



The Impact of an Experimental Nutritional Intervention in Childhood on Education among Guatemalan Adults

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Studies have shown that malnourished children in developing countries score lower on tests of cognitive function and fail to acquire fine motor skills at the normal rate. Do the effects of nourishment—good or bad—in early childhood linger into adolescence and adulthood, or do they fade away after a few years? This paper provides new evidence of the effects of early childhood nutritional interventions on adult outcomes, using longitudinal data and methods well suited to address the concerns that have been raised about earlier studies.

The 1969-77 Intervention

From 1969 to 1977, to test the hypothesis that improved preschool nutrition would accelerate mental development, the Institute of Nutrition of Central America and Panama (INCAP) made freely available a high-protein dietary supplement called *atole* to preschool-age children (under 7 years of age) in two rural villages, Conacaste and San Juan, in Guatemala. Concerned that the social stimulation of the feeding process might positively affect children's cognitive abilities, the researchers also made available a fruit-flavored drink called *fresco*, which contained no protein, to children in two other villages, Santo Domingo and Espíritu Santo. Assignment of the *atole* or *fresco* to villages was random. Data were collected on all children aged seven years or younger and all pregnant and breastfeeding women in the villages. Residents of all four villages also received free curative medical care and preventive health services. When the program ended in 1977, children ranged from 0 to 15 years of age.

Children received 40 to 120 kilocalories of *atole* a day, depending on age. At three years, the children who received the *atole* supplement were found to be 2.5 centimeters taller than children who only received the *fresco* drink, reducing the prevalence of severe stunting by half.

The 2002-04 Resurvey

Subsets of the original sample of 2,393 children were resurveyed periodically over the years to measure the effects of

the intervention on their health and nutritional status. Between 2002 and 2004 a multidisciplinary team of investigators (including the authors of this paper) attempted to resurvey these same individuals—now young adults—to determine whether the feeding intervention had positive effects on their cognitive abilities and educational attainments that could still be detected. The team went to great lengths to locate as many of the subjects as possible. They interviewed everyone currently in the four villages to determine who of the original sample still lived in the villages, who had died, and who had migrated to other locations. Of the 2,393 persons in the 1969–77 sample, 77 percent were alive and living in Guatemala, 11 percent had died, and 8 percent had migrated abroad. Nothing could be learned about the remaining 4 percent. This analysis uses data collected from 1,469 individuals (61 percent of the original sample) who answered the questionnaire pertaining to schooling, including information on the amount of schooling attained, their rates of progression through school, and measures of cognitive ability (using Raven's Progressive Matrices) and reading comprehension skills (using a pre-literacy test and, for the literate, vocabulary and comprehension tests from the Inter-American Reading Series).

Methodology

Outcome variables are taken from the 2002–04 follow-up, while the right-side variables use individual and household data collected from 1969 to 1977, supplemented by community information collected during the earlier studies and retrospectively in 2002. Individual characteristics include sex and age, while household characteristics include mother's and father's education, age, and dummy variables for the distance to the feeding center and an index of household wealth. Dummy variables for three of the four villages are included, reflecting differences in localities that influence education-related outcomes. One village, Espíritu Santo, is close to a larger town with more educational opportunities. Commu-

A quarter century after the feeding intervention, participants scored 9 percent higher on cognition tests and 14 percent higher on reading comprehension tests.

ity-level covariates include the availability of a permanent structure for the primary school and the student-teacher ratio when the child was between 7 (starting school) and 13 years of age (finishing primary school).

The Results

Although most of the respondents started school at age seven, 8 percent dropped out during primary school and 30 percent after completing grade six. About 20 percent attended secondary school, and 3 percent went on to advanced studies. Reflecting Guatemalan society, men completed more schooling than women, and younger people completed more than older people. Children from households where parents had more education and more wealth tended to complete more grades. Individuals born in Espiritu Santo had significantly more education. While a permanent school structure was not significant, the student-teacher ratio was.

The results indicate that the nutrition intervention had significantly positive and substantial effects. Women, in particular, were more likely to enter and complete primary school and some secondary school than their peers in the control group, and their progression through school was speedier. Both men and women scored higher on cognitive and educational achievement tests. For the full sample, there is no evidence that *atole* affected the number of grades attained. When the results are examined by sex, however, women who received the supplement are found to have completed one full grade more than those who did not.

Women who received *atole* were better able to negotiate the education system than those who received *fresco*. They

were less likely to repeat a grade or to drop out and re-enter. When the number of grades passed was divided by the number of years attended school, they were found to have completed 0.11 grades per year more than their counterparts.

The results of the Raven's tests of cognition are significant for both men and women, representing a 9 percent improvement over the average score. Because these estimates are the first to investigate the impact of a nutritional intervention on adult intellectual functioning more than 25 years after the feeding, they are particularly important.

The *atole* intervention increased reading comprehension scores by about 14 percent, on average, a quarter century later for both men and women. Although the number of grades completed by men was not affected by their exposure to the intervention, their reading ability apparently was. This may have been the result of later life experiences or it may be an indication of the improved cognition indicated by the Raven's test.

The results of this study provide strong evidence that nutrition of preschool-age children plays a crucial role in future educational attainments and underscores the value of including the preschool period in any approach to education.

Keywords: early childhood nutrition, education, nutritional intervention, Guatemala

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