categories of the stratifying variables.

Smoking

Tobacco use was reported by 42% of men in the sample and was rare among women, with only 12 women (1.6%) reporting current smoking; therefore, further analysis of trends among smokers was restricted to males. Fifty-five men (22% of smokers) reported smoking less than 1 day each week, another 67 men (27% of smokers) reported smoking 1 or 2 days per week, and 98 men (39% of smokers) report smoking daily. Typical daily cigarette consumption is low, with 194 men (78% of smokers) reporting consumption of three or fewer cigarettes on days that they do smoke; only 15 men reported smoking 10 or more cigarettes per day. Given the low frequency of reported cigarette use, few meaningful differences in smoking frequency were observed.

Discussion

In this paper we have presented the distribution of four sets of behaviors (physical activity, diet, alcohol consumption, and smoking) that are related to the risk of developing a wide range of chronic diseases and are markers of the stage of the nutrition and epidemiologic transition. Physical activity levels are low overall, and are lower among women than among men. With respect to diet, the macronutrient composition, as ascertained by this instrument, is characterized by heavy dependence on carbohydrates and moderately low fat intakes, low fruit and vegetable intakes, and some penetration of high-caloric density commercial foods. Alcohol and tobacco use patterns are strongly gender differentiated, with 30%–40% of men and virtually no women reporting use of either.

Diet, physical activity, and tobacco use were assessed in the younger members of this cohort living in the original study villages or in Guatemala City in 1997–98 using the same instruments as in the present study [13]. In the 1997–98 study, PAL-24 (estimated using the original algorithm) was 1.63 among men and 1.52 among women. Total fat intake was 21% and 19% for residents of Guatemala City and the villages, respectively. Smoking prevalence was 41% and 37% among men in urban and rural areas, respectively. These data are consistent with findings in the recent study and suggest substantial stability of behaviors over the intervening years.

In the case of both men and women, estimated food intakes exceed estimated energy requirements adjusted for physical activity level and body size by approximately 13%. While some, but not all, of the differences between men and women in absolute reported intakes are consistent with differences in energy needs (and indeed it is also likely that a substantial fraction of this cohort is in positive energy balance and is gaining weight [10]), we note that over-reporting by men relative to women was observed in an earlier round of data collection in these communities [13], and in both the food frequency questionnaire and in 24-hour recalls administered to village residents during the instrument validation study [17], although in neither of those studies was energy intake adjusted for PAL and body size. We suggest, therefore, that comparisons across sexes of absolute levels of intake of nutrients or foods are not meaningful, and that comparisons with other populations should be considered only after adjustment for PAL and body size. Within-sex analyses in our data are less subject to this bias. The database available does not permit derivation of intakes of free sugars, and the questionnaire was not developed to assess sodium intakes, as discretionary addition of salt was not ascertained.

All the data reported here are self-reported and as such are limited by the precision of the instruments and the potential for respondent bias. Further sources of error in the data management phase include missing and erroneous entries in the nutrient composition databases and in the assigning of metabolic equivalents to specific activities. Our assumptions with regard to the assignment of time to primary and secondary occupations, while rule-based and consistently applied to all respondents, may have introduced systematic or

TABLE 4. Intakes of selected nutrients and foods in the preceding three months[a], as assessed by food frequency in the Human Capital Study 2002–04, by parental socioeconomic tertile in 1975[b] and by sex[b]

Parental socioeconomic tertile:	Men					Women				
	Low $n = 216$	Middle $n = 234$	High $n = 201$	Missing $n = 46$	p^c	Low $n = 254$	Middle $n = 233$	High $n = 233$	Missing $n = 69$	p^c
Foods and food groups (servings per 1000 kcal per day)										
Bread	1.2 ± .8	1.3 ± .8	1.3 ± 1	1.3 ± 1.1	.4	1.5 ± .9	1.3 ± .9	1.7 ± 1.1	1.5 ± 1.1	< .01
Tortillas	4.1 ± 1.2	3.9 ± 1.2	3.7 ± 1.3	4.2 ± 1.5	< .01	3.8 ± 1.4	3.6 ± 1.3	3.4 ± 1.4	3.8 ± 1.6	< .01
Nutrition transition foods*d*	.4 ± .5	.4 ± 0.4	.4 ± .4	.3 ± .4	.7	.2 ± .4	.2 ± .4	.3 ± .4	.2 ± .4	.4
Milk products	.4 ± .3	.4 ± .4	.5 ± .4	.4 ± .4	.01	.5 ± .4	.5 ± .5	.5 ± .4	.5 ± .5	.06
Vegetables and fruits	1.3 ± 1.3	1.4 ± 1.1	1.5 ± 1.2	1 ± .8	.4	1.3 ± 1.1	1.7 ± 1.3	1.7 ± 1.4	1.2 ± 1.2	< .01
Meat	.5 ± .3	.5 ± .3	.6 ± .4	.5 ± .4	< .01	.5 ± .4	.6 ± .4	.6 ± .5	.5 ± .4	.05
Soda	.8 ± .4	.8 ± .5	.8 ± .5	1 ± .6	.3	.7 ± .5	.7 ± .5	.8 ± .6	.7 ± .5	.2
Nutrient density (% of energy)										
Protein	11.9 ± 1.6	11.8 ± 1.5	12 ± 1.7	12 ± 1.7	.4	12.4 ± 1.7	12.2 ± 1.6	12.3 ± 1.9	12.2 ± 1.8	.7
Carbohydrate	69.9 ± 5.4	70.1 ± 4.9	68.9 ± 5.5	70.9 ± 5.3	.04	68.8 ± 5.8	69.5 ± 5.3	68.4 ± 5.9	70 ± 6.7	.1
Fat	18.2 ± 4.6	18.1 ± 4.2	19.1 ± 4.8	17.1 ± 4.3	.04	18.9 ± 5	18.3 ± 4.7	19.3 ± 4.8	17.9 ± 6.1	.09
Saturated fat	4.6 ± 1.7	4.8 ± 1.7	5.2 ± 2.9	4.7 ± 1.8	< .01	5 ± 2	5 ± 2	5.2 ± 1.9	4.7 ± 2.5	.3
Monounsaturated fat	5.5 ± 1.6	5.6 ± 1.6	5.9 ± 1.7	5.3 ± 1.6	.03	5.7 ± 1.8	5.7 ± 1.7	5.8 ± 1.7	5.4 ± 2.2	.6
Polyunsaturated fat	4.1 ± 1.2	3.8 ± .9	3.8 ± .9	3.7 ± .8	< .01	3.7 ± 1	3.7 ± 1	3.6 ± 1	3.5 ± 1	.4

a. All data presented as mean ± SD.
b. Sample sizes for individual variables may differ slightly due to item non-response.
c. *p*-value for test of heterogeneity by one-way ANOVA.
d. Nutrition transition foods include: hamburger, cake, ice cream, candies or chocolates, pizza, hot dog or other sausage, and potato chips and other snacks.

TABLE 5. Alcohol and tobacco use in the Human Capital Study 2002–04, by sex[a]

	Men	Women	p^b
Alcohol intake			
Any alcohol (%)	32.7 ($n = 697$)	2 ($n = 789$)	< .01
Beer (servings/day)[c]	.9 ± 1.1 ($n = 218$)	.5 ± .8 ($n = 14$)	.2
Liquor (servings/day)	1.5 ± 2 ($n = 45$)	(—)[d]	
Tobacco use			
Current smokers (%)	41.8 ($n = 567$)	1.6 ($n = 734$)	< .01
Cigarettes per day	2.2 ± 4.4 ($n = 237$)	1.6 ± 2.1 ($n = 12$)	.7

a. All data presented as mean ± SD, except where noted. Sample sizes in parentheses.
b. p value by *t*-test or chi square, as appropriate.
c. Beer and liquor frequency only calculated for those reporting non-zero consumption in past 3 months. No women reported consuming liquor. Cigarette frequency only reported for current smokers.
d. No women reported consuming liquor.

differential biases that are not detectable in the absence of an objective measure. Hence, we urge caution in inferring that our sample (the women in particular) is highly sedentary, as we are unable to calibrate our physical activity levels to those observed in other studies. As a check on our results, we also estimated PAL-24 using the original algorithm as developed for the 1997–98 study. For men, the Pearson correlation between PAL-24 calculated using the original and the modified algorithms is 0.82 ($p < .01$), suggesting that the modified algorithm results in little change in either PAL levels or rank-ordering of individuals. However, the Pearson correlation for women is lower, 0.35 ($p < .01$). For many women, two activities are a prominent part of their daily life, household chores and child care. Neither are associated with high metabolic equivalents, but collectively these account for much of their waking activities. With little true variance in energy expenditure, small differences in the way these are accounted for in the algorithm can generate variability in the measurement of PAL.

While there were differences in dietary patterns between residents of the villages and of the migrants to Guatemala City, we were unable to demonstrate marked differences between these groups of respondents with respect to the consumption of a set of "transitional" foods. This may reflect the limitations of the set of foods included, which may not capture the diversity of commercial foods available in the urban environment. It may also reflect the fact that these villages are no longer isolated from the outside world, and commercial foods are widely available within the villages, whether brought in by individuals who commute to work in nearby towns or in Guatemala City, or through purchase in any of several stores scattered throughout the villages.

Findings with respect to dietary patterns and physical activity levels need to be considered in conjunction with considerations of occupational choices and anthropometry and the impact of these factors on the metabolic profile. The differences in physical activity level between men and women, and among men across strata of current residence and parental SES in 1975 are largely explained by difference in the physical activity expended during work. This finding is consistent with results from a separate module administered on economic activities that showed that the highest proportions of men engaged in sedentary work activities (such as clerical or administrative work) was highest in Guatemala City and among those whose parents were in the highest SES tertile [24].The strong gender differentiation of alcohol and tobacco use patterns has been widely observed in traditional societies. The relatively low prevalence of tobacco and alcohol use in the men of our cohort may reflect the high penetrance of evangelical Protestant beliefs, and may also reflect the cost of these items relative to income. Further research will be required to address this important question in detail.

In conclusion, the population is characterized by diets that are at an early stage of the nutrition transition and by moderately low physical activity levels. Alcohol and tobacco use are restricted to males, and are at low levels. Residents of Guatemala City appear to be further along the nutritional transition than are residents of the original villages or migrants to other parts of Guatemala.

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Physical fitness, body composition, blood pressure, and blood metabolic profile among young Guatemalan adults

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Abstract

We assessed the distribution of several risk factors related to health: muscular strength (handgrip strength), cardiovascular endurance (step test), flexibility (sit and reach test), anthropometry and body composition, blood pressure, fasting plasma glucose, lipid profile, and hemoglobin in a cohort of Guatemalan adults who were born in four rural villages between 1962 and 1977. By 2002 approximately 32% had migrated to Guatemala City or elsewhere in the country. Men are more physically fit and leaner than women. Fatness, poor physical fitness, and metabolic syndrome are highly prevalent in women living in both rural and urban areas. Risk profiles worsen with increasing age. Men who migrated to Guatemala City have lower physical fitness, greater fatness and systolic blood pressure, and worse lipid profile than men who still live in their original villages. Such a pattern was not evident in women, except that blood pressure was higher in urban women than in women who lived in their original villages.

Key words: Guatemala, Institute of Nutrition of Central America and Panama (INCAP), Human Capital Study, cholesterol, blood pressure, diabetes mellitus, glucose, body composition, fitness, $\dot{V}O_2max$

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Introduction

The epidemiologic, demographic, and nutrition transitions experienced by most developing countries are rapidly increasing morbidity and mortality rates due to non-communicable diseases, particularly cardiovascular diseases (CVD). According to the World Health Report 2004, in 2002 29.3% of the world's mortality was due to CVD [1]. Sixty-two percent of those deaths occurred in developing countries and by 2025, 75% of deaths from CVD and diabetes mellitus are expected to occur in these nations [1, 2]. CVD is already the main cause of death in Central American countries apart from Guatemala, where it is the second leading cause, after infectious diseases [3, 4].

Unfortunately, there is a paucity of data on the prevalence of CVD risk factors in much of the developing world [2]. With respect to obesity, among women of reproductive age and children under 5 years old, using anthropometric data collected in national Demographic and Health Surveys, it has been established that obesity is a significant problem in developing countries, particularly in urban areas [5–7]. Several pathways link urbanization to increased rates of chronic diseases [8].

Guatemala is a country suffering a double burden of disease with a recent initiation of the epidemiologic transition. The ratio of non-communicable to communicable causes of mortality increased from 0.25 to 0.76 between 1986 and 1999 [4]. An earlier report based on a portion of the present study population who were studied in 1997–98 showed that a high proportion of rural and urban women were overweight and sedentary and migration to the city increased the CVD risk of men [9]. This study updates and extends that report on body composition, blood pressure, and blood glucose and lipid profiles. The present follow-up provides a larger sample size, a wider age range, and data on a wider range of measures, including physical fitness and metabolic syndrome. Another paper in this volume includes data on behavioral risk factors for CVD, including physical activity, diet, alcohol consumption, and smoking [10].

Methods

Research design, data source, and study sample

Data were collected as part of the Human Capital Study 2002–04, a follow-up of a longitudinal growth and development study conducted by the Institute of Nutrition of Central America and Panama (INCAP) between 1969 and 1977, in four villages in Eastern Guatemala [11]. In 2002, we attempted to trace all 2,393 individuals who had participated as children. Of the 2,393 former subjects, 272 had died, 102 were considered untraceable, and 163 had migrated out of the country. The target subject population thus consisted of 1,856 (77%) subjects known to be living in Guatemala (26–41 years of age in 2003). Of these, 68% reside in or near their native villages, 23% live in Guatemala City, and 9% live in other towns in Guatemala. Full details on subject tracing and contact, and a discussion of attrition of cohort members, are provided elsewhere [11].

All individuals who could be contacted were invited to participate. The study protocol was approved by institutional review boards at INCAP, Emory University, and the International Food Policy Research Institute (IFPRI), and all participants provided written consent. A field team consisting of two physicians and four field workers collected all biomedical data. The field workers obtained anthropometric measurements at each subject's home. The physicians carried out a physical exam that included blood pressure measurement, assessment of physical fitness, and obtaining a finger-stick whole-blood sample. All biomedical data were collected at INCAP facilities in the study villages, at INCAP headquarters in Guatemala City, or at the homes of the migrants.

Physical fitness

Muscular strength was assessed using an isometric handgrip strength test. Handgrip strength correlates with total strength of 22 other muscles of the body [12]. The test was performed using a Lafayette dynamometer (Model 78010, Lafayette Instrument Co., Lafayette, Ind.), with the subject in the standing position, head facing straight ahead, the subject's forearm at any angle between 90° and 180° of the upper arm, and wrist and forearm at the mid-prone position. All subjects were asked to exert a maximal and quick handgrip. Two trials were allowed alternatively with each hand, with at least 30 seconds between trials. The maximal values of the dominant and non-dominant hands, expressed in Newtons, were recorded. We calculated weight-adjusted grip strength by dividing the sum of values for each hand by body weight [13].

Cardiovascular endurance was assessed using a modified Harvard step test [14]. Subjects were instructed to avoid stimulants (tobacco, coffee, colas, chocolate, etc.) and any heavy meal within 3 hours of the test. A 40-cm height step-box was used for men and a 33-cm height was used for women. The step rate was 22.5 steps per minute and the duration of the test was 5 minutes. A metronome was set to 90 beats per minute. All subjects were encouraged to keep cadence and to finish the test. The subject sat down immediately upon completion of test and the heart rate was registered for 15 seconds, starting 15 seconds after completion of the exercise (5:15 to 5:30), using a heart rate monitor (Polar, Model Advantage XL, Finland). The carotid pulse was also obtained. Maximal oxygen consumption, expressed in ml/kg/min, was calculated from exercise recovery heart rate according to published algorithms [14].

The sit-and-reach test was used to assess flexibility of the hamstrings, lower back, buttocks, and calf muscles, according to the method described by the American Alliance for Health, Physical Education, Recreation, and Dance (AAHPERD) [15]. The test apparatus was a wooden box with a measuring scale (cm) on its upper surface. The 23rd-cm line was exactly in line with the vertical plane of the subject's soles and heels against the front edge of the box. The technician asked each subject to remove their shoes, then sit on the floor with their feet against the box, keeping legs fully extended, and feet about shoulder-width apart. The technician held one hand on the subject's knees while the participant bent forward as much as he/she could, with arms extended and hands placed on top of each other. Four trials were allowed and the maximal value was registered in cm.

Anthropometry and body composition

Body weight, height, and waist circumference were measured using standard methods [16]. Weight was measured on subjects dressed in their normal underclothes with no shoes or objects in their pockets. The measure was taken using a digital scale (model 1582, Tanita®, Japan) with a precision of 100 grams. Height was measured to the nearest 0.1 cm, with the subjects bare footed, standing with their backs to a stadiometer (GPM, Switzerland). Waist circumference was measured at the umbilicus using a plastic inextensible measuring tape to the nearest 0.1 cm. All measurements were done twice. If the difference between the two first measurements was greater than 0.5 kg for body weight, 1.0 cm for height, or 1.5 cm for waist circumference, a third measurement was done and the two closest measurements were used. The mean of each measure was calculated. BMI was computed as weight (kg) divided by height squared (m^2). Overweight was defined as a BMI between 25.0 and 29.9 and obesity as a BMI equal or greater than 30.0 kg/m^2. Percent body fat and fat free mass was estimated using predictive equations derived from a similar population using weight, height, and

waist circumference in women and weight and waist circumference in men (non-published data).

Blood pressure

Three measurements of blood pressure were taken using a digital sphygmomanometer (OMRON, Model UA-767; A & D Medical, Milpitas, CA), according to procedures described by the Pan American Hypertension Initiative in 2003 [17]. Sphygmomanometers were periodically checked for precision and accuracy. Participants were instructed to refrain from tobacco products, alcohol or caffeine in the 30 minutes preceding the measurement. Each participant sat quietly, with the left arm resting in a flat surface (arm at the level of the heart), for at least 5 minutes before the first measurement. Measurements were done at 3- to 5-min intervals. When the 2nd and 3rd measures (either systolic or diastolic pressure) did not coincide within 10 mm Hg, a fourth measurement was taken. The average of the second and third measurements was registered. If a fourth measurement was needed, the two closest readings were averaged. Blood pressure was categorized according to the classification given by the National High Blood Pressure Education Program of the United States [18]. Subjects with known hypertension were also included in the hypertension group.

Plasma glucose and lipid profile

A whole-blood sample was obtained by finger prick after an overnight fast. Plasma glucose and lipid profile were determined with an enzymatic/peroxidase dry chemistry method (Cholestech LDX System, Hayward, CA). Lipid values were calibrated against a venous blood assay at Emory University's Lipid Research Laboratory [19]. LDL cholesterol (LDL-C) concentration was calculated using Friedewald's equation. Hemoglobin concentration was measured using a portable photometer (Hemocue AB TM, Angelholm, Sweden) and anemia rates were adjusted by age, gender, and altitude. Impaired fasting glucose was defined as a plasma glucose concentration between 110 and 125 mg/dL and diabetes mellitus equal or greater than 126 mg/dL [20]. All subjects with known diabetes were also included in the latter group. Blood lipid cut-off values and metabolic syndrome were defined according to the Third Report of the US National Cholesterol Education Program [21]. Finally, anemia was defined as a hemoglobin concentration < 12.0 mg/dL for women and < 13.6 mg/dL for men, adjusted by altitude and age [22]. The blood glucose concentration of one woman who fasted for < 5 hours, and blood lipids concentrations of 60 men and 65 women who fasted for < 8 hours, were excluded from analysis.

Statistical analysis

Mean and SDs for continuous variables and percentages for categorical ones are given by gender, birth cohort, current residence (categorized as living in or near the original village, in Guatemala City, or elsewhere in Guatemala), and socioeconomic status (SES) of the respondent's parental household in 1975 (categorized as tertiles of the distribution of the first component of a principal components analysis model incorporating measures of household assets) [23]. All analyses were stratified by gender. We tested for differences among groups using ANOVA and *t*-test for continuous variables and χ^2 for categorical variables; $p < .05$ was used to assess significance.

Results

Muscular strength, anthropometry, and blood pressure measurements were successfully assessed in 1,312, 1,309, and 1,420 subjects, respectively, yielding a response rate between 61% and 69% in men, and between 76% and 85% in women. The flexibility, cardiovascular endurance, and blood tests were accepted and completed by fewer subjects (response rates between 52% and 58% in men, and between 61% and 77% in women). Overall, the completion rates for these modules were lower than those for other parts of the study, particularly for men in the original study villages.

Table 1 stratifies by gender and birth year for all the studied variables. Men have significantly greater physical fitness (strength, cardiovascular endurance, and flexibility) and lower indicators of fatness (BMI, waist circumference, and % fat) than do women. The step test was started but not completed (< 5 minutes) by 4% of men and 24% of women. Mean systolic and diastolic blood pressure are higher in men than women, as are the proportions of subjects classified as having pre-hypertension and hypertension. There are no differences between men and women in plasma glucose and impaired glucose levels, and the prevalence of metabolic syndrome is twice as high in women as compared with men. Strength adjusted by weight decreases with age in men, whereas cardiovascular endurance diminishes with age in women. Fatness increases with age in men, but not in women. The metabolic profile and blood pressure also deteriorate with age in both genders. This is evident for systolic blood pressure, plasma glucose, and metabolic syndrome in women, and diastolic blood pressure, total cholesterol, triglycerides, and LDL-C in both genders.

Men living in their original village are fitter, leaner, and have lower blood pressure and better lipid profile than men living in Guatemala City (**table 2**). By contrast, differences are not as striking across these measures among women living in different settings, except

for blood pressure, which is lower in women living in villages as compared with women living in Guatemala City or elsewhere in Guatemala. All differences persist after adjusting for age. Amongst individuals living in villages, men and women living in Espíritu Santo have greater cardiovascular endurance and flexibility as compared with men and women in the other villages ($p < .05$).

In relation to respondent's parental SES in 1975, men and women in the highest tertile of parental SES have greater height and fat free mass than the other groups ($p < .05$). Women in the lowest parental SES group have greater flexibility ($p < .05$), and lower LDL concentration ($p < .05$) than women in the other SES groups (not shown).

Discussion

A small difference in age (7 ± 3 years between birth cohorts) is sufficient to generate observable disparities in CVD risk profiles, which deteriorate with age. A very high proportion of women are overweight or obese (62%, mean percent fat = 39 ± 5, 91.6% with high waist circumference), regardless of age and with no differences between women living in their original villages (rural setting, 65%, mean percent fat = 39 ± 6, 91.0% with high waist circumference) and women living in Guatemala City (urban setting, 62%, mean percent fat = 38 ± 5, 91.4% with high waist circumference). The high prevalence of fatness seems to be recent, because a sample studied 5 years ago, at age 19–29 years showed that only 24% of women were overweight or obese, compared with 65% in the younger group in the present study, who are now 26–34 years old [9]. This increment in fatness has started to modify other CVD risk factors, reflected by the metabolic syndrome that is already present in one-third of women. In the case of men, although the proportion who are overweight or obese is less than that observed in women (41%, mean percent fat 26 ± 5), it has increased just as quickly (the study based on data 5 years ago reported that 11% of men were overweight or obese) [9]. One important result in men is that those living in their birth villages have significantly better CVD risk profiles than those living in Guatemala City (**table 2**).

The data on diet and physical activity level (PAL) reported elsewhere in this supplement [10] are consistent with our results. In men, those who live in the villages are not only leaner and more fit, but also have higher PAL, mainly related to more physically demanding primary occupations. Relative to men, women are less likely to be engaged in wage employment or own-agriculture and more likely to operate their own home-based businesses and their PAL values were low. Furthermore, all men and women seem to be in positive energy balance (they report greater energy dietary intake than PAL) [10], which may explain the high proportions of overweight and obese subjects. These suggestive results indicate links between occupation and CVD risk. More research is needed in this area.

The 2002 Guatemalan Maternal and Child Health National Survey showed that 13.8% of women (15–49 years old) and 6.8% of men (15–59 years old) are obese nationwide, and 18.0% and 4.7% in the geographical region where the original study villages are situated [24]. In an urban municipality of Guatemala (Villa Nueva) 18% and 9% of women and men (20–39 years old) are obese (personal communication, M. Ramírez-Zea). These data are broadly consistent with results presented here with disparities possibly related to the differences in the age groups studied. The Villa Nueva study also shows similar proportions of other CVD risk factors for men and women as compared with the proportions described in this paper for residents in Guatemala City (hypertension 4% and 4%, diabetes 6% and 2%, high total cholesterol 36% and 23%, metabolic syndrome 9% and 21%) (personal communication, M. Ramírez-Zea). While the population studied in the current paper is not representative at the regional or national level, the correspondence with other data is reassuring.

Cardiovascular endurance should be considered a CVD risk factor, distinct from physical inactivity, since the reduction in relative risk is nearly twice as great for cardiovascular endurance than for physical activity [25]. If we classify those who did not complete the step test as having poor fitness, 20% of men and 47% of women had a low cardiovascular fitness level when compared against a reference population from a developed country [26]. Unfortunately, there is a lack of data on similar populations and on the validity of the association among CVD risk and cardiovascular fitness and other physical fitness components (e.g., muscular strength and flexibility) in different ethnic groups.

People who maintain their muscular strength and flexibility are more likely to accomplish daily activities, have less risk of developing low-back pain and other muscle, tendon, and joint injuries, and have better balance, coordination, and agility, which in turn may help to prevent falls [27, 28]. Resistance training has effects similar to those of cardiovascular endurance training on bone mineral density, glucose tolerance, and insulin sensitivity [29]. When compared with a US population, men in the present study have lower muscular strength (age-adjusted median handgrip strength at the 30th percentile) and women higher (age-adjusted median handgrip strength at the 60th percentile) [13]. By contrast, 54% of women and 25% of men are below the average category for flexibility of norms developed in Canada [30]. These results suggest that the studied population is at elevated risk for health problems related to their poor fitness level.

In conclusion, the prevalence of fatness and low

TABLE 1. Physical fitness, body composition, blood pressure, and metabolic profile in the Human Capital Study, 2002–04, by gender and birth cohort[a]

	Men				Women				
Birth cohort:	1962–68	1969–1977	p^b	Total	1962–68	1969–77	p^b	Total	p^c
Handgrip muscle strength	$n = 182$	$n = 386$		$n = 568$	$n = 274$	$n = 470$		$n = 744$	
Dominant hand (Newtons)	409 ± 76	410 ± 72	.97	409 ± 73	266 ± 47	263 ± 48	.31	264 ± 47	< 0.01
Non-dominant hand (Newtons)	385 ± 74	386 ± 68	.86	385 ± 70	248 ± 47	245 ± 48	.36	246 ± 48	< 0.01
Dominant + non-dominant, adjusted by weight (Newtons/kg)	$n = 172$ 11.8 ± 2.0	$n = 348$ 12.5 ± 2.2	< .01	$n = 520$ 12.3 ± 2.2	$n = 259$ 8.5 ± 1.8	$n = 413$ 8.6 ± 1.8	.52	$n = 672$ 8.6 ± 1.8	< 0.01
Cardiovascular endurance—$\dot{V}O_2$max(ml/kg/min)	$n = 156$ 45.2 ± 7.4	$n = 333$ 46.5 ± 7.4	.07	$n = 489$ 46.1 ± 7.4	$n = 219$ 37.6 ± 4.7	$n = 343$ 39.0 ± 4.6	< .01	$n = 562$ 38.5 ± 4.7	< 0.01
Flexibility (cm)	$n = 170$ 30.4 ± 7.1	$n = 371$ 31.6 ± 7.2	.06	$n = 541$ 31.2 ± 7.2	$n = 244$ 29.3 ± 7.4	$n = 402$ 30.3 ± 7.1	.08	$n = 646$ 29.9 ± 7.2	< 0.01
Anthropometry and body composition	$n = 212$	$n = 401$		$n = 613$	$n = 265$	$n = 431$		$n = 696$	
Height (cm)	162.8 ± 6.0	162.8 ± 6.0	.95	162.8 ± 6.0	150.7 ± 5.7	150.7 ± 5.5	.97	150.7 ± 5.6	< .01
Body-mass index (kg/m^2)	25.4 ± 3.7	24.2 ± 3.4	< .01	24.7 ± 3.6	27.2 ± 5.0	26.6 ± 4.6	.09	26.8 ± 4.7	< .01
Overweight, 25.0–29.9 (%)	36.3	29.9	< .01	32.1	39.2	37.6	.37	38.2	< .01
Obese, 30.0 (%)	13.2	6.7		9.0	25.7	22.3		23.6	
Waist circumference (cm)	89.3 ± 9.4	85.4 ± 8.8	< .01	86.8 ± 9.2	93.4 ± 12.1	91.6 ± 11.7	.05	92.3 ± 11.9	< .01
> 102 cm for men, > 88 cm for women	10.4	4.2	< .01	6.4	64.2	60.8	.37	62.1	< .01
% body fat	22.5 ± 6.8	19.5 ± 6.4	< .01	20.5 ± 6.7	35.6 ± 7.5	34.6 ± 7.0	.06	35.0 ± 7.2	< .01
Fat free mass (kg)	51.7 ± 5.5	51.3 ± 5.2	.31	51.4 ± 5.3	39.0 ± 3.8	38.8 ± 3.5	.46	38.9 ± 3.6	< .01
Blood pressure (mm Hg)	$n = 218$	$n = 424$		$n = 642$	$n = 290$	$n = 488$		$n = 778$	
Systolic	117 ± 11	117 ± 11	.60	117 ± 11	110 ± 15	107 ± 11	< .01	108 ± 13	< .01
Diastolic	74 ± 9	71 ± 9	< .01	72 ± 9	71 ± 11	69 ± 9	< .01	70 ± 10	< .01
Pre-hypertension, 120–139/80–89 (%)	41.7	39.2	.36	40.0	17.9	18.0	< .01	18.0	< .01
Hypertension, 140/90 (%)[d]	4.6	2.8		3.4	5.5	0.8		2.6	
Plasma glucose (mg/dL)	$n = 168$ 94.8 ± 17.3	$n = 322$ 92.4 ± 10.4	.06	$n = 490$ 93.2 ± 13.2	$n = 262$ 99.0 ± 36.4	$n = 443$ 91.4 ± 22.9	< .01	$n = 705$ 94.2 ± 28.9	.42
Impaired fasting glucose, 110–125 (%)	4.8	3.4	.09	3.9	5.0	3.4	.02	4.0	.39
Diabetes mellitus, 126 (%)[d]	3.6	0.9		1.8	5.3	1.8		3.1	

Blood lipids (mg/dL)	$n = 137$	$n = 288$		$n = 425$	$n = 239$	$n = 397$		$n = 636$	
Total cholesterol	165 ± 33	156 ± 31	< .01	159 ± 32	169 ± 32	163 ± 32	.02	165 ± 32	< .01
≥ 200 (%)	15.3	10.4	.15	12.0	16.7	11.6	.07	13.5	.47
Triglycerides	191 ± 94	169 ± 91	.02	176 ± 92	179 ± 79	164 ± 87	.03	169 ± 84	.23
≥ 150 (%)	56.9	51.4	.28	53.2	56.9	47.9	.03	51.3	.54
HDLC	34 ± 10	34 ± 9	.63	34 ± 9	39 ± 10	41 ± 12	.13	40 ± 11	< .01
< 40 (%)	72.3	74.7	.41	73.9	57.7	50.9	.15	53.5	< .01
≥ 60 (%)	1.5	0.3		0.7	3.8	6.3		5.3	
LDLC	95 ± 30	88 ± 27	.02	90 ± 28	94 ± 26	90 ± 26	.05	91 ± 26	.60
≥ 130 (%)	10.0	6.5	.21	7.6	8.1	5.9	.29	6.8	.61
Metabolic syndrome[e] (%)	17.5	13.9	.34	15.1	39.7	31.8	.04	34.8	< .01
Hemoglobin (mg/dL)	$n = 168$ 15.9 ± 1.5	$n = 321$ 16.1 ± 1.4	.15	$n = 489$ 16.1 ± 1.4	$n = 263$ 13.8 ± 1.6	$n = 444$ 14.0 ± 1.4	0.30	$n = 707$ 13.9 ± 1.5	< .01
Anemia (%)[f]	6.5	4.0	.22	4.9	9.1	10.1	0.66	9.8	< .01

a. Mean ± SD, unless specified as *n*, and proportions (%).
b. *t*-test and χ^2 for differences between birth cohorts.
c. *t*-test and χ^2 for differences between men and women.
d. Includes known cases with the disease.
e. Three or more of the following: waist circumference > 102 cm for men and > 88 cm for women; triglycerides 150 mg/dL; HDLC < 40 mg/dL for men and < 50 mg/dL for women; blood pressure 130/85 mmHg; and fasting glucose 110–125 mg/dL.
f. < 12.0 for women and < 13.6 for men, adjusted for altitude and age.

TABLE 2. Physical fitness, body composition, blood pressure, and metabolic profile of subjects born in one of four villages in Guatemala between 1962 and 1977 and evaluated in 2002–04, by current residence[a]

	Men				Women			
Current residence:	Villages	In Guatemala City	Elsewhere in Guatemala	p^b	Villages	In Guatemala City	Elsewhere in Guatemala	p^b
Handgrip muscle strength	$n = 424$	$n = 100$	$n = 43$		$n = 542$	$n = 141$	$n = 61$	
Dominant hand (Newtons)	405 ± 68	424 ± 86	423 ± 87	.03	263 ± 46	268 ± 56	268 ± 37	.36
Non-dominant hand (Newtons)	382 ± 64	393 ± 81	403 ± 92	.07	247 ± 47	244 ± 56	244 ± 41	.76
Dominant + non-dominant, adjusted by weight (Newtons / kg)	n = 380 12.5 ± 2.2	n = 96 12.0 ± 1.9	n = 43 11.7 ± 2.2	< .01	n = 419 8.6 ± 1.8	n = 125 8.4 ± 1.9	n = 58 8.5 ± 1.8	.66
Cardiovascular endurance – $\dot{V}O_2$max (mL/kg/min)	n = 367 46.6 ± 7.5	n = 81 45.5 ± 6.0	n = 40 43.7 ± 7.0	< .01	n = 419 38.6 ± 4.6	n = 105 38.4 ± 4.8	n = 38 37.9 ± 5.3	.69
Flexibility (cm)	n = 414 31.7 ± 7.0	n = 86 30.2 ± 8.3	n = 40 29.1 ± 7.4	< .01	n = 486 29.8 ± 7.3	n = 115 29.7 ± 7.3	n = 45 31.7 ± 5.9	.24
Anthropometry and body composition	n = 468	n = 101	n = 43		n = 502	n = 136	n = 58	
Height (cm)	162.5 ± 6.1	164.3 ± 5.0	162.9 ± 6.2	.03	150.4 ± 5.5	151.8 ± 5.8	150.1 ± 5.4	.02
Body mass index (kg/m^2)	24.3 ± 3.4	26.0 ± 3.8	26.0 ± 3.8	< .01	26.8 ± 4.9	26.6 ± 4.0	27.3 ± 4.7	.61
Overweight, 25.0–29.9 (%)	29.1	42.6	41.9	< .01	38.2	50.0	48.3	< .01
Obese, 30.0 (%)	7.1	15.8	14.0		23.6	15.4	20.7	
Waist circumference (cm)	85.6 ± 8.8	90.4 ± 9.5	90.7 ± 9.3	< .01	92.1 ± 12.3	92.1 ± 10.6	94.7 ± 11.4	.28
> 102 cm for men, > 88 cm for women	5.1	11.9	7.0	.04	59.4	66.2	75.9	.03
% body fat	19.7 ± 6.4	23.0 ± 6.9	23.5 ± 6.6	< .01	34.9 ± 7.5	34.8 ± 6.2	36.0 ± 7.2	.51
Fat free mass (kg)	50.9 ± 5.3	53.3 ± 4.9	52.3 ± 5.5	.53	38.7 ± 3.7	39.4 ± 3.3	38.7 ± 3.4	.53
Blood pressure (mm Hg)	n = 498	n = 100	n = 43		n = 569	n = 148	n = 61	
Systolic	116 ± 11	119 ± 12	118 ± 13	.02	107 ± 12	111 ± 15	113 ± 16	< .01
Diastolic	72 ± 9	74 ± 11	74 ± 10	.11	69 ± 9	71 ± 10	73 ± 12	< .01
Pre-hypertension, 120–139/80–89 (%)	37.6	53.0	39.5	< .01	16.7	23.6	16.4	.01
Hypertension, 140/90 (%)[c]	3.0	4.0	7.0		1.9	2.7	8.2	
Plasma glucose (mg/dL)	n = 351 94 ± 14	n = 95 92 ± 10	n = 43 89 ± 10	.01	n = 500 95 ± 26	n = 145 93 ± 32	n = 60 95 ± 40	.72
Impaired fasting glucose, 110–125 (%)	4.0	5.3	0.0	.44	4.0	5.5	0.0	.40
Diabetes mellitus, 126 (%)[c]	2.3	1.1	0.0		3.0	2.8	5.0	

Blood lipids (mg/dL)	n = 308	n = 84	n = 32		n = 466	n = 127	n = 43	
Total cholesterol	156 ± 30	167 ± 34	163 ± 41	.02	165 ± 31	168 ± 36	160 ± 28	.29
200 (%)	9.7	17.9	18.8	.06	13.5	15.7	7.0	.35
Triglycerides	171 ± 86	191 ± 109	184 ± 102	.18	173 ± 83	164 ± 88	150 ± 87	.17
150 (%)	53.6	51.2	53.1	.93	54.3	43.3	41.9	.04
HDLC	35 ± 9	32 ± 9	33 ± 9	.14	40 ± 12	41 ± 11	40 ± 9	.40
< 40 (%)	72.7	76.2	81.2	.70	55.2	48.0	51.2	.29
60 (%)	1.0	0.0	0.0		6.0	3.9	2.3	
LDLC	88 ± 26	98 ± 32	95 ± 32	< .01	91 ± 26	94 ± 27	90 ± 25	.36
130 (%)	5.3	14.1	13.3	.02	6.1	9.8	4.8	.30
Metabolic syndrome[d] (%)	13.0	21.4	18.8	.14	34.8	35.4	32.6	.94
Hemoglobin (mg/dL)	n = 351 16.0 ± 1.4	n = 94 16.6 ± 1.3	n = 43 15.7 ± 1.2	< .01	n = 503 13.9 ± 1.5	n = 144 14.2 ± 1.3	n = 60 13.2 ± 1.7	< .01
Anemia (%)[e]	6.0	1.1	4.7	.15	9.1	7.6	20.0	.02

a. Mean ± SD, unless specified as *n*, and proportions (%).
b. *t*-test and [illegible].
c. Includes known cases with the disease.
d. Three or more of the following: waist circumference > 102 cm for men and > 88 cm for women; triglycerides 150 mg/dL; HDLC < 40 mg/dL for men and < 50 mg/dL for women; blood pressure 130/85 mmHg; and fasting glucose 110–125 mg/dL.
e. < 12.0 for women and < 13.6 for men, adjusted for altitude and age.

physical fitness is high in individuals living in rural and urban settings in Guatemala, particularly among women. The consequences for other CVD risk factors are becoming manifest as metabolic syndrome in the third and fourth decades of life. Rural living is associated with reduced prevalence of these risk factors in men; it is likely that this is related to their more physically demanding occupations.

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Labor force activities and income among young Guatemalan adults

John Hoddinott, Jere R. Behrman, and Reynaldo Martorell

Abstract

This paper considers labor force activities among adults (26 to 41 years of age in 2003) who participated as children in a nutrition supplementation trial in Guatemala. The vast majority of men are engaged in some type of income-generating activity in 2002–04. However, unlike their fathers, these men are much more likely to be engaged in wage labor, even if they remain in the original study villages. Those engaged in wage employment appear to do so steadily. Women are much more likely to be engaged in some type of income-generating activity than their mothers. For both men and women, there appears to be considerable movement in and out of own business activities. In Guatemala City, wage work is the predominant economic activity with more than half of the women interviewed working for wages; elsewhere operating non-farm businesses is the most often cited activity. For both men and women, agriculture now appears to be very much a secondary activity.

Key words: Guatemala, Institute of Nutrition of Central America and Panama (INCAP), Human Capital Study, labor force participation, wage employment, wages, income, self-employment, agricultural work

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Introduction

From January 1969 to September 1977 the Institute of Nutrition of Central America and Panama (INCAP) conducted a longitudinal study of child growth and development that involved a food supplementation trial. The study was conducted in four villages and subjects of study were all children aged 7 years or less and all pregnant and lactating women. A comprehensive follow-up survey was undertaken in 1988 as well as other specific studies in 1991–96, and 1998 [1]. These data have been extensively analyzed from the perspective of assessing the long-term impact of the nutrition intervention on the physical status and health of former participants and their children. However, at the time of the last follow-up (1988) that collected extensive socioeconomic data, few of the participants in the study had entered the labor force; indeed, the youngest were only half way through primary school. Consequently, little is known about how these individuals have fared in the labor force.

The setting for the initial nutrition intervention was four villages in eastern Guatemala, located 36 to 102 km from Guatemala City and relatively close to the Atlantic Highway, which connects Guatemala City to Guatemala's Caribbean coast. Historically, the principal economic activity in these villages has been subsistence agriculture—particularly the cultivation of maize and beans—with some commercial agriculture activity that varied from village to village (e.g., tobacco, manioc, horticulture) [2–4]. However, a number of changes have taken place in these villages over the last 30 years that have made livelihoods based on agriculture much less attractive while access to wage employment has increased.

First, the population has grown significantly. At the time of the intervention, these villages contained somewhere between 500 and 1000 people. Currently, their populations range from 1269 to 2303. There has been no expansion of cultivable area; indeed, the availability of fertile land has declined in part due to expansion of area devoted to housing and commerce. Second,

a series of adverse shocks has under-cut the viability of commercial crop production. As noted in [2]:

> The production of cheaper corn starch in Brazil destroyed the market for manioc starch from San Juan during the early 1980s. Fluctuating tomato prices and increasing costs of pest control and irrigation resulted in the folding of the agricultural cooperative that supported horticulture in Conacaste in 1991. Most recently, hurricane Mitch washed away fertile tobacco fields along the lower Motagua River near Espíritu Santo in 1998.

By contrast, the availability of wage employment has increased markedly with the expansion of *maquilas* in Guatemala City and the opening of the cement factory operated by *Cementos Progreso*. In addition, construction work has created demand for individuals with carpentry or masonry skills. Access to these jobs also improved markedly with the construction of reasonably good roads into the villages and the concomitant development of improved bus services. Moreover, human capital investments in these villages have shifted from learning-by-working on family farms and in other family enterprises to greater formal schooling [5]. Furthermore, a number of the study subjects have migrated to other areas, perhaps motivated in part by perceived better labor market prospects.

It is against this backdrop that we consider labor force activities and income among former participants in the INCAP supplementation trial.

Data and key variables

As part of the Human Capital Study 2002–04 described in [6], participants in the 1969–77 supplementation trial have been surveyed about their income-generating activities. The survey instrument draws in part on the earlier (1988) socio-economic survey instruments and the World Bank's Encuesta Nacional Sobre Condiciones de Vida (called ENCOVI) that was fielded in Guatemala in 2000, as well as the results of extensive pilot testing. In the original study villages, the survey instrument has been implemented as part of the third wave of data collection that began in March 2003. Interviews have been at times and places convenient to the respondents; meaning in practice that interviews have been in a variety of locales including individuals' homes, their work places, and bus stops, and at a variety of times, weekdays and on weekends, early in the morning, during the day and during the evening. Subsequently, the instrument has been used as part of the interviews undertaken with migrants in Guatemala City and elsewhere in the country. On average, the questionnaire takes approximately 40 minutes to implement, but there has been considerable variation around this average.

The survey instrument consists of an introduction (designed to ascertain which sections are relevant for any given respondent) and a five-part questionnaire. Topics covered include: (1) wage labor activities (type of work; hours, days and months worked; wages and fringe benefits received; and a description of the employer) both currently and in the previous year, 2002; (2) agricultural activities (amount of land cultivated; crops grown; production levels; use of inputs; hours, days and months worked) in 2002; (3) non-agricultural own-business activities (type of activity; value of goods or services provided; capital stock held; hours, days and months worked) both currently and in 2002; (4) labor force activities prior to the arrival of Hurricane Mitch in 1998 and a description of the first paid employment undertaken by the individual; and (5) transfer income (remittances, pensions and so on) received by the respondent. The historical data are included because we want to determine whether Hurricane Mitch, which caused considerable destruction in parts of Guatemala, had significant effects on labor force activities and because we want to see whether occupations changed over time.

Results

Labor force participation

The first set of rows in **Tables 1, 2 and 3** provide descriptive statistics on labor force participation in 2002 disaggregated by sex; by year of birth and sex; by current residence and sex; and by parental socio-economic status (SES) and sex. As in other papers in this special issue, a significance level of .05 is used as the cutpoint defining "significant" differences in aspects of labor force activities and income across these strata, and a significance level of .10 is used as the cutpoint defining "marginally significant" differences across strata.

The 2002 survey instrument is designed to capture engagement in three broad sets of activities: wage labor, own-farm activities, and non-farm-owning business activities. These categories are not mutually exclusive. **Table 1** indicates that in 2002, virtually all (98%) of men and most (70%) of women are engaged in some sort of income-generating activity. The latter figure contrasts strikingly with data on the mothers of these subjects. In 1974, 68% of the mothers of these subjects reported *no* income-generating work as their primary occupation. In 1987, this figure had risen to 77% [7]. While younger women are less likely to report engaging in work for income (perhaps because they are at a stage of life in which they are more likely than older women to be engaged in care of infants and small children), there are no other meaningful differences when we disaggregate by current residence, parental SES or, in the case of men, age.

We next examine what type of work these individu-

TABLE 1. Income generating activities in the Human Capital Study 2002–04, by sex and birth cohort*

	Men ($n = 650$)	Women ($n = 766$)	p	Men			Women		
				Born 1962–68 ($n = 219$)	Born 1969–77 ($n = 431$)	p	Born 1962–68 ($n = 285$)	Born 1969–77 ($n = 481$)	p
Labor force participation									
Any labor force participation	99%	70%	< .01	98%	99%	.33	76%	67%	.01
Worked for wages	80	33	< .01	74	83	.01	33	34	.89
Worked on own farm	43	21	< .01	47	41	.20	25	18	.01
Operated non-farm business	28	34	.01	34	25	.02	39	31	.03
Worked 9+ months for wages	60	22	< .01	57	62	.23	24	22	.54
Worked 9+ months on own farm	7	1	< .01	9	7	.37	1	1	.27
Worked 9+ months operating non-farm business	20	26	< .01	28	16	< .01	31	23	.02
Worked 9+ months in one sector	78	45	< .01	80	77	.27	51	42	.02
Worked 9+ months by combining work in more than one sector	11	2	< .01	10	11	.61	3	1	.19
Current wage labor activities	($n = 694$)	($n = 311$)		($n = 213$)	($n = 481$)		($n = 118$)	($n = 193$)	
Casual agricultural laborer	17 [4.4, 40][a]	11 [4.3, 10]	.01	17	18	.86	13	10	.52
Casual non-agricultural laborer	14 [6.3, 44]	31 [6.3, 10]	< .01	17	13	.14	40	26	.01
Domestic worker	2 [8.8, 48]	19 [4.2, 54]	< .01	2	1	.28	21	18	.44
Unskilled worker (formal sector)	22 [9.3, 48]	15 [7.3, 47]	.01	22	22	.94	14	16	.55
Semi-skilled/skilled worker	27 [10.7, 50]	9 [6.8, 59]	< .01	23	28	.15	6	11	.11
White-collar worker	14 [11.1, 60]	12 [12.5, 44]	.25	15	14	.88	5	15	< .01
Type of business operated	($n = 227$)	($n = 316$)		($n = 95$)	($n = 132$)		($n = 133$)	($n = 183$)	
Food processing	12	6	< .01	14	11	.48	8	4	.23
Manufacturing	8	18	< .01	5	9	.28	15	20	.24
Trading	47	60	< .01	55	42	.05	62	59	.54
Services	59	30	< .01	58	59	.86	32	29	.62
Individual participated in growing	($n = 280$)	($n = 157$)		($n = 102$)	($n = 178$)		($n = 72$)	($n = 85$)	
Maize	91	93	.41	89	92	.51	94	92	.52
Beans	75	71	.45	76	74	.81	72	71	.82
Squash	8	5	.33	8	7	.87	7	4	.33
Cucumbers	5	4	.47	6	5	.77	3	5	.53
Lemons	5	4	.57	7	4	.28	3	5	.53
Tomatoes	4	1	.06	5	3	.37	1	0	.28

* Descriptives for wage work, own-business activities, and growing of crops limited to individuals who report working in those sectors.
a. The first figure in square brackets is the median hourly wage, in quetzals. The second figure is the median number of hours worked in the previous 7 days.

TABLE 2. Income generating activities in the Human Capital Study 2002–04, by current residence and sex

	Men				Women			
Current residence	Study villages and vicinity	Guatemala City	Elsewhere in Guatemala	*p*	Study villages and vicinity	Guatemala City	Elsewhere in Guatemala	*p*
Labor force participation	(*n* = 507)	(*n* = 99)	(*n* = 44)		(*n* = 567)	(*n* = 138)	(*n* = 61)	
Any labor force participation	99%	99%	100%	.71	71	67	75	.51
Worked for wages	81	77	80	.70	29	52	34	< .01
Worked on own farm	51	7	30	< .01	26	1	13	< .01
Operated non-farm business	26	38	32	.03	37	22	41	< .01
Worked 9+ months for wages	58	70	61	.11	18	38	28	< .01
Worked 9+ months on own farm	8	3	9	.19	1	1	3	.13
Worked 9+ months operating non-farm business	17	33	32	< .01	28	16	34	< .01
Worked 9+ months in one sector	74	93	86	< .01	42	53	59	< .01
Worked 9+ months by combining work in more than one sector	13	1	5	< .01	2	1	2	.86
Current wage labor activities	(*n* = 552)	(*n* = 97)	(*n* = 45)		(*n* = 200)	(*n* = 85)	(*n* = 96)	
Casual agricultural laborer	20	2	22	< .01	18	0	0	< .01
Casual non-agricultural laborer	16	7	16	.09	33	25	35	.31
Domestic worker	1	2	4	.24	18	16	39	.03
Unskilled worker (formal sector)	21	31	18	.06	14	20	12	.33
Semi-skilled/skilled worker	27	27	24	.94	7	14	12	.16
White-collar worker	12	31	9	< .01	7	25	4	< .01
Type of business operated	(*n* = 166)	(*n* = 43)	(*n* = 18)		(*n* = 255)	(*n* = 32)	(*n* = 29)	
Food processing	14	5	11	.25	7	0	3	.27
Manufacturing	10	2	0	.12	21	3	10	.03
Trading	45	49	67	.20	60	53	76	.16
Services	59	61	50	.73	28	44	31	.20

als did in 2002. **Table 1** indicates that 80% of men are working for wages, 43% report working on their own farms, and 28% operate their own business. Again, this represents a striking contrast with the previous generation. Using somewhat different categories, 83% and 55% of the fathers of these individuals reported own-farm agricultural activities (as a tenant farmer or small landowner) as their primary occupation in 1967 and 1987, respectively [7]. A third of women now work for wages, another third operate their own business, and a fifth work on own-agricultural activities.

There are some interesting, statistically significant differences when the data are disaggregated (**tables 1 and 2**). Compared with older men and women, younger men and younger women are less likely to operate their own business, younger men are more likely to be engaged in wage employment and younger women were less likely to report working on the

TABLE 3. Income generating activities in the Human Capital Study 2002–04, by parental socioeconomic tertile in 1975 and sex

	Men					Women				
Parental socioeconomic tertile:	Low	Medium	High	Missing	*p*	Low	Medium	High	Missing	*p*
Labor force participation	(*n* = 205)	(*n* = 214)	(*n* = 187)	(*n* = 44)		(*n* = 250)	(*n* = 225)	(*n* = 222)	(*n* = 69)	
Worked for wages, on own farm or for own business	100%	98%	99%	98%	.08	71	68	71	74	.72
Worked for wages	82	79	78	77	.54	33	3	35	38	.54
Worked on own farm	47	43	45	20	.65	22	22	19	16	.66
Operated non-farm business	25	25	37	21	.01	35	32	37	29	.49
Worked 9+ months for wages	62	60	59	61	.87	21	20	23	28	.54
Worked 9+ months on own farm	7	8	6	9	.84	1	1	1	1	.58
Worked 9+ months operating non-farm business	18	17	26	21	.04	27	21	30	25	.07
Worked 9+ months in one sector	78	77	78	82	.92	44	39	51	51	.03
Worked 9+ months by combining work in more than one sector	12	12	11	0	.87	3	2	1	0	.55
Current wage labor activities	(*n* = 232)	(*n* = 228)	(*n* = 186)	(*n* = 45)		(*n* = 100)	(*n* = 80)	(*n* = 99)	(*n* = 32)	
Casual agricultural laborer	27	14	9	21	< .01	22	4	8	6	< .01
Casual non-agricultural laborer	15	15	15	8	.98	32	40	26	22	.15
Domestic worker	1	2	2	4	.69	18	18	15	38	.85
Unskilled worker (formal sector)	20	24	20	27	.49	13	14	18	16	.55
Semi-skilled/skilled worker	22	31	30	19	.05	5	13	11	9	.17
White-collar worker	11	10	23	17	< .01	6	11	18	9	.03
Type of business operated:	(*n* = 60)	(*n* = 69)	(*n* = 87)	(*n* = 11)		(*n* = 102)	(*n* = 88)	(*n* = 103)	(*n* = 23)	
Food processing	2	16	17	0	.01	2	5	12	0	.01
Manufacturing	13	9	1	18	.01	30	13	11	17	< .01
Trading	53	41	48	46	.34	53	65	61	74	.23
Services	52	59	61	73	.51	31	32	28	26	.83

household farm. Engagement in agricultural activities is considerably higher for individuals who remained in the original study villages. Women are more likely to work in wage employment but less likely to operate their own business if they live in Guatemala City. There is no statistically significant difference in the proportions of men reporting that they work for wages when we disaggregate by current residence. This finding is striking because often analysis of migration is motivated substantially by improved work prospects [8, 9]. Indeed, men who remain in the original study villages are slightly more likely to report working for wages (81%) than men who moved to Guatemala City (77%) although the difference is not statistically significant. A higher proportion report operating a non-farm business in Guatemala City (38%) than do those residing in the study villages (26%).

Is this work full or part-time? We define individuals working full-time in a given activity if they work more than 9 months in that activity in 2002. Using this definition, **table 1** shows that 78% of men and 45% of women report working full-time in one activity and an additional 11% of men and 2% of women work more than 9 months in two or more activities. Older men are more likely to operate their own businesses full-time as are older women. Full-time wage work is more prevalent, particularly for women, if they had migrated from the original study villages.

We also consider two further temporal dimensions of work. As part of the survey, individuals are asked to indicate which months they worked in different activities in 2002. Aggregating these data into quarters, **figures 1 and 2** show the percentages of men and women reporting work by time of year. The percentages of men and women who report working for wages or operating their own non-farm businesses hardly varies over the year. By contrast, engagement in agricultural activities does vary seasonally. It is low in the dry season January–March, increases gradually with the advent of the rains in April before peaking at 40% for men in the period July–September (when weeding and harvesting of crops planted in May occurs and when additional planting takes place) and 12% for women in the period October–December (corresponding to the final harvest period for the season). If we disaggregate the data underlying these figures by current residence, we see that male participation in wage labor is higher in Guatemala City—approximately 73% throughout the year—and, not surprisingly, engagement in agricultural activities almost non-existent (not shown). More surprising are the results for men who remain in the original study villages. Even at the peak period of engagement in agriculture (July–September), fewer men (47%) are engaged in working their own farms than are engaged in wage employment (69%) (not shown).

A second temporal dimension is whether individuals remain in the same activity over time or whether they enter and exit from different activities. One reference period pertains to current activities versus activities just prior to Hurricane Mitch, an event that is well-remembered by sample respondents, so it is a good reference point—that is, just before October 1998. Beginning with wage employment, several features are noteworthy. First, the total percentages of both men and women reporting either entering or exiting wage labor after 1998 are relatively low, about 20% for both men and women (table not shown). About 90% of men and 70% of women who report working for wages in 1998 also report working for wages in 2002.

By contrast, there is considerable movement in and out of non-farm-owning business activities. About 40% of men and women either entered or exited this type of work since 1998. Men are more likely to have exited; indeed less than 30% of the men who report operating their own business in 1998 also report doing

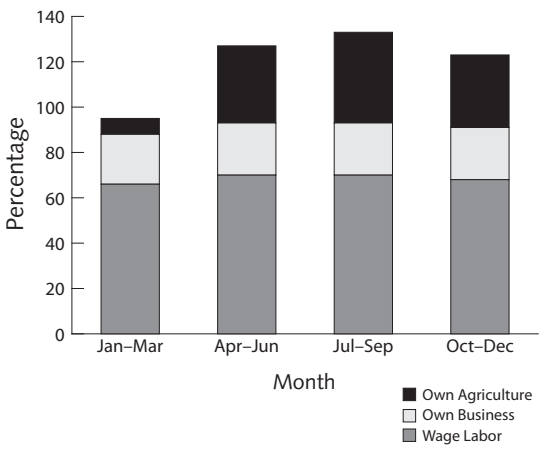

FIG 1. Labor force activity in 2002, men in the Human Capital Study

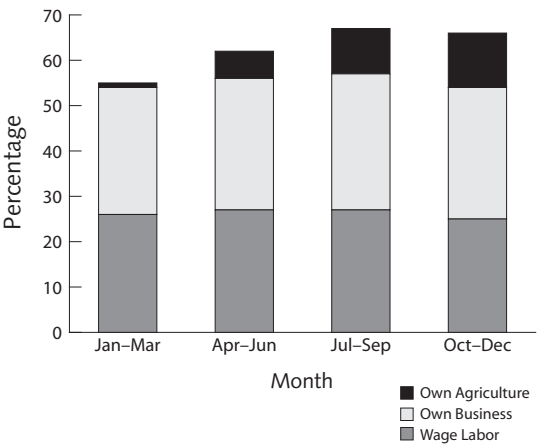

FIG 2. Labor force activity in 2002, women in the Human Capital Study

so in 2002. While women are more likely to have started their own business, only 44% report operating their own businesses in 1998 and 2002. While 83% of men who were farming before Hurricane Mitch also report operating their farm in 2002, just under 50% of women who were farming 5 years prior to the survey continued to do so in 2002.

Respondents are also asked if they were still in school at age 15 and if they were working (these questions are not mutually exclusive). There are statistically significant differences in entry into the wage labor market by age 15 among women by village of origin and among men by current residence. In the latter case, entry was highest among men currently residing in the original study villages. Roughly half the men in the sample were engaged in wage work at age 15 compared with 38% of women, a statistically significant difference. Statistically significant differences in likelihood of working at age 15 were found among men and women disaggregated by village of origin. Also we find that individuals whose parents had high SES scores were much less likely to be working at age 15 (not shown), in part because they were more likely to be in school.

Wage employment

We now consider participation in wage employment in more detail. **Tables 1, 2 and 3** provide descriptive information on the type of wage employment that the respondents engaged in the week preceding their interview.

Based on self-reports, we divide wage work into six categories: casual agricultural laborers; casual non-agricultural laborers (for example, individuals working as laborers on road construction); domestic workers (for example, maids, guards); unskilled workers in the formal sector; semi-skilled or skilled workers; and white-collar workers (including individuals holding clerical, administrative, technical, or professional positions). While these categories are fairly self-explanatory, it is useful to clarify that the distinction between casual non-agricultural laborers and unskilled workers in the formal sector lies in the nature of the contractual arrangements between worker and employer. All casual workers work without a formal contract, whereas more than 85% of unskilled workers in the formal sector have a formal contract with their employer. The latter type of workers received benefits such as the "*bono 14*," an end-of-year work bonus (received by 66% of unskilled workers in the formal sector) and their employers contribute to the government-operated social security system, *IGSS* (a benefit received by 72% of these unskilled workers).

Several comments are in order. Apart from those working as casual laborers, 87% of men and 64% of women have a formal contract with their employer (the figure for women rises to 89% if we exclude those women working as domestics). Labor union participation is very low even if we exclude individuals working as casual laborers—7% for men, and 2% for women. Virtually all persons, 92% of men and 96% of women who report working for wages in the previous week, do so in the private sector. The one exception to that 33% of male and 25% of female white-collar workers is employed by the public sector.

There are statistically significant gender differences in occupations. Women are more likely to work as casual non-agricultural laborers or as domestic workers whereas men are more likely to work as casual agricultural laborers, unskilled, semi-skilled, or skilled workers in the formal sector. **Table 1** also reports (in square brackets) the median hourly wage in quetzals (8.1 quetzals = US$1 on March 2004, the final survey month) received by workers in the most recent pay period and the number of hours worked in the last seven days. These wages are net of deductions such as for taxes and social security but do not include the value of employer-provided meals, transport, uniforms, and end-of-year bonuses. We also calculated a second measure of net wages that includes these in-kind and year-end benefits based on information collected in the survey instrument. The correlation between net wages in the last pay period and the second measure of net wages that includes these items is very high, around 0.97. Strikingly, as we move down the categories in **table 1**, we see for men that work in these different categories becomes progressively better remunerated. Also, hours worked also increases so that those men working, for example as semi-skilled laborers, earn higher incomes both because their hourly wages are higher and because they work for more hours. The pattern for women is slightly different. Women working as casual laborers report working considerably fewer hours than women working either as domestics or in the formal sector. Women's pay is broadly similar to men's pay at the lower end of the occupational structure and at the higher end (we cannot reject the null hypothesis that the mean net hourly pay for men and women working either as agricultural laborers, non-agricultural laborers or as white-collar workers are equal) but is less than men's in unskilled, domestic, semi-skilled or skilled work.

When we examine occupational status by sex and current residence, we find, not surprisingly, that casual agricultural labor is considerably higher amongst men and women who remain in the original study villages when compared with individuals who migrated to Guatemala City while the converse is true when we consider white-collar work. However, other differences in occupation are less marked. The proportions of men who remained in the original study villages that reported being employed as semi-skilled or skilled workers are virtually identical to the proportions of those men who migrated to Guatemala City. Further, the proportion

of men employed as unskilled workers, either casually or formally, is virtually the same for men remaining in the original study villages and those who migrated to Guatemala City, the difference being that the latter group was more likely to undertake unskilled work in the formal sector.

Differences in occupation by age are not especially marked. There are only two exceptions—a decline in the proportion of women working in casual non-agricultural work and an increase in the proportion of women working in white-collar employment amongst younger women. By contrast, there are some marked differences in employment by parental SES. Men and women coming from better-off homes are considerably more likely to hold white-collar jobs and considerably less likely to be working as casual agricultural laborers. However, there would appear to be some intergenerational upward mobility in terms of occupation even by individuals coming from the lowest parental SES households. Just over 30% of men whose parents were in the lowest SES tertile had moved to relatively well-paying jobs as semi-skilled, skilled or white-collar workers.

Lastly, we consider occupational mobility over time separately for men and women. We take as our sample all individuals who provided information on their first wage job and compare those initial occupations with those currently held. There are several striking results. Among men, relatively few, only a quarter, who started as agricultural laborers remain so in 2002. While just over 15% do not report any current wage occupation, a non-negligible number (just over 40%) move into formal sector work, both unskilled and skilled. By contrast, virtually all men—90%—who currently report working as casual agricultural laborers also report this as their first job and we observe few cases of "downward occupational mobility" among men.

The picture for women is somewhat different. Out of the 613 women who describe their first job as having been a wage job, more than half (317) do not report any current wage work. One implication of this is that the percentage of women reporting that they work for wages in 2002 understates the percentage of women who *ever* had worked in wage jobs (though not as an indicator of the percentage who currently are working in a wage job) in that it does not capture a significant number of women who initially entered the wage market but subsequently left. The most common first job for women is domestic work; however, relatively few women continue in this as a long-term occupation. Fewer than 20% of the women who indicate that their first job was as a domestic are doing so at the time of interview. While there are few cases of downward occupational mobility, there are also, in contrast to men, relatively few cases of upward mobility.

Operating a non-farm business

Tables 1, 2 and 3 provide some descriptive information on the types of non-farm-owning businesses operated by these respondents. They are divided into four broad categories: food processing; manufacturing; trading; and services. Among men who report such an activity, almost three-fifths (59%) provide services (for example, tailors, cobblers, mechanics, taxi drivers, barbers) and almost half (47%) engage in trading (for example, selling clothes, food, merchandise), while relatively few undertake manufacturing or food processing. The pattern is slightly different for women, with 60% engaged in trading and 30% in services.

While many of the differences in own-business activity based on sex and residence are statistically significant, they are in fact driven by a common cause. Palm weaving has been an important source of income since the 1960s in one of the original villages, Espíritu Santo [2–4]. These individuals make items such as hats, cribs and miniatures on a piecework basis. Concomitant with this work in Espíritu Santo is a much lower prevalence of trading and, to a lesser extent, service work.

Farming on own account

The descriptive information provided in **table 1** and **figures 1 and 2** suggests that operating a farm is not a major economic activity. The last set of rows in table 1 provides information on the six most frequently grown crops, which allows us to consider farming further. Restricting ourselves only to those individuals who report growing crops in 2002 (43% of the male sample and 21% of the female sample), we see that the dominant crops grown are, not surprisingly, maize and beans. Conditional on participating in crop production, 91% of men and 93% of women grow maize and 75% of men and 71% of women grow beans. Strikingly, few individuals grow any of the next four most-frequently-grown crops, squash, cucumbers, lemons, and tomatoes. All are grown by less than 10% of men who are growing any crops (who themselves are less than half of the sample of all males).

The apparent limited engagement in production of agricultural goods is corroborated by other information collected in the survey. For example, plot sizes are not large, nor are the gross values of harvested maize and beans. To put some perspective on these figures, some one working full-time as a casual agricultural laborer would earn, using the data reported in **table 1**, about 660Q *per month*, an amount equivalent to the value of median maize harvests and 70% of the value of the median bean harvest. It is true that the median value of cucumber and tomato harvests is considerably higher and that there are a few individuals valuing their own harvests at amounts considerably higher than the median. Nevertheless, while income from on-farm

operations may be large in magnitude for a small number of individuals, on the whole farming does not appear to be an economically important activity for the majority of the sample.

Returns to labor, hours worked, and income generation

Descriptive statistics on returns to labor, hours worked and income generation are given in **table 4**. These results are disaggregated by sex, age and sex and residence and sex.

To construct these data, we draw on the series of questions asked about labor force activity in 2002. For each activity, individuals are asked the number of months in which they work and how many days per month and hours per day they typically work. These data are used to generate the hours-worked variables. In the case of wage labor, individuals are asked about both gross and net earnings as well as additional payments and deductions such as bonuses, transport and food in the unit of time (hourly, daily, weekly, and so on) that is most appropriate and this information is aggregated and then converted to net hourly wages. In the case of own-farm operations, information on the value of crops harvested is collected (note that this encapsulates the value of crops both produced and consumed by the household) and aggregated. The cost of land rentals is deducted and, for each person, an hourly return to farming is calculated based on the number of hours that individual works. In the case of own-business activities, information on net profits as well as the value of own consumption is collected and aggregated over all own-business activities and, for each person, an hourly return to own-business activities is calculated based on the number of hours that individual work.

Three caveats should be noted. First, use of purchased inputs is relatively uncommon. Of those individuals who report operating their own farm, less than 30% report purchasing seeds or hiring labor, though about 70% report buying fertilizer. Because we do not have details on the amounts purchased, returns from agriculture are slightly overestimated. Second, hours worked multiplied by hourly returns gives an estimate of total income, but it is important to stress that this is an approximation given that the questionnaire asks about "typical earnings" and "typical hours worked." Lastly, these income data are relatively poor representations of welfare levels because individual welfare will reflect not only their own earnings, but also those of other household members and non-earnings income and assets as well as the "rules" regarding the allocation of household income and leisure. We also note that the survey instrument captures information on income received in the form of transfers from parents, siblings, children as well as pensions. Few individuals (less than 10%) receive such transfers and typically trivial amounts are received. These transfer incomes are not reported separately but have been included in the calculation of total income.

The first three rows of **table 4** report these income estimates only for individuals who report engaging in these activities. Beginning with the first two columns of **table 4**, we see that men have higher returns in the wage labor market, women have higher returns to farming (at the 10% significance level) and returns to own-business activities are roughly equal. Men work considerably more hours in wage employment and farming while hours worked in own-business activities are broadly equal between men and women. Income from wage employment represents 71% of income earned by men; for women, income from wage employment and own business activities both contribute just under 40% of the income derived from all three activities. Overall, men earn more income than women and income from agriculture is relatively unimportant for both sexes.

There are some noteworthy differences when we disaggregate along various dimensions. Older men and women work slightly longer hours in own-farm and own-business activities but younger men work more hours in wage employment. Net hourly wages are higher for men and women who have migrated to Guatemala City so while there is no statistically significant differences in the number of hours worked by location, those men who have migrated to Guatemala City earn higher wage income than those who did not move. Strikingly, there is no statistically significant difference in incomes derived from these three activities when we compare across men and women who remain in the original four study villages.

Conclusions

These data indicate that the vast majority of men are engaged in some type of income-generating activity in 2002. However, unlike their fathers, these men are much more likely to be engaged in wage labor, even if they remain in the original study villages. Those engaged in wage employment seem to do so steadily, when we look at their engagement seasonally and relative to the work they did prior to Hurricane Mitch. Women, in comparison with their mothers, are much more likely to be engaged in some type of income-generating activity. For both men and women, there appears to be considerable movement in and out of own business activities. In Guatemala City, wage work is the predominant economic activity with more than half of the women interviewed working for wages; elsewhere operating non-farm businesses is the most cited activity. For both men and women, agriculture now appears to be very much a secondary activity.

The associations that are described in this paper

TABLE 4. Returns to labor, hours worked, and income by activity and total in 2002, Human Capital Study

				Men			Women		
	Men	Women	*p*	Born 1962–68 (*n* = 219)	Born 1969–77 (*n* = 431)	*p*	Born 1962–68 (*n* = 285)	Born 1969–77 (*n* = 481)	*p*
Net hourly wage, workers only	11.3	7.8	< .01	12.5	10.8	.08	7.7	7.9	.90
Hourly returns to farming, farmers only	8.1	11.2	.10	8.2	8.1	.95	12.5	10.2	.57
Hourly returns to own businesses, own business operators only	16.9	13.6	.42	14.6	18.6	.38	11.1	15.4	.50
Hours worked in wage employment	1,748	552	< .01	1,542	1,853	< .01	540	559	.80
Hours worked on own farm	292	41	< .01	355	259	.03	58.6	30.2	.01
Hours worked on own business	409	469	.23	531	347	.01	552	419	.07
Total hours	2,430	1,055	< .01	2,416	2,437	.79	1,141	1,004	.14
Wage employment income	19,253	4,113	< .01	18,160	19,809	.35	4,135	4,100	.96
Own farm income	2,107	212	< .01	2,702	1,804	.19	254	188	.33
Own business income	5,066	4,372	.46	6,859	4,155	.03	4,610	4,230	.79
Total income (including transfers)	26,637	8,972	< .01	27,989	25,951	.30	9,396	8,720	.67

	Men				Women			
	Study villages and vicinity (*n* = 507)	Guatemala City (*n* = 99)	Elsewhere in Guatemala (*n* = 44)	*p*	Study villages and vicinity (*n* = 567)	Guatemala City (*n* = 138)	Elsewhere in Guatemala (*n* = 61)	*p*
Net hourly wage, workers only	10.7	16.2	8.7	< .01	6.2	11.2	9.1	< .01
Hourly returns to farming, farmers only	7.2	29.6	15.3	< .01	11.7	3.0	4.3	.65
Hourly returns to own businesses, own business operators only	16.9	17.3	16.3	.99	12.5	22.7	11.9	.56
Hours worked in wage employment	1,713	1,909	1,797	.33	436	996	623	< .01
Hours worked on own farm	355	25	167	< .01	50	14	16	.02
Hours worked on own business	349	698	449	< .01	499	267	640	.01
Total hours	2,403	2,577	2,412	.27	982	1,277	1,232	.02
Wage employment income	17,959	27,287	16,097	< .01	2,690	9,815	4,446	< .01
Own farm income	2,424	829	1,328	.17	262	41	141	.03
Own business income	3,653	11,831	6,118	< .01	4,312	3,659	6,536	.62
Total income (including transfers)	24,240	40,222	23,704	< .01	7,592	13,623	11,274	< .01

	Men[a]					Women[a]				
	Santo Domingo	Conacaste	San Juan	Espíritu Santo	*p*	Santo Domingo	Conacaste	San Juan	Espíritu Santo	*p*
Wage employment income	19,783	17,663	20,081	12,962	.04	3,532	2,157	2,755	2,295	.21
Own farm income	2,290	2,406	1,182	4,178	.12	265	392	230	84	.08
Own business income	3,481	3,218	3,305	5,137	.46	3,241	4,884	3,309	6,016	.67
Total income (including transfers)	25,677	23,610	24,618	22,584	.69	7,388	7,909	6,518	8,579	.90

a. Includes only current residents of the original villages.

indicate some important changes over the long run, considerable labor mobility over shorter periods of time, and some important differences in labor market experiences by gender, birth cohort, parental SES, and place of current residence. One of the most striking changes, for example, is the substantial increase in women's participation in labor force activities over recent decades. On the other hand, the absence of some associations with the stratifying variables is also of interest. For instance, given the emphasis on labor market incentives for migration, the lack of associations between current residence and overall labor force participation is of interest because it is unexpected. Thus, several associations that differ by the stratifying variables and several that do not raise provocative questions about what is causing changes in some respects and stability in others in labor market behaviors, and how such behaviors are related to human resource investments, marriage, fertility, productivity, and other outcomes. The larger project of which this issue is an initial stage will investigate these questions using the many special aspects of the accumulating data over the decades on the subjects in this panel data set.

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Household expenditures and wealth among young Guatemalan adults

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Abstract

In this article, we describe expenditure and wealth patterns, indicators of long-run economic well-being, for a sample of young Guatemalan adults interviewed for the Human Capital Study 2002–04, finding a number of differences across subgroups of the sample. The main difference across birth-year cohorts is that younger subjects tend to live in smaller households, with lower total annual household expenditures (and fewer durable goods), though per capita measures are similar across cohorts. This appears to be related to life-cycle fertility patterns. There is a clear positive association between parental socioeconomic status (SES) and current levels of expenditure and durable goods ownership. This association does not hold for all households, however, as there is both upward and downward "mobility" in the sample. Those living in the capital have the highest overall wealth levels, consistent with typical rural-urban patterns. Where there are expenditure differences across groups, they tend to be driven by differences in nonfood rather than food expenditures. Lastly, the study sample is relatively well off compared with their compatriots, with a poverty rate of 35% and an extreme poverty rate of only 3%, against national averages of 56% and 15%, respectively.

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Introduction

Improved nutrition in early childhood has been shown to affect a variety of human capital outcomes later in life, many of which are likely to be reflected in living standards. In economic research, expenditures and wealth are two commonly used measures of well-being. These measures have certain advantages over other indicators of economic well-being, such as income, since they are typically both easier to measure and less subject to temporary fluctuations, including seasonality. As a result, they are often considered indicators of long-term well-being.

For a sample of young Guatemalan adults who received nutrition supplements as children, we do the following: (1) document the methodology used to construct various household expenditure measures; (2) describe patterns of expenditures, housing characteristics, and durable good ownership, with emphasis on how they vary by "initial" conditions including birth year cohorts and SES of the family during childhood, as well as how they vary by current location; and (3) place the sample in the context of contemporary Guatemala, particularly in terms of poverty levels. The aim is to describe patterns in the sample for different measures of wealth; we leave to future analyses an exploration of the links between those patterns and the original nutrition intervention.

Methods

Individuals selected for this study were born between 1962 and 1977 and had participated as children in the INCAP Longitudinal Study (1969–77) of nutrition supplementation [1]. The most recent follow-up, the Human Capital Study, was conducted between 2002

and 2004. Of 2,393 individuals, 2,019 were traceable, i.e., determined to be alive; of these, 163 had left the country, resulting in 1,856 individuals living in Guatemala and targeted for follow up in 2002–04 [2]. The subjects were between 26 and 41 years of age in 2003.

Data

The principal data are drawn from three survey instruments used in the Human Capital Study: (1) a census; (2) an expenditure survey; and (3) a community-level food price survey. For comparison, the 2000 Guatemalan "*Encuesta Nacional Sobre Condiciones de Vida*" (ENCOVI) is also used. The Guatemalan ENCOVI is a comprehensive household survey, often referred to as a living standards measurement survey [3], which includes a broad array of information on the socioeconomic condition of Guatemalans from a nationally representative sample of more than 7,200 households. Among other things, it includes sections on household demographics and living conditions, and food, education, health, housing, and other nonfood expenditures [4].

The Human Capital Study census provides information on the types of durable goods owned by nuclear families (the level at which the census survey is implemented) and the characteristics of their homes [5].

The Human Capital Study expenditure survey provides information on food and nonfood household expenditures. The principal reason for collecting expenditure data in 2002–04 was to provide a measure of economic well-being. The main difficulty, however, is that it is infeasible to collect such information at the *individual* level because people live, and spend, with others. As the focus of the overall study is at the individual level, the individual was taken as the starting point, and then their "expenditure" world built around them. First, we formulated an economic definition of the household, a group of individuals that share resources, including meals, and sleep under the same roof. During the census, all households and household members were determined using this economic definition. The expenditure section was then pre-printed (or in some cases information was transcribed) with all members of the household to which a targeted subject belonged. New household members could also be registered or previous members removed, for example, if household composition had changed during the period between the census and the expenditure survey. The number of days each person (including visitors) was present also was recorded. As a result of this approach, unlike the other survey modules in 2002–04, only one expenditure survey per household was necessary, even when it included more than one target subject.

The remainder of the Human Capital Study expenditure survey is a modified version of the ENCOVI expenditure module. Working with ENCOVI trained enumerators, we field-tested modified versions of the ENCOVI survey questionnaire to capture the bulk of the expenditure information in about 45 minutes, rather than the 90 minutes needed to implement the full ENCOVI module in this population. The length was reduced by combining categories of food items rarely reported in ENCOVI and eliminating questions on *usual* food purchases and food purchases during the previous 12 months, retaining only questions focusing on the previous 15 days.

Fieldwork in the original four villages began in August 2002 with interviewers rotating from one village to the next every 2 weeks, and the bulk was completed by mid-November to reduce the possibility of seasonality effects, particularly those due to the secondary harvest, which begins in November. Migrants, most of whom reside in the capital, were interviewed during the course of 2003 and early 2004. In the vast majority of the interviews the person in charge of household food purchases was interviewed.

While it is possible to derive unit prices for food using the information collected in the household expenditure survey (which includes quantity and value), often such household reports vary in ways related to household behavior, e.g., because different households demand different quality levels or because they purchase larger or smaller quantities that will affect the unit price [6]. Therefore, a community food price survey was implemented in the four villages on a monthly basis during the collection of expenditure data in those same villages (however, it was not feasible, given budget constraints, to implement the price survey in other parts of Guatemala). This independent source of information allows the assessment of price variation for identical goods across the villages and over time and, if necessary, the construction of a price index in order to adjust reported expenditures. This is important since if two households with identical composition are consuming the same quantity of identical goods then they should be treated as equally well-off; if one of them has to pay more for the same goods, however, and welfare is measured with a money metric such as expenditures, the analyst would incorrectly conclude that the household that spent more was better off [7].

Components of aggregate consumption

Expenditures, instead of income, are often used to assess economic well-being—given that they are easier to measure and have less variability throughout the year and across years [7, 8]. This approach is not without its problems, however, particularly because at times it is ambiguous whether some expenditures (e.g., emergency health care) are positively associated with welfare. Also some expenditures are on goods that are consumed over periods of time longer than a year, and thus do not only represent current well-being

(e.g., clothing, furniture, and durable goods such as radios). To facilitate comparison with national data, we replicate, to the extent possible, the methodology used by the World Bank in the analysis of ENCOVI for Guatemala's poverty assessment [4, 7].

Food expenditures (both purchased and non-purchased)

Both cash expenditures (real out-of-pocket costs) and non-cash expenditures or consumption need to be considered in assessing total household expenditures. Food consumed by household members includes not only purchased food (including restaurant meals) but also food obtained but not purchased. The survey questionnaire asks about the purchase of approximately 60 different food items in the previous 15 days, the quantity purchased, and how much was paid. In addition to purchases, for each food type the survey questionnaire asks the same information about the acquisition of food by other means such as household or farm production, donations, or gifts received from persons outside the home, payments in kind, home businesses (but not business expenses), barter, or other means. The respondents are then asked to estimate the value of these items. Thus, the survey measures expenditures and the value of food obtained for home consumption during the reference period, but not actual consumption. The information for each food item is converted to an annual food expenditure using the cost (or estimated value) and the frequency of purchase. For example, if a household indicated that it purchased 10 quetzals (or Q10) worth of meat in the previous 15 days, this would yield Q10 × 24 periods = Q240.

Neglecting to collect information about non-purchased food would have underestimated total expenditures significantly. Moreover, this bias would be different for each household, depending on the proportions of purchased and non-purchased foods, a proportion associated with location in rural versus urban areas. For example, more than 85% of the households report obtaining non-purchased food items and nearly 70% of those are produced or harvested by the household. The foods most commonly produced include maize (both fresh and dry), beans, eggs, fruit, and herbs. While non-purchased foods are common, the average value of the non-purchased foods is only 13% of the average total value of food expenditures in the sample. This average, however, masks the fact that for nearly one-quarter of the households, non-purchased food items comprise 20% or more of their total food budget.

Nonfood expenditures (excluding rent)

The survey also collects information on the expenditures on household items other than food. These nonfood expenditure items are listed in three subsections of the survey form, each of which has a different reference period reflecting the frequency with which the different items are usually purchased. As with food purchases, respondents are asked how much they spent on a list of items during a specific reference period. For regular spending such as transportation costs for the household, a shorter reference period of one week is used to help the respondent remember and report the expenses more accurately. For articles bought less frequently, such as furniture or durable goods, asking about purchases in the previous week would be unlikely to measure the expenditures very well—therefore, for such items a longer period, such as one year, is used.

Durable goods

Items like food have obvious consumption value and can only be used once, in other words, once eaten they are no longer available. This is not the case for many other items, particularly durable goods, because after being used once they still have utility and can continue to be used in the future. The consumption value of durable goods (over a given period) is an approximation of how much the services delivered by the good would cost, if they could be purchased for that period of time only. One component of aggregate consumption not captured in the expenditure analysis (in contrast to the ENCOVI methodology) is the value of these service flows from durable goods owned by the household but not bought in the previous 12 months [4, 7]. The fact that the value of durable goods purchased in the previous 12 months *are* included in our aggregate measure (non-food expenditures above), however, offsets this concern because, for those items, we attribute their entire value to one year, even though they are likely to provide services to the household for a longer period of time.

It is in part for these reasons that in addition to analyzing expenditures, we also directly examine ownership of durable goods and characteristics of households. A second reason for doing so is that the latter measures likely capture different dimensions of wealth, and therefore, well-being. The highest correlation between an expenditure measure and a durable good or housing characteristic measure considered in this article is 0.45, and most are closer to 0.20. The final reason for analyzing these wealth measures is that because they are measured in dummy variable form (only whether or not a household has a durable good or housing characteristic, and not their value), they may be less susceptible to any biases arising from regional price variation.

Housing expenditures (rent)

Housing or implied rental costs are also often difficult to measure. Here again the ENCOVI methodology is

used. First, when the household does not own its home and pays rent, we ask for the amount of rent paid. For those who do not pay rent (90%), the respondent is asked to estimate the value of monthly rent if they had to pay to rent the home in which they live. As with food expenditures, all nonfood expenditures, including housing expenditures, are annualized, using the reported expense and the reference period.

Total and per capita expenditures

Total annual household expenditures are calculated by adding all of the expenditure components. As fieldwork was carried out over a period of nearly 2 years, all nominal values are adjusted to real values at a common date (the final survey month, March 2004, when the official exchange rate was Q8.1 to the US dollar), using the Guatemalan consumer price index [9]. For the ENCOVI, which is nationally representative, there is a price index and expenditures also are adjusted in different areas of the country to control for spatial differences in prices, as well. This is not possible for the Human Capital Study data; below we discuss the extent to which the resulting analysis may be biased.

As a first step toward making sensible comparisons among households, we express total annual household expenditures, as well as food expenditures, on a per capita basis by dividing them by the number of persons in each household. This admittedly ad hoc standardization has some important weaknesses. It implicitly assumes that a young child has the same expenditures as an adult, not very plausible when considering food expenditures, for example. To the extent that household composition varies across households, crude calculations of per capita measures treating each family member the same will be biased in a fashion related to household composition. This approach also ignores the possibility that some items, such as housing expenses, are fixed and shared among household members. In other words, there might be economies of scale in household expenditures.

To address these problems, a separate measure, per capita adult equivalent expenditures with economies of scale, is calculated. Rather than dividing total annual household expenditures by household size, they are first divided by the number of "adult equivalent" persons in the household and then allowances are made for economies of scale in household expenditures. The formula used to calculate per capita adult equivalent expenditures with economies of scale is:

$$\frac{\text{Expenditures}}{(i\,\square 0.3 + c\,\square 0.5 + a)^{q}}$$

where i represents the number of children under 6 years, c children between 6 and 15 and a persons over 15 years. The exponent, q, represents the economy of scale factor, which when equal to 1 assumes no economies of scale (i.e., the situation assumed in calculating per capita expenditures above); in the analyses below, it is set to 0.90. All these weights are somewhat arbitrary, though commonly used values [7]. This more refined, though still ad hoc, measure is used to assess the robustness of the results using per capita expenditures under the assumption of no economies of scale.

Accurately measuring expenditures, while arguably easier than measuring income, has many pitfalls. This section made clear that the methodology for measuring expenditures used here is not perfect, nor does flawless methodology exist—the possible effects of measurement error are considered in the concluding section. We also redo all the analyses reported below, dropping observations in the highest and lowest 1% of per capita annual expenditures to assess whether outliers may be driving any results, but find little change apart from a tendency for average expenditures and their associated SDs to decline slightly.

Results

Expenditure and wealth patterns in the Human Capital Study

Interviews were completed for households covering a total of 1,522 targeted subjects, out of 1,856 traceable subjects living in Guatemala, for an overall response rate of 82%. Completion rates were higher among residents of the original study villages (93%) than among migrants (66%). Interview rates for households with female target subjects were about five percentage points higher than those with males [2].

Since the INCAP Longitudinal Study (1969–77) included all individuals born in the villages in a 15-year period, many original subjects intermarried. This pattern, combined with 40 households in which two or more siblings were living together when interviewed in 2002–04, means that 288 of the 1,522 distinct individual level observations are "duplicates" at the household level, using our economic definition of the household. The unit of analysis in what follows is the household, so duplicates are dropped leaving a sample of 1,234 households (below we describe how we decide who to drop).

We first summarize the expenditure information for the entire sample (top panel of **table 1**, final column). Total annual household expenditures average approximately Q36,000 ($4500), though there is substantial heterogeneity. On average, households spend about 10% on (implied) rent and a little less than half of their budget on food (47%), though again there is substantial variation with about one-quarter spending less than 40% and nearly one-quarter spending more than 60% on food. Over 85% of the value of food is

TABLE 1. Expenditures, durable goods, and household characteristics in the Human Capital Study 2002–04, by birth cohort

Birth cohort	1962–68	1969–77	p^a	Total 1962–77
Expenditures[b]	$n = 482$	$n = 752$		$n = 1,234$
Total annual household expenditures	38.4 ± 29.9	35.0 ± 23.7	.13	36.3 ± 26.3
Total annual household food expenditures	16.2 ± 8.8	15.1 ± 8.0	.08	15.6 ± 8.3
Food share (%)	47	47	.99	47
% of food purchased	86	88	.22	88
Total annual household nonfood expenditures	22.2 ± 23.6	19.9 ± 18.7	.23	20.8 ± 20.8
Per capita annual expenditures	8.2 ± 6.7	8.4 ± 6.8	.19	8.3 ± 6.8
Per capita annual food expenditures	3.4 ± 2.1	3.5 ± 2.2	.15	3.5 ± 2.2
Per capita annual health expenditures	0.3 ± 0.9	0.3 ± 0.8	.82	0.3 ± 0.8
Per capita annual education expenditures	0.3 ± 0.7	0.2 ± 0.4	< .01	0.2 ± 0.5
Per capita adult equivalent expenditures	10.2 ± 7.3	10.4 ± 7.6	.27	10.3 ± 7.5
Per capita adult equivalent food expenditures	4.6 ± 2.5	4.8 ± 2.7	.28	4.7 ± 2.6
Household size	5.3 ± 2.0	4.8 ± 1.7	< .01	5.0 ± 1.9
Number of children under 15	1.8 ± 1.7	1.5 ± 1.5	.01	1.6 ± 1.6
Durable goods and housing characteristics	$n = 470$	$n = 726$		$n = 1,196$
Own refrigerator (%)	38	34	.52	36
Own television (%)	81	81	.83	81
Own cell phone or house phone (%)	46	48	.45	47
Own vehicle (%)	15	12	.13	13
Total number of durable goods (of possible 18)[c]	5.7 ± 3.1	5.4 ± 2.9	.20	5.5 ± 3.0
Own home (%)	76	67	< .01	71
Home with all high quality materials (%)	72	74	.39	73

a. *p* value for test of equality of populations across birth year cohort using two-tailed proportion test for proportions and non-parametric Kruskal-Wallis test for all others.
b. All expenditure values in thousands of March 2004 quetzals at 8.1 quetzals to the US dollar.
c. Durable goods included are: radio, stereo, cassette player, television, video machine, refrigerator, cell or home phone, cable television, microwave, blender, typewriter, computer, iron, mill, sewing machine, bicycle, motorcycle, and vehicle.

purchased rather than produced. The largest component of the food budget is grains (28%) followed by meat (18%). On average, less than 4% of total annual household expenditures is spent on health and 3% on education. A small number of households, however, spend substantially more on one or both of these. About 10% spend 5% or more on education and 10% spend 10% or more on health.

Average household size is 5.0 persons, so that average per capita annual expenditures are just over Q8,300 ($1000), though the median is Q2,000 lower, consistent with a skewed distribution typical of expenditure patterns [8]. The average is one-third lower than the national GDP per capita measure of $1500 in 2002. **Figure 1** presents the density function for logarithmic per capita annual expenditures in the sample. As evidenced by the superimposed normal distribution, logarithmic per capita annual expenditures are approximately normally distributed (though they fail to pass a Shapiro-Wilkes normality test [10]). One-third of the subjects report per capita annual expenditures of Q5,000 or less and 75% spend less than Q10,000.

Selected durable goods and housing characteristics are presented in the bottom panel of **table 1**. There are 38 fewer observations than in the top panel due to missing census data for some individuals. Similar to the presentation of expenditures, information for the nuclear family in which the target subject lives is reported. As this information is taken from the 2002–04 census, the unit of analysis is slightly different than in the top panel of the table, since the census is carried out for nuclear families rather than economic households [5]. A comparison of household size and nuclear family size for the 1,196 overlapping observations indicates that nuclear family size is smaller, but only by 0.25 members and in less than 10% of the observations is there more than a one-person difference between the two measures—for these reasons, in the analysis that follows the household and the nuclear family are treated as equivalent and both referred to as "households."

While electricity in the home is nearly universal (not shown), ownership of electric consumer durable goods is not. Only 36% of the households own a refrigerator, though television ownership is much more prevalent (81%). Vehicle ownership, on the other hand, is

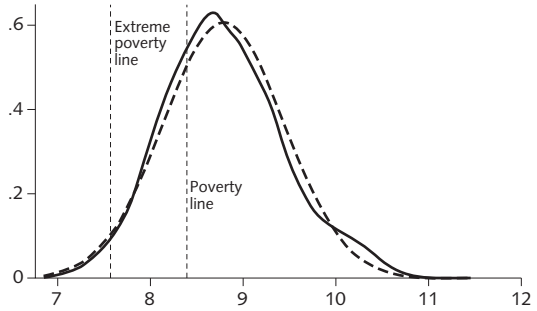

FIG 1. Density function of logarithmic annual total per capita expenditures in the Human Capital Study (2002–04)

uncommon. On average, households report 5.5 out of a possible 18 items listed in the census. More than two-thirds indicate they own their home and observations of the flooring, wall, and roofing materials indicate those homes are of high quality materials. High quality materials are defined as the following: (1) brick, tile, or cement for flooring; (2) adobe, wood, cement block, or metal sheets for walls; and (3) metal sheets or concrete for roofing.

Next, the various expenditure, durable goods, and housing characteristic measures are stratified by birth year cohort of the original subject (**table 1**), an index of the subject's parents' SES in 1975 (**table 2**), and current residence (**table 3**). When there is more than one targeted subject in a household, the characteristics of the oldest male, if there is a male, and the oldest female, if not, are used for stratifying the household. Within each table, we test for heterogeneity of the stratum averages using either the Kruskal-Wallis non-parametric test of the hypothesis that several samples are from the same population (a non-parametric alternative to ANOVA), or, where appropriate, a proportion test [10]. ANOVA tests are not used because only for a handful of the measures considered are the necessary conditions of normality and equality of variance across groups satisfied, even after taking logarithmic transformations of the variables.

Comparisons of the expenditure measures between those born before 1969 and those born between 1969 and 1977 indicate few significant differences. An important exception is household size, which is on average 5.3 for those in the older cohort and 4.8 for the younger, an apparent lifecycle effect as households in the older cohort have on average 0.3 more children under 15 years. This difference explains why apparently higher household total and food annual expenditures for the older cohort disappear when per capita or per capita adult equivalent expenditures with economies of scale are compared instead. These findings are robust to adjustments in per capita food expenditures that account for the number of days individuals (including visitors) were present in the household during the reference period (not shown). Per capita annual expenditures on education are about twice as much in the older cohort, in part because they have more school-age children.

There are also few differences between the birth year cohorts in terms of durable goods and housing characteristics, although the older cohort is 9 percentage points more likely to own their home ($p < .01$). This difference is likely associated with households with older members being more established.

When stratified by the tertiles of the parental SES index [11], there is a clear positive association of parental family background and current expenditures, durable goods, and housing characteristics (**table 2**). The pattern is seen for total (and food) annual expenditures and, given a negative association between the 1975 SES index and current household size, it is even sharper for the per capita measures. Average per capita annual expenditures increase 50% between those categorized in the lowest tertile of parental SES and those in the highest; the majority of this increase reflects increases in annual nonfood rather than food expenditures.

Ownership of durable goods and of homes increase and housing characteristics improve across tertiles of the parental SES index and three of the seven indicators in **table 2** are significantly different across the three groups ($p < .01$, excluding those households with missing index scores). These findings hint at the importance of family background and the possible intergenerational transmission of wealth in rural Guatemala, though they do not shed light on the mechanisms underlying such transmission. The data are also consistent, however, with the possibility of upward (or downward) mobility over time, at least for some. For example, 5% of those in the lowest tertile of parental SES have per capita expenditures in the top 10% of the entire sample, and 10% of those in the middle tertile of parental SES do. There is no obvious pattern for households missing an initial parental SES index (because their family was not present during the 1975 census [11]), and they appear to be about evenly balanced among the three groups.

The previous two tables stratified on "initial" conditions, characteristics of the subjects or their families dating back to the original study in the 1970s. **Table 3** stratifies on location of residence during 2002–04, categorizing individuals living in (or near) their natal village, living in Guatemala City, or living elsewhere in Guatemala. The differences are significant for all the expenditure categories considered ($p < .01$). Expenditures tend to be lower in the original villages (closely followed by those living elsewhere in Guatemala) and higher for those living in the capital. This is particularly true for per capita measures since households in the capital have on average 0.5 fewer persons. While per capita food measures are not substantially different across the groups, total per capita measures are more than 50% higher in Guatemala City. Total annual

TABLE 2. Expenditures, durable goods, and household characteristics in the Human Capital Study 2002–04, by parental socioeconomic tertile in 1975

Parental socioeconomic tertile:	Low	Middle	High	p^a	Missing
Expenditures[b]	$n = 374$	$n = 385$	$n = 375$		$n = 100$
Total annual household expenditures	30.8 ± 19.8	36.5 ± 28.7	41.5 ± 28.6	< .01	37.0 ± 25.9
Total annual household food expenditures	14.5 ± 8.6	15.6 ± 8.6	16.5 ± 7.7	< .01	15.8 ± 8.5
Food share (%)	50	47	45	< .01	48
% of food purchased	86	88	88	.20	90
Total annual household nonfood expenditures	16.3 ± 13.6	20.8 ± 22.5	25.0 ± 24.0	< .01	21.2 ± 20.0
Per capita annual expenditures	6.7 ± 4.7	8.2 ± 6.1	10.1 ± 8.6	< .01	7.9 ± 6.6
Per capita annual food expenditures	3.1 ± 1.8	3.5 ± 2.1	3.9 ± 2.5	< .01	3.2 ± 1.8
Per capita annual health expenditures	0.2 ± 0.7	0.3 ± 0.8	0.4 ± 1.0	< .01	0.4 ± 1.0
Per capita annual education expenditures	0.1 ± 0.2	0.2 ± 0.5	0.3 ± 0.7	< .01	0.3 ± 0.8
Per capita adult equivalent expenditures	8.5 ± 5.2	10.4 ± 7.1	12.3 ± 9.2	< .01	9.4 ± 7.7
Per capita adult equivalent food expenditures	4.3 ± 2.2	4.9 ± 2.6	5.2 ± 2.8	< .01	4.0 ± 2.4
Household size	5.1 ± 1.8	5.0 ± 1.9	4.8 ± 1.8	.01	5.4 ± 1.9
Number of children under 15	1.8 ± 1.6	1.8 ± 1.7	1.5 ± 1.6	.02	0.7 ± 1.3
Durable goods and housing characteristics	$n = 361$	$n = 372$	$n = 365$		$n = 98$
Own refrigerator (%)	27	35	46	< .01	35
Own television (%)	78	82	86	.14	71
Own cell phone or house phone (%)	43	44	51	.12	66
Own vehicle (%)	9	12	17	.16	14
Total number of durable goods (of possible 18)[c]	5.0 ± 2.7	5.3 ± 3.0	6.3 ± 3.1	< .01	5.6 ± 3.3
Own home (%)	69	72	75	.33	57
Home with all high quality materials (%)	65	75	81	< .01	67

a. *p* value for test of equality of populations across parental SES index tertile using non-parametric Kruskal-Wallis test, excluding missing category.
b. All expenditure values in thousands of March 2004 quetzals at 8.1 quetzals to the US dollar.
c. Durable goods included are: radio, stereo, cassette player, television, video machine, refrigerator, cell or home phone, cable television, microwave, blender, typewriter, computer, iron, mill, sewing machine, bicycle, motorcycle, and vehicle.

household nonfood expenditures comprise the bulk of the difference between expenditures in the capital and elsewhere, including educational expenditures, which are more than double. Urbanization is also reflected in the percentage of purchased to total annual food expenditures, which is 95% for those currently residing in the capital, but 87% or less in the other areas. While much of the survey work for those in Guatemala City occurred after that in the original villages, since all figures are inflated to a common date using the consumer price index the observed differences are not the result of the timing of the survey. Furthermore, the most likely difference in reported expenditures arising from the more intensive administration of survey modules to migrants would be underestimation as respondents tired of the series of questionnaires.

With the exception of nonfood and health expenditures, all the expenditure indicators are also different across the four villages after excluding those living in Guatemala City and elsewhere ($p < .01$). Per capita annual expenditures are on average highest in Santo Domingo, the most urban village and closest to Guatemala City [5].

An important consideration when comparing across villages or across regions of Guatemala is the extent to which there are price differences. The community-level price information collected during September, October, and November 2002 in the four villages and the local municipal seat indicate that price variation on commonly purchased goods is minimal within the areas covered by the villages, both across villages and over time. Therefore, expenditure differences across villages are not due to price differences.

While it is not possible to construct indices for all of our data since there is no price information for those in Guatemala City or elsewhere in Guatemala, there is some information on spatial price variation from ENCOVI [4]. In particular, those data showed price variation across differing regions of Guatemala from 0.99 to 1.07, with prices in Guatemala City set to 1.00. If anything, then, the comparisons made in **table 3** (that do not adjust for regional prices) understate differences between the capital and other areas, strengthening the conclusions made above.

Durable good ownership and housing characteristics across current residence largely mimic the results for expenditures. In particular, measures are substantially higher in Guatemala City for all items considered *except*

home ownership where it is more than 20 percentage points lower. Among the four villages, durable good ownership is lowest in Espíritu Santo, not Conacaste where expenditures are the lowest.

The Human Capital Study 2002–04 in the Guatemalan context

There are two national poverty lines calculated based on the ENCOVI [4]. First, the extreme poverty line is defined as the cost of a basic "food basket" able to provide the minimum daily caloric requirement (2,172 kcal). Thus, it represents the hypothetical situation where a household spends its resources exclusively on food. In 2000, the estimated cost, i.e., the extreme poverty line, was Q1,912 per capita per annum ($246 in 2000 when the official exchange rate was Q7.8 to the US dollar [9]). The overall poverty line is the extreme poverty line plus an allowance for nonfood items where the latter is calculated by examining the expenditure patterns of households whose food budget was at or near the extreme poverty line. The estimated full poverty line in 2000 was Q4,319 ($556) [4].

In 2000, more than half (56%) of all Guatemalans lived in poverty or extreme poverty, with 15% in extreme poverty. As in most developing countries,

TABLE 3. Expenditures, durable goods, and household characteristics in the Human Capital Study 2002–04, by current residence[a]

Current residence:	Santo Domingo and nearby	Espíritu Santo and nearby	Conacaste and nearby	San Juan and nearby	Guatemala City	Elsewhere in Guatemala	*p*
Expenditures	*n* = 257	*n* = 161	*n* = 269	*n* = 217	*n* = 224	*n* = 106	
Total annual household expenditures	33.0 ± 18.0	33.1 ± 22.1	31.2 ± 23.2	33.4 ± 19.4	50.6 ± 32.2	37.7 ± 41.2	< .01
Total annual household food expenditures	15.5 ± 7.4	16.9 ± 10.3	13.7 ± 7.3	15.9 ± 8.0	16.7 ± 7.9	15.4 ± 10.1	< .01
Food share (%)	49	53	48	50	37	48	< .01
% of food purchased	87	87	83	87	95	86	< .01
Total annual household nonfood expenditures	17.6 ± 13.1	16.3 ± 13.8	17.5 ± 18.4	17.5 ± 13.5	33.9 ± 27.0	22.3 ± 32.9	< .01
Per capita annual expenditures	7.6 ± 5.1	7.1 ± 5.1	6.5 ± 4.7	7.3 ± 5.2	13.3 ± 10.0	7.8 ± 6.9	< .01
Per capita annual food expenditures	3.5 ± 2.1	3.5 ± 1.9	2.9 ± 1.6	3.5 ± 2.2	4.3 ± 2.4	3.2 ± 2.6	< .01
Per capita annual health expenditures	0.3 ± 0.7	0.3 ± 0.7	0.2 ± 0.6	0.3 ± 0.8	0.7 ± 1.4	0.2 ± 0.6	< .01
Per capita annual education expenditures	0.1 ± 0.3	0.1 ± 0.2	0.1 ± 0.2	0.1 ± 0.3	0.6 ± 1.1	0.2 ± 0.4	< .01
Per capita adult equivalent expenditures	10.2 ± 6.1	9.3 ± 5.7	8.6 ± 6.4	9.4 ± 5.7	14.8 ± 10.6	8.9 ± 7.5	< .01
Per capita adult equivalent food expenditures	5.1 ± 2.7	5.1 ± 2.5	4.1 ± 2.1	4.9 ± 2.7	5.0 ± 2.7	3.8 ± 2.7	< .01
Household size	4.9 ± 1.8	5.1 ± 1.9	5.1 ± 1.8	5.2 ± 1.9	4.4 ± 1.7	5.5 ± 2.0	< .01
Number of children under 15	2.1 ± 1.5	2.1 ± 1.6	2.0 ± 1.5	1.9 ± 1.8	0.3 ± 0.8	0.4 ± 0.9	< .01
Durable goods and housing characteristics	*n* = 252	*n* = 154	*n* = 261	*n* = 200	*n* = 223	*n* = 106	
Own refrigerator (%)	33	23	31	30	61	33	< .01
Own television (%)	82	66	81	82	91	75	< .01
Own cell phone or house phone (%)	31	24	44	38	87	62	< .01
Own vehicle (%)	13	6	8	7	26	16	< .01
Total number of durable goods (of possible 18)	5.0 ± 2.6	4.4 ± 2.7	5.2 ± 2.6	5.0 ± 2.8	7.7 ± 3.1	5.9 ± 3.0	< .01
Own home (%)	84	69	80	77	43	63	< .01
Home with all high quality materials (%)	87	61	58	76	84	67	< .01

a. See Table 2.

poverty in Guatemala is predominantly a rural phenomenon—81% of the poor and 93% of the extreme poor live in rural areas such that three-quarters of all rural residents live in poverty and one-quarter in extreme poverty [4].

While similar, the ENCOVI and Human Capital Study 2002–04 follow-up surveys are not identical. Hence, a number of adjustments are made to compare them and calculate poverty levels in our sample. First, a small number of components included in the ENCOVI but not in our survey, including the use-value of consumer durable goods, are removed. Second, all values are deflated to year 2000 quetzals using the Guatemalan consumer price index [9]. Next, because of different sample proportions in different parts of the country, we disaggregate the Human Capital Study households by location, examining separately those in Guatemala City and those in the northeast region for a more direct comparison with the ENCOVI sample households. (ENCOVI is a representative sample at the regional level.) Finally, only ENCOVI households that have members between 25 and 40 years are retained, to ensure households have approximately the same demographic and age composition in both samples. In all, 1,128 of the 1,234 Human Capital Study households examined in the earlier tables, and 1,465 households from the Guatemalan ENCOVI, are retained.

Our sample has average total annual household expenditures that are lower than the ENCOVI sample in the capital, but higher in the northeast region (**table 4**). Average per capita annual (food) expenditures in our sample are about 8% (5%) lower in the capital and 32% (37%) higher in the northeast region ($p < .01$).

Because for this analysis some items were removed from the aggregate expenditures originally calculated using ENCOVI, it would be incorrect to apply the national poverty lines to the adjusted ENCOVI data or to the Human Capital Study data, for that matter. Using the adjusted aggregate expenditures from ENCOVI, we calculate adjusted poverty lines such that they yield the same levels of extreme poverty and poverty reported in the ENCOVI [4]. This results in a reduction of 7% in each of the poverty lines.

The extreme poverty rate in our sample is 3% and general poverty rate (including the extreme poor) 35% (**figure 1**). When considered by region (**table 4**) there are very few extremely poor households in the capital, just as in ENVOCI, but 4% extremely poor households in the northeast region, substantially less than in that region as a whole (17%). General poverty rates are not significantly different between the samples in Guatemala City, but 21 percentage points lower in the northeast region. One characteristic of the four villages that may be associated with their having higher average expenditures than others in the same region is that their proximity to Guatemala City and the income-generating opportunities that proximity may provide [5].

Conclusions

In this article, we describe the expenditure and wealth patterns, indicators of long-term economic well-being, for a sample of young Guatemalan adults interviewed for the Human Capital Study 2002–04, finding a number of differences across subgroups of the sample. The main difference across birth year cohorts is that younger subjects tend to live in smaller households,

TABLE 4. Comparison of expenditure patterns and poverty between the Human Capital Study 2002–04 and ENCOVI

	Guatemala City			Northeast Region[a]		
	Human Capital Study $n = 224$	ENCOVI $n = 569$	p^b	Human Capital Study $n = 904$	ENCOVI $n = 896$	p^b
Total annual household expenditures[c]	40.1 ± 25.5	52.8 ± 46.4	< .01	25.8 ± 16.4	22.1 ± 15.5	.09
Total annual household food expenditures	13.2 ± 6.3	17.6 ± 11.0	< .01	12.1 ± 6.5	10.9 ± 6.6	.11
Food share (%)	36	40	.10	50	52	.97
Total annual household nonfood expenditures	26.9 ± 21.4	35.2 ± 37.4	< .01	13.7 ± 11.9	11.2 ± 10.8	.07
Per capita annual total expenditures	10.5 ± 7.9	12.2 ± 10.9	< .01	5.6 ± 4.0	4.5 ± 4.1	< .01
Per capita annual food expenditures	3.4 ± 1.9	4.0 ± 2.7	< .01	2.6 ± 1.6	2.2 ± 1.7	< .01
Per capita annual health expenditures	0.5 ± 1.1	0.8 ± 1.5	< .01	0.2 ± 0.5	0.1 ± 0.4	< .01
Per capita annual education expenditures	0.5 ± 0.8	0.7 ± 1.2	.02	0.1 ± 0.2	0.1 ± 0.4	.85
Household size	4.4 ± 1.7	4.9 ± 2.1	.06	5.1 ± 1.9	5.8 ± 2.4	< .01
Extreme poverty (%)	0.4	0.7	.99	4	17	< .01
General poverty (%)	11	14	.86	41	62	< .01

a. The Northeast Region includes the departments of El Progreso, Baja and Alta Verapaz, Izabel, Zacapa, and Chiquimula.
b. *p* value for test of equality of populations across Human Capital Study and ENCOVI using two-tailed proportion test for proportions and non-parametric Kruskal-Wallis test for all others.
c. All expenditure values in thousands of March 2004 quetzals at 8.1 quetzals to the US dollar.

with lower total annual household expenditures (and fewer durable goods), though per capita measures are similar across cohorts. This appears to be related to life-cycle fertility patterns. There is a clear positive association between parental SES and current levels of expenditure and durable goods ownership. This association does not hold for all households, however, as there is both upward and downward "mobility" in the sample. Those living in the capital have the highest overall wealth levels, consistent with typical rural-urban patterns. Where there are expenditure differences across groups, they tend to be driven by differences in non-food rather than food expenditures. Lastly, the Human Capital Study sample is relatively well-off compared with their compatriots, with a poverty rate of 35% and an extreme poverty rate of only 3%, against national averages of 56% and 15%, respectively. Differences in poverty rates persist when more direct comparisons are made based on current location.

Because the Human Capital Study sample members are from four villages in a country of 12 million inhabitants, it is obvious that part of the difference between the Human Capital Study and ENCOVI samples reflects the fact that the Human Capital Study sample is not representative of Guatemala as a whole. Another possible source of difference between the two surveys is that given their different designs (and sample sizes), it is likely that our study was more carefully supervised and therefore possible that there are fewer measurement errors or omissions. The fact that in one region expenditures are higher than ENCOVI and in another lower, however, is evidence against systematic bias. Lastly, the differences also may reflect in part sample selection due to such factors as attrition and migration out of the country.

Throughout, we are careful not to "over-interpret" patterns uncovered by these simple two-way comparisons, given various possible confounding factors. Future analyses will explore the causal effects of the original nutrition interventions on these measures of well-being or, in other cases, employ them as (endogenous) conditioning factors that proxy for permanent income or resource availability.

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Research Note: A socioeconomic index for the INCAP Longitudinal Study 1969–77

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Abstract

In this note, we calculate and describe proxy measures that account for variation in standard of living across subjects in the Institute of Nutrition of Central America and Panama (INCAP) Longitudinal Study (1969–77), at the time of the original intervention. Using principal components analysis, we construct two linear indices from an array of household consumer durable goods and housing characteristics, measured at the nuclear family level in the 1975 cross-sectional census. The two indices perform well on three dimensions. First, they are internally coherent in that average ownership and quality of housing characteristics increase with the principal component score. Second, they are robust in that the different approaches yield similar results, for example, in classifying nuclear families into tertiles. And third, they are consistent in that they yield results similar to scores constructed by previous researchers. The indices can be used as background controls in analyses of the INCAP Longitudinal Study (1969–77) data and subsequent follow-up studies, including the Human Capital Study 2002–04. Several articles presented in this supplement to the Food and Nutrition Bulletin *used the 1975 index.*

Key words: Guatemala, Institute of Nutrition of Central America and Panama (INCAP), Human Capital Study, SES index

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Introduction

The main objective of this note is to construct a proxy measure that accounts for variation in wealth across subjects in the INCAP Longitudinal Study (1969–77), at the time of the original intervention in the 1970s [1]. Using principal components analysis, we construct a linear index, hereafter called a socioeconomic (SES) index, from an array of household consumer durable goods and housing characteristics, measured at the nuclear family level in the 1975 cross-sectional census [2].

Methods

Our approach is guided by, but not identical to, previous analyses using these data [3, 4]. In the past, factor analysis was employed to construct SES indices for the INCAP Longitudinal Study (1969–77). Factor analysis is used when the analyst posits a causal model in which one or more unobservable constructs determine a set of observable variables. The goal is to *explain* the common variance among observable variables that arises from their relationship with the unobservable construct(s). By contrast, the method of principal components is used when one wishes simply to *account* for variation in a set of observed variables by constructing from them a set of new, mutually uncorrelated, variables. These so-called principal components are ordered with respect to the amount of variance they account for in the original variables. As a result, the first few principal components typically account for much of the variation present in the original variables [5].

Given our objective, we use principal components rather than factor analysis, largely to avoid making explicit assumptions about a causal model explaining observed wealth. In practice, the resulting indices are similar if instead factor analysis is used.

A second difference from previous research is that the data in this analysis are standardized across the entire sample rather than within each community.

This approach maximally accounts for variation across communities, but may not maximally capture variation within each community. A drawback to this approach is that the relative weights of the durable goods and housing characteristics are restricted to be equivalent—despite possible differences (e.g., in prices)—across communities. For this reason, researchers may wish to include community-level factors (or dummy variables), in addition to the nuclear family level SES index, in their analyses. Community dummies would shift the mean across communities and thereby make standardization *within* communities less necessary, especially if the SES index also is interacted with the community fixed effects.

The first, and our preferred, measure closely follows Filmer and Pritchett [6] but includes adjustments to suit these data. Each durable good or household characteristic, including previously categorical variables such as type of water source, is characterized as a 0/1 dummy variable. One exception is the number of rooms in the house pertaining to the nuclear family, which is standardized by the number of residents. As such, this approach is referred to as the "dummy variable method." It has the advantage that it does not assume equal "distance" (in value) between categories in categorical variables (e.g., the improvement from open source water to a public pump is the same as from a public pump to a private well), as would be assumed if these variables remained in their categorical form.

Categories of a categorical variable that represent less than 1% of the sample are combined with the most similar category before analysis. For each categorical variable, the dummy variable for the least costly or most rudimentary category is excluded, consistent with the treatment of ownership of durable goods. Finally, a small number of the constructed dummy variables with negative loadings when the model is estimated for census data from 1987 and 1996 are excluded from the analysis: (1) whether the housing structure is semiformal, (2) whether the kitchen is used for sleeping and/or is in a detached structure, and (3) whether water is collected from an open public source that is not a well. With these modifications, all categorical variables in the data, even those that originally had more than two categories, are reduced to only two categories (with one dummy variable remaining in the analysis for each original variable).

One drawback in using principal components when the original variables are binary is that their inclusion formally violates the (asymptotic) normality assumptions underlying the methodology. Nevertheless, we follow the literature where common practice is to construct indices via principal components using dichotomous variables [6].

The second measure is akin, but not identical, to that described in Rivera et al. [3]. This approach treats the categorical variables not only as ordinal in their representation of the underlying durable goods or household characteristics, but also as cardinal, in the sense that moving from the first to the second category is given the same value as moving from the second to the third. This approach is referred to as the "categorical variable method."

For each of the two methods, we retain only the first principal component. Each durable good or household characteristic is assigned a weight using the first principal component from a principal components analysis on standardized (mean zero, SD one) data, and the associated principal component score is used as the SES index.

For each method, we limit the analysis to one principal component score mainly for pragmatic reasons; when modeling interactions with other variables, analyses would become complicated quickly if more than one proxy for wealth were included. This decision overrides several (arbitrary) rules of thumb about the number of principal components to retain [5]. It also underscores the extent to which the proposed index is a proxy measure, since it captures only a portion of the total variance in the original variables. Also following Filmer and Pritchett [6], all variables are retained in the analysis, regardless of the magnitude of their weights or loadings.

The detailed components for each method are:

Dummy variable method. Principal components combining durable goods and housing characteristics: includes dummy variables for whether or not the nuclear family owns specific durable goods and dummy variables (except for number of rooms) created from categorical housing characteristics (see **table 1** for list).

Categorical variable method. Principal components using the number of durable goods owned and ordered categorical housing characteristics. Housing characteristics are included in their original categorical form from the census, (thereby assuming increments between categories to be equal in magnitude), and the durable goods are summed and included as a single variable.

The resulting principal component scores, the SES indices, are then used to categorize the population: nuclear families are ranked by principal component score and then divided into tertiles—three groups with the same number of nuclear families in each group.

Results

All calculations are carried out in Stata 8.0. Using the dummy variable method, the variance accounted for by the first principal component is 18%, after which it drops substantially for the second (10%) and third

TABLE 1. Weights and summary statistics for variables used in the computation of the SES index using dummy variable method ($n = 754$)

	Weight	Unadjusted loading (Weight ÷ SD)	Means		
			Poorest 33%	Middle 33%	Richest 33%
Own radio	0.22	0.44	0.28	0.53	0.79
Own record-player	0.19	1.22	0.00	0.00	0.07
Own bicycle	0.18	1.12	0.00	0.01	0.07
Own sewing machine	0.25	0.82	0.00	0.02	0.31
Own refrigerator	0.30	1.98	0.00	0.00	0.07
Own television	0.18	1.92	0.00	0.00	0.03
Own motorcycle	0.19	3.77	0.00	0.00	0.01
Own automobile	0.14	3.80	0.00	0.00	0.01
Own plot of land for house	0.03	0.06	0.69	0.76	0.76
Own their house	0.03	0.07	0.83	0.86	0.85
Number of rooms in house/ number of individuals	0.20	0.40	0.40	0.55	0.86
Live in a formal house	0.38	1.37	0.00	0.00	0.26
High-quality flooring	0.39	1.22	0.00	0.01	0.34
High-quality roofing	0.22	0.49	0.36	0.88	0.93
High-quality walls	0.27	0.55	0.07	0.73	0.90
Kitchen separate room in house	0.17	0.42	0.05	0.14	0.46
Formal cooking medium	0.26	0.52	0.10	0.46	0.83
Has electricity	0.09	0.30	0.06	0.09	0.17
Latrine/toilet	0.26	0.70	0.01	0.09	0.39
Drinking water from well	0.06	0.20	0.07	0.09	0.15
Dummy variable SES index	NA	NA	–1.52	–0.39	1.92

NA, not available

(9%) principal components. For the categorical variable method, which has a smaller number of variables, the first principal component accounts for just over 50% of the variation (and the second, 9%). This apparent gain comes at the expense of the implicit assumptions underlying that formulation, in particular that the categories represent equally sized steps in improved quality and that each durable good has the same value, as explained above.

Table 1 presents the results from the principal component score calculations using the dummy variable method. The weights for the first principal component are listed in the first column and the loadings, unadjusted for the latent root (i.e., simply the weight divided by the SD), in the second column. For 0/1 dummy variables, the unadjusted loading has the interpretation that it is the amount the index would change if the family obtains the item or characteristic. The individual variable means are shown by wealth groups (poorest third, middle third, and wealthiest third, as ranked by the estimated principal component scores for each nuclear family shown in the bottom row) in the final three columns.

Having formulated all the variables to be increasing in value, it is reassuring that all the weights for the first principal component are positive. The scores load most heavily on ownership of motorcycles and automobiles, followed by ownership of refrigerators and televisions, as well as whether the nuclear family lives in a formal housing structure.

Internal coherence

To explore how well the scores reflect wealth, we examine the raw variable means across tertiles of the score. Except for the number of rooms per person, each of the means presented in the last three columns represents the proportion of nuclear families owning the durable good or having that particular housing characteristic. Although ownership of some of the durable goods is not common among any of the wealth groups, **table 1** shows that the incidence of durable good ownership increases monotonically across the wealth groups for every durable good; these increases are especially marked for radios and sewing machines. Furthermore, only families in the richest third live in a formal house and report owning record players, refrigerators, televisions, motorcycles, or cars. The number of rooms per person increases across groups, with the wealthiest third having twice the living space per person as the poorest third. Whether the house is formal, and indicators of higher quality materials for flooring, roofing, and walls,

all rise by wealth group, as do the quality of the kitchen and medium of cooking, availability of electricity, toilet facilities, and source of drinking water.

A similar analysis for the categorical variable method leads to the same conclusions (not shown). In sum, the evidence indicates that the SES index is associated with wealth when divided into tertiles.

Robustness

We next consider to what extent the two methods yield similar results. The Spearman rank correlation coefficient between the two measures is 0.90 ($p < .01$), indicating that they are very similar. Furthermore, the Spearman rank correlation coefficients between these two measures and that used in Rivera et al. [3] are also very high, 0.95 ($p < .01$) for the dummy variable method and 0.93 ($p < .01$) for the categorical method. **Table 2** shows to what extent the two indices constructed in this paper lead to similar classifications of families into tertiles. The two methods have classified nuclear families in the same tertiles when an observation appears on the downward sloping diagonal of the first three columns. Overall, crude agreement is 74%. Furthermore, in only 2 cases do one method classify a nuclear family at one extreme (top or bottom tertile) and the other method at the other extreme. Most of the disagreement comes from different classifications across adjacent groupings, and at least part of the disagreement is associated with the absolute nature of the cut-points. The kappa statistic, a measure of chance-corrected agreement between two or more ratings, between the two methods is 0.61 ($p < .01$).

TABLE 2. Comparison of tertile rankings for SES indices using dummy variable versus categorical methods ($n = 754$)

	Categorical variable method			
Dummy variable method	Poorest tertile	Middle tertile	Wealthiest tertile	Total
Poorest tertile Number of families (%)	218 (29)	35 (5)	0 (0)	253 (34)
Middle tertile Number of families (%)	32 (4)	153 (20)	65 (9)	250 (33)
Wealthiest tertile Number of families (%)	2 (0)	63 (8)	186 (25)	251 (33)
Total number of families (%)	252 (34)	251 (33)	251 (33)	754 (100)

Discussion

The proposed index includes ownership of durable goods, characteristics of the dwelling, and access to basic services, and thus is a broad measure of welfare. Although the index is more precisely described as a *durable goods and housing index*, we use the abbreviated term *SES index*, since we consider it a measure for standard of living, and therefore a proxy measure of permanent income. Including such an index in analyses is not equivalent to controlling for current expenditures or income, but is likely to yield similar results, given the relationship between durable goods, household characteristics, and access to services on the one hand, and expenditures on the other [7].

Unlike other SES indices, particularly some in the sociological literature, ours does not include measures of education, income, or occupation [8, 9]. First, no income data are available in the census. Second, given the emphasis on education, health, and occupation in their own right in the INCAP Longitudinal Study (1969–77) and the Human Capital Study (2002–04) [10], as well as the problems inherent in aggregating these individual-level characteristics to the family or household level, we do not include measures of human assets, occupation, or occupational prestige. As a result, this measure fails to capture the extent to which some families invest in human, or other productive assets rather than consumer durables. These caveats must be considered when interpreting results including this index since decisions to invest in those ways may be correlated with outcomes under consideration.

The ideal approach for constructing this index would be to sum all the items included using second-hand market prices as weights for each one. When information on market prices or the quality or value of assets is not available, some researchers use simple counts of items, assigning them either equal weights or arbitrary weights to reflect relative market prices. An alternative to summing arbitrarily weighted items is to include indicators for them directly in the relations being estimated; these indicators may be highly correlated, however, and may yield imprecise estimates. By using an index constructed via principal components that captures much of the variation of the original measures, our approach reduces the number of variables to be included in analyses, mitigating the problem of multicollinearity.

Including all the variables in the calculations suggests a potential lack of discrimination among their different roles in different analyses. For example, it is arguable whether access to water, sanitation, electricity, or other publicly held resources should be included in an index intended to measure private standards of living if these things are publicly provided. If migration is possible, then they likely reflect household-level characteristics, since households that value them more can move to areas where such services exist. Even without migration, services are not likely to be exogenously placed;

for example, wealthier neighborhoods may receive services first. Finally, for most services (including electricity), substantial within-community variation is apparent in 1975.

Durable goods and housing are to some extent public goods for co-resident individuals, so some sort of standardization may be warranted to reflect accurately their value at the individual level. Only the number of rooms is standardized (by the number of residents), thereby treating the other characteristics as perfect public goods within the family.

Conclusions

This note describes the construction and interpretation of two SES indices based on the 1975 census data from the INCAP Longitudinal Study (1969–77). The two indices perform well on three dimensions. First, they are *internally coherent* in that average ownership and quality of housing characteristics increase with the principal component score. Second, they are *robust* in that the different approaches yield similar results, for example, in classifying families into tertiles. And third, they are *consistent* in that they yield results similar to scores constructed by previous researchers using these same data. These findings mitigate potential concerns that results from previous research are functions of the different methodologies or data used—in other words, rerunning previous analyses with the newly constructed measures is unlikely to alter inferences.

Given the similarities between methods, we argue that the index formed by the dummy variable method is preferable because it requires weaker assumptions regarding the relative value of different assets and housing characteristics. As such, this measure is the one used in many of the articles presented in this issue of the *Food and Nutrition Bulletin*. Those articles take as their sample subjects re-interviewed for the Human Capital Study (2002–04) [10] and assign to each individual the 1975 SES index (calculated here from the entire 1975 census population) for his or her family, referred to as "parental" SES. Therefore, the tertiles used in the other articles in this supplement are calculated for a subsample and may differ somewhat from those presented in this note.

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The Human Capital Study 2002–04 would not have been possible without the dedication and outstanding work of a field team coordinated by Dr. Paúl Melgar of INCAP, a data coordination center directed by Humberto Méndez and Luis Fernando Ramírez, both at INCAP, and data management by Alexis Murphy at IFPRI and Meng Wang at Emory University. We gratefully acknowledge the financial support of the US National Institutes of Health (R01 TW-05598 funded by the Fogarty International Center, NIMH, OBSSR and the NICHD: PI Martorell; R01 HD-046125: PI Stein) and the US National Science Foundation (SES0136616: PI Behrman) for present activities and the many organizations (US National Institutes of Health, Thrasher Research Fund, Nestle Foundation) that have funded the work of the INCAP Longitudinal Study since inception. Finally, the investigators thank the participants of the INCAP Longitudinal Study for their cooperation and past investigators and staff for establishing and maintaining this invaluable sample.

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