Infant mortality rates before, during, and after a nutrition and health intervention in rural Guatemalan villages

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Abstract

Village-level infant mortality rates (IMRs) before, during, and after a food supplement and health care intervention in four villages in eastern Guatemala 1969–1977 and in three control villages are compared. Data on all pregnancies and outcomes for 988 women were obtained by means of a retrospective women's life history survey. After controlling for baseline values, the average IMR in two villages receiving supplementation with a protein- and energy-rich drink and health care was 60 per 1,000 live births, compared with an average rate of 113 in the control villages ($p < .05$). The rate in two villages receiving the same type of health care but a low-energy supplement was 91 per 1,000 and not significantly different from that in the control villages. The decline in the IMR in these villages points strongly to the programme's impact, but the relative importance of food supplements and health care is ambiguous.

Introduction

Infant mortality rates (IMRs) have long been used in public health as an indicator of general levels of health [1] or of the economic development level of countries or regions [2]. A number of projects have used them to evaluate the impact of nutrition and health interventions [3–6]. Although they reveal only part of the complex picture of child health, the relative ease and reliability with which they can be measured makes them a useful indicator in cross-project evaluations [7].

One of the challenges in evaluating the effects of health and nutrition interventions is controlling for changes in the IMR that would have occurred in the study areas in the absence of treatment. IMRs show a decreasing trend in most developing countries, and this is no less evident in Central America, where recent research has revealed declines in Nicaragua [8], Costa Rica [9], and Guatemala [10]. If there is a background decline in IMRs, analyses of nutrition and health programmes need to take this into account in interpreting results.

Comparison of the IMRs in treatment areas with national averages is one method, but because of extensive variations within countries it is not recommended. For example, a report by the Commission on Health Research for Development pointed out that the IMR for the rural area of the Indian state of Bihar is over three times as great as that for urban areas in the state of Kerala [11]. In Guatemala, a national survey found that the risk of dying before the age of five years is 31% higher for rural children than for those living in urban areas [10].

The use of communities similar in all important characteristics but lacking the nutrition and health intervention, that is, control communities, can provide a more precise gauge of the significance of the improvement found in the communities receiving treatment. Although this method is not without its difficulties, it has the advantage that data obtained internally by a project can be collected in a consistent manner using the same instruments and interviewer-training procedures.

A follow-up study was recently conducted in Guatemala to measure the impact of nutritional supplementation in early childhood on biological and social functioning in adolescence and adulthood. The original longitudinal study was conducted from 1969 to 1977 in four villages in the Guatemalan highlands, and included nutrition supplementation and health intervention components. The follow-up study, carried out in 1988–1989, presents an opportunity to consider the possible effect of this initial intervention on the IMR as well as to examine changes in the IMR in the communities after the end of the programme. The design of the follow-up study was improved with the inclusion of three control villages that did not benefit from nutrition or health interventions but were otherwise similar. Extensive details about the history and design of the longitudinal study [12, 13] and the follow-up study [14, 15] as well as an overview of their findings [16, 17] are presented elsewhere in this issue of the *Food and Nutrition Bulletin*.

Methods

All the data were collected by the Institute of Nutrition of Central America and Panama (INCAP). The four study villages included in the longitudinal study were selected from among many more because of their similarity in economic, demographic, and health indicators [12, 13]. From a list of 12 villages seriously considered for inclusion in 1968, three were selected at the time of the follow-up study for comparison with the original study villages and are referred to as the control villages. They were the closest in geographic proximity to the original study villages.

The four study villages were exposed to INCAP's presence for the duration of the longitudinal study. All four benefited from free medical care delivered by auxiliary nurses under close medical supervision [13]. Services included prenatal care, tetanus immunization, and neonatal and infant assessments. Two villages received *atole*, a high-protein, high-energy liquid supplement, and two received *fresco*, a low-energy drink. The atole provided 163 kcal and 11.5 g of protein per cup (180 ml), and the fresco provided 59 kcal per cup and no protein. Consumption was free and *ad libitum*.

No intervention was provided by INCAP in the three control villages. Medical services were provided by the Guatemalan Ministry of Public Health through rural health posts. No food supplements or nutrition programmes are known to have been provided to the control villages.

The data for this analysis come from two parts of the follow-up study: the women's life history survey and the census. The methods are described in detail elsewhere [18]. The life history survey, conducted in 1988 and 1989, was a retrospective interview to assess status and changes over time. Information was collected on current reproductive status, parity, gravida, and reproductive history as well as other health and demographic variables. The reproductive history included information on pregnancy outcome, newborn birth data, and mortality for each pregnancy. The census was conducted in 1987 to obtain basic demographic information on households in the atole, fresco, and control communities. The analysis conducted here is based on the experience of 988 women whose records contained birth outcome information.

The total number of live births in each village was summed for each of four time intervals; 1949–1958, 1959–1968, 1969–1977, and 1978–1989. The first two intervals are before 1969, when the study began; the third spans the duration of the study; and the last includes the post-study years. The number of deaths of children under one year old for the same intervals was also summed and divided by the number of live births. The resulting figure multiplied by 1,000 is the village IMR. Similar calculations were made for neonatal mortality (0–1 month), post-neonatal mortality (1–12 months), and child mortality (12–60 months). Note that the denominator in child mortality rates is typically the population of children one to four years old at the mid-point of the time interval. Since this number was not available, the number of live births in the relevant time interval was used. In analyses of variance, the first two time intervals were combined (i.e., 1949–1968) to yield a more stable baseline estimate.

Analysis of variance was carried out using a standard pretest–post-test design [19] with the village as the unit of analysis. The general linear models procedure of the Statistical Analysis System [20] was used for these analyses. The mortality rate for the time interval of interest (e.g., 1969–1977) was the dependent variable. The type of intervention received by the village was the independent variable and was coded as control ($n = 3$), fresco ($n = 2$), or atole ($n = 2$). Mortality rates for the previous time period (1949–1968) were also used as independent variables to control for village-level variations. When analysis of variance revealed a significant intervention-type effect, multiple pairwise comparison testing was performed using Tukey's test [19]. An intervention effect was considered significant if the null hypothesis was rejected with a one-tailed type-I error rate of alpha = .05.

Results

Table 1 shows the number of live births per village and time interval. Information on 5,505 live births was obtained from 988 women who contributed birth outcome information to the life history surveys. The number of births per woman averaged around 6 and ranged from 1 to 19.

The IMRs for these villages for the four time intervals are shown in table 2. The control villages had an average IMR of 104 per 1,000 live births for the decade before the intervention (1959–1968). For the same period, the fresco villages averaged a rate of 119 and the atole villages 185. On average, an over-

TABLE 1. Number of live births by village and time interval

	1949–1958	1959–1968	1969–1977	1978–1989
Control villages				
Subinal	47	113	136	121
Las Obejas	74	160	187	208
El Caulote	98	161	186	223
Fresco villages				
Santo Domingo	106	269	310	327
Espiritu Santo	80	193	251	230
Atole villages				
Conacaste	125	290	350	375
San Juan	97	196	289	303

TABLE 2. Infant mortality rates by village and time interval

	1949–1958	1959–1968	1969–1977	1978–1989
Control villages				
Subinal	43	106	118	66
Las Obejas	189	88	107	87
El Caulote	367	118	113	108
average	200	104	113	87
Fresco villages				
Santo Domingo	104	130	94	52
Espiritu Santo	138	109	88	52
average	121	119	91	52
Atole villages				
Conacaste	192	176	69	59
San Juan	124	194	52	92
average	158	185	60	76

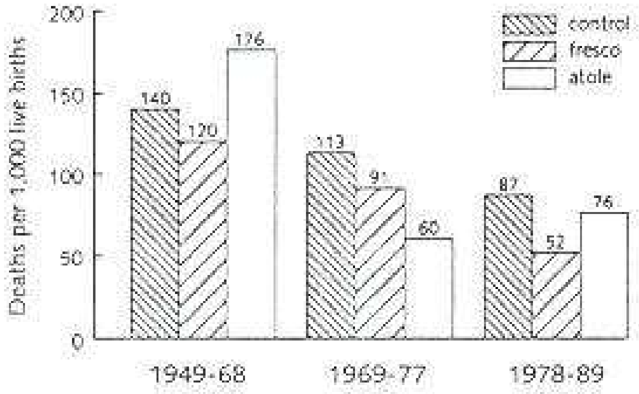

FIG. 1. Infant mortality rates by time interval and village type

TABLE 3. Average infant, neonatal, and post-neonatal mortality rates by type of intervention before and during the longitudinal study

	1949–68	1969–77	% change
Infants (0–12 months)			
Control	140	113	−19.3
Fresco	120	91	−24.2
Atole	176	60*	−65.9
Neonates (0–1 month)			
Control	91	57	−37.4
Fresco	69	47	−31.9
Atole	120	26	−78.3
Post-neonates (1–12 months)			
Control	49	55	+12.2
Fresco	51	44	−13.7
Atole	56	34	−39.3

*Significantly different from control group at alpha = .05. There were no other significant differences in infant mortality rates. See the text for additional details regarding the analysis of variance methods and results.

all decline in IMRs was seen in the three types of villages, but a casual glance reveals that the biggest drop came in the latter two periods and particularly in the atole and fresco villages (fig. 1).

Table 3 shows the change in IMRs between 1949–1968 and 1969–1977. The average IMR in the atole villages dropped by 116 deaths per 1,000 live births, or approximately 66%. The fresco village rates also decreased, by approximately 24%, and the control villages decreased an average of 19%. Analysis of variance in which the initial time period rates were used to adjust the latter time period revealed a significant village-type effect. Subsequent multiple comparison testing showed that the atole villages were significantly different from the control villages. The same cannot be said for the fresco villages; that is, the hypothesis of equal means could not be rejected.

All three village types showed declines in neonatal mortality, ranging from a 32% decline for the fresco villages to 78% for the atole villages. Declines for post-neonatal mortality were less dramatic.

The changes in mortality from the baseline levels to the levels after the departure of INCAP from the study communities are shown in table 4. Infant mortality declined in all three types of villages, by amounts ranging from 37.9% in the control com-

TABLE 4. Average infant, neonatal, and post-neonatal mortality rates by type of intervention before and after the longitudinal study

	1949–68	1978–89	% change
Infants (0–12 months)			
Control	140	87	−37.9
Fresco	120	52	−56.7
Atole	176	76	−56.8
Neonates (0–1 month)			
Control	91	25	−72.5
Fresco	69	20	−71.0
Atole	120	26	−78.3
Post-neonates (1–12 months)			
Control	49	62	+26.5
Fresco	51	32	−37.3
Atole	56	49	−12.5

There were no significant differences between groups in the 1978–1989 interval after controlling for rates in the previous time interval. The type-I error rate was set at alpha = .05.

TABLE 5. Average child (1–4 years) mortality rates by type of intervention before and during the longitudinal study

	1949–68	1969–77	% change
Control	50	33	−34.0
Fresco	42	28	−33.3
Atole	79	25	−68.4

There were no significant differences between groups in the 1969–1977 interval after controlling for rates in the previous time interval. The type-I error rate was set at alpha = .05.

munities to 56.8% in the atole villages. The differences in rates among the three types of villages in the post-study period are not statistically significant after adjustment for the initial baseline rates. The largest drop in infant mortality for all the villages occurred in the neonatal period.

Table 5 presents the child mortality rates by type of intervention before and during the longitudinal study. The rates dropped in all the communities, from an average of 33% in the fresco villages to 68% in the atole villages. No significant differences were observed during the intervention across the three village types after controlling for baseline values.

Discussion

The follow-up study provides an opportunity to use trends in IMRs to evaluate a nutrition and health intervention project. Food supplementation projects rarely collect infant mortality data. Those that do often compare the results in treatment communities with national averages. This technique was employed in India [21], Jamaica [22], and Haiti [23], where infant mortality rates were reported to be 25%, 52%, and 77% lower in treated areas than overall averages for their respective countries. The problem with using national averages for comparison, which mask profound differences within countries, was mentioned earlier.

It is even less common for food supplementation interventions to compare the IMRs in the treated areas with control or comparison areas. When this is done, it is almost exclusively a point estimate comparison. For example, the Narangwal nutrition study, carried out in India from 1970 to 1973, found that rates were 31% lower in villages that had an on-site food supplementation programme than in the control villages [24]. A project in Jamkhed, India, found infant mortality in the treatment areas to be 57% lower than in the control areas [7]. Earlier food supplement programmes in Guatemala [25] and Peru [26] reported differences in infant mortality between treatment and control communities of 24% and 64% respectively. (It should be noted that both the Guatemalan and the Peruvian interventions not only made point estimate comparisons between treatment and control communities but also compared the rates with earlier baseline values. Unfortunately, the Guatemalan study used a sample size of only one village in each cell. In the Peruvian study, peculiarities of the design raise questions about the interpretation of the results.)

The problem with point estimates is that IMRs are not static; they are declining throughout the developing world, and so comparison of treatment and control areas only at the end of a project may not accurately reflect the impact of the treatment. And, if infant mortality was higher in the control areas at the beginning of the project, one would expect it to be higher at the end of the project, regardless of the type or effectiveness of the intervention in the treatment areas.

The results reported here strongly suggest that the programme had an impact on infant mortality. A striking decline in the IMR was seen in the atole communities and a more modest decline in the fresco communities compared with the control villages. The rate dropped 65.9% in the atole villages, from the baseline level of 176 deaths per 1,000 live births to the treatment period level of 60. This is roughly 3.5 times the decline in the IMR in the control communities, which dropped 19.3% (from 140 to 113 deaths) during the same period. The fresco villages were in between, with a 24.2% decline, or about 1.25 times that in the control villages.

The results are ambiguous about which aspect of the intervention—food supplementation or health care—may have caused these declines. It is known from earlier studies that, on average, the atole children received more calories and protein than their fresco counterparts [27]. In addition, a greater percentage of pregnant women in the atole communities (47%) consumed over 20,000 calories from supplements than in the fresco communities (37%) [28]. This level of supplementation was associated with a lower prevalence of low-birth-weight babies, who in turn are more likely to die in the first year. Thus, it would appear that the greater impact on the atole communities may be due to food supplementation. However, review of table 3 shows that the greatest drop in mortality came in the neonatal period. This is most likely to be a result of the health care package, which included tetanus immunizations and prenatal care.

The follow-up study also gives an opportunity to examine the trends in IMRs after the nutrition and health intervention ended. Although the IMR was lower for the atole and fresco villages than for the control villages in the period after the intervention, the differences were not statistically significant. It appears that over the long run, IMRs will tend to decline to a similar level as public health care facilities provide broader coverage in immunizations and basic health services.

Although village-level studies are useful as a starting point, they have limitations. Many important biological and social factors are lost in considering aggregate values. For example, household factors such as socio-economic status, maternal education, and sanitation all play an important role in the determination of child health. Individual biological factors such as maternal height, age, and degree of supplementation are equally relevant. None of these variables can be included in village-level studies. A re-examination of the INCAP mortality data with an individual-level model could incorporate some of these factors and thus provide new insights into the impact of intervention on infant mortality.

Acknowledgements

Data collection and analyses were supported by NIH grant HD22440. The study was a collaborative effort involving investigators at several institutions: R. Martorell (principal investigator, originally at Stanford University, now at Cornell University), J. Rivera (INCAP, Guatemala), E. Pollitt (University of California at Davis), and J. Haas (Cornell University).

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