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The Effects of Education on Fertility and Mortality

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Abstract

This volume consists of two reports, "The Effects of Education on Mortality: A Quick Review of the Evidence," and "The Effects of Education and Urbanization on Fertility."

The effects of education on mortality and fertility provide insight into both the determinants of demographic phenomena and the social consequences of education. The evidence is clearest with respect to infant and child mortality. The higher the level of the parents' education, the lower the mortality of their children. The effect of education on fertility is somewhat more complicated. While fertility decreases uniformly with education in some environments, there appears to be a threshold level of education and only at levels beyond primary school does fertility decrease with increases in education.

The evidence presented in this paper tends to confirm earlier findings that parental education is inversely related to child mortality. This relationship is somewhat stronger for women's education than men's education, as had been previously found. Evidence also confirms that education does not have a uniformly inverse relationship with fertility in all circumstances. In some environments, there is a threshold level of education which must be achieved before fertility declines. Also, the education of women is more likely to be inversely related to fertility than is the education of men. And finally, the more urbanized a country, the more likely education is to be uniformly inversely related to fertility.

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THE EFFECTS OF EDUCATION ON MORTALITY:
A QUICK REVIEW OF THE EVIDENCE

THE EFFECTS OF EDUCATION ON FERTILITY AND MORTALITY

A Quick Review of the Evidence

In June of 1979 WHO sponsored a conference in Mexico City entitled "The Socioeconomic Determinants and Consequences of Mortality." A number of papers at that conference examined the relationship between national levels of mortality and levels of development including measures of education. In addition, papers by Hugo Behm, John Caldwell and Paul Schultz analyzed the effect of the education of parents on the mortality of their children. All found a strong effect of education on mortality in developing countries. Data from Latin America and Asia assembled elsewhere by Arriaga had also confirmed a strong inverse relationships between infant and child mortality and mother's education. (Arriaga 1979a and 1979b).

In late 1979 and early 1980 the World Bank sponsored a review of both the aggregate and the household level data on the relationship between education and mortality (Cochrane, O'Hara and Leslie, 1980). They used the existing tabulations that could be found from censuses and surveys as well as reviewing multivariate analysis of household data sets. The findings were fairly striking. In the simple bivariate comparisons of parental education and child survival they found virtually no deviation from the expected pattern. The more schooling the mother or father had the lower the mortality of their offspring. On average an additional year of mother's schooling was associated with a 9 per thousand reduction in child mortality.

The Bank researchers attempted to determine to the extent possible with existing studies, whether or not these results were spurious. First, they tested whether the effects were explained by urban, rural differences. Controlling for residence did not eliminate the effects of education. Second they attempted to determine if the relationship between wife's education and her child's mortality was the result of the fact that more educated women were in wealthier households married to more educated men. Crude tests indicated that only part of the effect of a mother's education could be the result of the fact that more educated women were married to more educated men. The effects of husband's education were generally found to be about half as great as the effect of mother's education. A review of the few multivariate studies that existed at that time led to the conclusion that of the 9 per thousand effect, 6 per 1,000 was the result of the woman's own education and 3 per 1,000 was the effect of the fact that she was married to a more educated, higher income husband.

New Data

Since the 1980 World Bank review, a considerable amount of work has been done on the relationship between parental education and child mortality. One reason that it has been possible to do so much more work has been because the WFS collected data on infant and child mortality on a wide range of developing countries. Table 1 shows comparisons of child survival by parental education characteristics of the family from the WFS data. This is a valuable addition to the earlier information on mortality and education because it provides comparable data from 28 developing countries.

These data show a fairly uniform relationship between paternal education and child survival. There are a few deviation from the expected pattern. If only sample sizes over 500 are examined there is only 1 deviation from the expected pattern for mother's education which exceeds 2%. For father's education there are 6 deviations of that size or larger.[1/] The data show that on average under 5 mortality falls from 152 to 67 per 1,000 over the range of mothers education and from 148 to 84 per 1,000 over-the range of husband's education. Assuming the average education of the 7+ group is 9 years that gives us a reduction of under 5 mortality of 9.4 per 1,000 per year of schooling for mother's education and 7 per 1,000 for husband.[2/]

These findings strongly confirm the results found in the earlier Bank review: parental education has a close relationship with child survival, the strength of the relationship is greater for mother's education than father's education and the magnitude of the relationship is a reduction of 9 per 1,000 for an additional year of mother's schooling.

The average relationship between education and child survival gives us some information. Deviations from that pattern are also informative. In the earlier study it was found that countries that had higher levels of expenditure per capita on public health tended to show smaller effects of education on mortality, i.e., public health effects appeared to substitute for education effects.[3/]

The regularity and strength of the relationship between parental education and child health raise important questions of causation. These findings could result from the fact that parental education is associated with other variables. This possibility was discussed briefly above. In addition if the association is not spurious, then it becomes necessary to understand the channels through which education has its effects. Hobcraft, McDonald and Rutstein (1984b) whose data were cited above have done analysis which addresses both the question of spurious association and in another paper they provide indirect insight into the question of channels.

In their paper on socio-economic differences in child survival, they examined five socio-economic variables; mother's education, her husband's education, current residence, her work status since marriage and her husband's occupation. They estimated the best fit models with these 5 variables. Their results varied depending on the type of mortality analyzed. For neo-natal and post neo-natal mortality, mother's education was the most important variable in a third to a fourth of the countries while it was signficant, if not the most important variable, in another third to a half of the cases. Husband's education was important in approximately the same proportion of the cases. They found that the effect of mother's and husband's education gained in importance as the child aged. For mortality from ages 1 to 5, they found mother's education was included in the best model in 19 out of 20 cases and husband's education in 16 of 26 cases. Thus, they confirmed the importance of parental education controlling for other socioeconomic variables in the majority of the cases among older children, and husband's or mother's education was the most important variable in 21 of 26 cases. These new data, therefore, support the importance of parental education when controlling for other socioeconomic variables, but do not support the ealier finding that mother's education had much stronger effects than husband's education.

In attempting to understand the channels through which education operates it is important to determine the extent to which its effects are through differences in the fertility behavior of women which in turn affect mortality and the extent to which it operates through differences in child care practices unrelated to the biology of reproduction.[4/]

Hobcraft et al (1983) and others have shown the importance of child spacing on the survival chances of the children. Other studies have shown that family size, birth order and maternal age are important factors affecting child survival. Does education have its effect only because more educated women have fewer, better spaced children? Hobcraft et al (1984a) have estimated the effects of these biological determinants in a multivariate analysis which includes parental education and this allows us to determine if the effects of parental education are eliminated when biological variables are included.

The Hobcraft et al study included data from 39 developing countries using WFS survey data. This paper used multivariate analysis to analyze child survival. The authors included the biological and demographic factors of sex of child, birth interval, age of mother and parity. Their results confirm the very substantial importance of birth internal (child spacing) on child survival. Nevertheless controlling for all these biological factors they find that parental education continues show substantial impacts of child survival status.

Other Studies

There have been a substantial number of other studies published in the past couple of years which provide either general insight on the education and health relationship or provide empirical estimation of the relationship in one or several countries using household data. A conference held at the University of Michigan in March 1981 entitled "Literary, Education and Health Development" provides a collection of a wide variety of papers on the subject.[5/] Papers given at that conference by Caldwell and McDonald, Rosenzweig and Schultz, Simmons and Bernstein and Trussell and Preston and Chowdhury [6/] provide estimation of the relationship between education and child survival at the household level.

The methodology of these studies vary enormously. The results show more consistency. Caldwell and McDonald use cross tabulation of data and multiple classification from ten WFS countries and conclude "Taking the ten countries as a whole, the parents' education has over three times the impact on child mortality as father's occupation. Mother's education is somewhat more important than father's education and the jump from primary schooling to secondary schooling is twice as important as that of the original step to primary schooling ..... further ..... establishes the fact that more educated mothers achieve lower child mortality in spite of the considerable disadvantge of earlier weaning" (Caldwell, 1982, 264).

Rosenzweig and Schultz used data from the 1973 Colombia census to test, not only the relationship between maternal education and child mortality and fertility, but also to determine how the impact of access to health and family planning varied by the education of the mother. This paper thus addresses the question raised earlier of whether public health facilities could substitute for maternal education. They find education is strongly inversely related to child mortality ratio and fertility. Furthermore, they find in urban areas public health activities act as substitutes for maternal education. In rural areas the interaction of maternal education and access to public health showed no significance either because the measurement of "access" is more difficult in rural areas or other mechanisms are at work.

George Simmons and Stan Bernstein used household survey data from rural Northern India to study the determinants of child survival. They separate their analysis for males and females in the neonatal and postneonatal period. Controlling for other factors a measure of the parents combined education shows no relationship to mortality for males or females in the neonatal period. In the postneonatal period it is found that mortality of female children was significantly lower where the mother had attended school than when neither parent or only the father had attended school.[7] For male children, the coefficient for mother's education is marginally significant at 10%. In evaluationg these findings the authors stress that the levels of education are very low in this sample. In addition, it is necessary to bear in mind that for all levels of mortality they found sex differences in mortality determinants and found strong evidence that child survival was associated with whether or not a child of that sex was wanted. These findings suggest that the determinants of mortality are more complex in this environment than a simple model of survival maximization might suggest.

The Trussell and Preston paper presented at the 1982 Michigan Conference was largely a methodological exercise to determine preferred methods of estimating the magnitude of relationship between child survival and the socioeconomic variables of residence, mother's education and husband's education and occupation. Using a variety of multivarite specifications the authors found that the results were fairly robust with respect to methodology and that mother's and father's education had proportionate and large effects on child mortality in Sri Lanka and Korea. They estimated that completion of ten years of schooling by a mother or father in Sri Lanka reduced child mortality by 50 to 55% while in Korea completion of high school reduced it by 47%. (Trussell and Preston, 1982).

Another recent paper on the determinants of child mortality uses data from three WFS surveys in Asia (Martin et al, 1983). The multivariate models used there show that education was second only to length of exposure to risk in determining child mortality. However, education's effects differed substantially between countries. Mother's education had a stronger effect on mortality than father's education in the Philippines and Pakistan, but the reverse was true in Indonesia. Their finding confirm that education's effect in these countries is not just an "income" effect for mother's education remains significant when father's education is included in the model and where other measures of socioeconomic level are included in the one case where they were available, the Philippines.

There have been a number of other published and unpublished studies of the determinants of child survival in recent years using either WFS data sets (Meegama, 1980) or other large household surveys (Zachariah and Patel, 1982). These surveys generally confirm the importance of maternal education in multivariate models. A more complete review of these studies, their methodologies and the comparability of their findings is needed, but it is even more important to begin to increasingly focus on the channels through which education has its effects.

Frameworks for analyzing these channels are provided in work currently being done. A Rockefeller/Ford Foundation joint conference held at Bellagio in October 1983 provides numerous papers which directly or indirectly address the issue of paternal education and child health.

Helen Ware's paper directly addresses the effect of maternal education on child mortality. Ware reviews various ways in which education would alter behavior which in turn reduces mortality. She discusses the design of surveys and survey instruments that might capture these effects. In the process of reviewing the various hypotheses she presents bits and pieces of fascinating data on the linkages in various countries. This is probably the first article to attempt a partial review of the evidence on linkages and as such is quite valuable. She also accurately summarizes why the linkages are of policy relevance. "Clearly, for example, if the relationship between mother's education and her child's survival is largely established by controlling for the birth weight of the child, then the policy implications are very different from those that would arise from a proven link between maternal education, hygiene practices and child survival." (Ware, 1984, 210).

At the Bellagio conference papers by both Mosley and Chen and Schultz formulate models of child survival in which education's effects could be estimated. The two approaches differ substantially. In particular, the channels through which education may operate in the Schultz's framework are primarily two: those of the demand for health inputs and of the production function for child survival. This economic model of the determinants of health inputs is used by Schultz to discuss the channels (in terms of prices, preferences, technologies and opportunities) through which education might affect child survival. It is an interesting framework but the demands it makes are so great that discretion often demands a second best solution (reduced form estimation) which ultimately surpresses the estimation of the channels whereby education or other variables operate and only leaves us with estimates of the net effect of exogenous variables such as education.

The Mosley and Chen (1984) framework has five channels through which any socio-economic variable can be expected to have their effects on survival. These are:

(1) Maternal factors - age, parity, birth interval.

(2) Environmental contaminations: air; food/water/fingers; skin/soil/inanimate object; insect sectors.

(3) Nutrient deficiency: calories, protein, micro nutrients (vitamins and minerals).

(4) Injury: accidental, intentional.

(5) Personal illness control: personal preventive measures; medical treatment.

This framework provides guidance for studying the channels through which education and other socio-economic variables can affect child health and survival. Unlike the proximate model of fertility which it resembles, it is not possible to use this framework in a mathematical way to estimate the impact of various socio-economic variables on child survival through the various channels. It is nonetheless a valuable framework for organizing future work on the link between socio-economic variables and child health.

The Bellagio paper by Tekce and Shorter represents the first attempt to use the Mosley-Chen framework to estimate both the impact of education on child survival and to estimate some of the channels through which education and other socio-economic variables have their effect on child survival. The first part of their paper estimates the relationship between socio-economic factors and child survival and the second part examine the intermediate mechanisms. Mother's education was found to have significant net effects on: the use of a trained birth attendant, DPT immunization, use of professional health care when a child is ill and nutritional status of the surviving children.[8/] None of the other socio-economic variable was significantly related to more than 2 of the 5 intermediate variables. (The only variable not related to education was presence of soap in the toilet area. This was affected, however, by housing quality, household income and occupation of head of household). Thus this paper provides a rich analysis of the role of education in determining child survival in Amman, Jordan.

Conclusion

The recent publication of the Michigan and Bellagio Conference papers on child survival and the WFS survey results on child survival put us in a much better position to assess education's role on determining child survival than we were in 1980. The relationship between parental education and child survival does not appear to be the spurious effect of education's association with other socio-economic variables nor does it appear to result exclusively from the relationship between education and reproductive behavior. We are still uncertain, however, of what channels education does act through and considerably more work needs to be done of the type done for Jordan by Tekce and Shorter.

It will also be necessary, however, to do more work on model development as well as data collection which will allows us to assess the quantitative impact of education on survival through different channels.

Footnotes

1/ The authors of study from which Table 1 is taken attribute the deviation to probably reporting errors, but their argument for why there are more deviations for husband's than mother's education is not completely convincing.

2/ If father's in the 7+ group are assumed to have on average more years of schooling than mothers in that group, the difference in the magnitude of "effect" between mother's and father's education is even greater.

3/ Mosley (1983) found that the strength of eduction's affect depend on the community. Specifically Mosley found in poorer areas there were wider education differentials.

4/ This distinction is important for designing policies for child survival. If the effects are biological, then policy requires the change in reproductive behavior while if they are child care, then it's possible to reduce mortality without necessarily changing reproduction. Ideally one would attempt to affect mortality through both channels if possible.

5/ These papers were published together in Health Policy and Education, Vol. 2, No. 314 March 1982, edited by Robert N. Grosse and John Friedl.

6/ This latter was a very small sample and the results will not be discussed here. It is a fairly unique study, however, since it is prospective rather than retrospective. A review of the paper would be valuable for anyone planning future survey work.

7/ The effects of education remained strong when a control was introduced for land ownership. Suggesting that education was not simply a proxy for wealth.

8/ Mother's education has a positive relationship with nutritional status despite the fact that more educated women were shown to breastfeed for shorter periods.

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Table 1: UNDER FIVE MORTALITY RATES (PER 1,000 BIRTHS) BY PARENTAL EDUCATION

	Mother's Education				Husband's Education /a				
	0	1-3	4-6	7+	0	1-3	4-6	7+	Total
Africa									
Senegal	296	(178)	(113)	(19)	310	(261)	(138)	(74)	287
Lesotho	(224)	215	185	169	185	212	196	169	190
Kenya	181	164	128	111	185	208	159	127	162
Sudan	146	-------	109	-------	155	152	104	84	140
America									
Haiti	226	(176)	(206)	(89)	230	204	(191)	(150)	214
Peru	237	171	98	55	241	217	150	75	170
Dominican Republic	198	140	122	82	175	134	133	112	139
Mexico	153	118	87	50	155	121	96	53	114
Columbia	146	127	82	49	139	129	86	68	112
Costa Rica	157	100	85	45	138	113	81	44	95
Paraguay	110	88	67	32	(87)	88	76	41	77
Guyana	(83)	(89)	80	64	(38)	(89)	87	66	71
Panama	134	90	52	43	100	91	60	45	65
Venezuela	79	60	60	35	84	61	58	43	61
Jamaica	(82)	(78)	74	51	(57)	(69)	70	55	58
Trinidad & Tobago	(74)	(67)	59	43	80	117	57	43	49
Asia									
Nepal	261	(204)	(157)	(136)	270	(216)	(234)	167	259
Bangladesh	222	198	186	(122)	230	221	191	176	215
Pakistan	208	(143)	(138)	(112)	215	(172)	208	155	202
Indonesia	193	194	143	77	199	205	165	99	180
Thailand	145	105	110	(38)	151	(162)	109	83	116
Jordan	112	83	84	67	112	115	105	77	100
Syria	104	(75)	75	50	109	94	86	70	95
Philippines	130	118	94	53	118	122	96	62	90
Sri Lanka	104	97	80	53	122	98	93	57	84
Korea	107	94	74	56	102	(134)	90	67	83
Malaysia	67	64	56	18	88	59	60	40	61
Fiji	70	67	60	46	59	66	65	55	59
Average	152	122	102	67	148	140	116	84	127

/a These are current husbands of the mothers and may not be the father of the children who may have been born in a previous marriage.

Source: From Table 3 Hobcraft, McDonald and Rutstein (1984b).

THE EFFECTS OF EDUCATION AND URBANIZATION ON FERTILITY*

EFFECTS OF EDUCATION AND URBANIZATION ON FERTILITY

The purpose of this paper is to document the effects of education and residence on fertility. The effect of education has been much more carefully documented (Cochrane, 1979) than that of residence; however, both raise similar methodological issues.

First, neither education nor residence can affect fertility directly in the same way as age at marriage, lactation, and contraceptive use, but must operate through such variables. Although these intervening channels are not the focus of this paper, they must be recognized if the "true" effects of education and residence are to be assessed. If all these channels were included in the analysis, the measured effect of education would be reduced to zero.

In addition to these problems of causal modeling, there is a second problem--linearity. If the relationship between two variables is linear, one can aggregate with impunity. Unfortunately, the evidence indicates that the relationship between education and fertility is nonlinear, and is in fact not even monotonic. In a previous literature review, uniformly inverse relationships were found in only 49 percent of the cross-tabular studies; significant negative coefficients were found in only 31 percent of the regression studies in which income and wealth were controlled along with age and residence (Cochrane, 1979). In most cases, if the relationship was not monotonically inverse, fertility first rose with education and then fell. In these cases, peak fertility was generally found at lower primary education. The new data reviewed in this paper confirm the existence of two different patterns--the inverse pattern and an inverted "U." Similarly, it is unlikely that the relationship between residence and fertility is linear, although this has not been documented. Therefore, studies should probably be restricted to the individual rather than the aggregate level.

The methodological issues involved in assessing the effects of education and residence on fertility are discussed in detail below.

Following this discussion is a summary review of the literature on these effects.

MEASURING THE EFFECTS OF EDUCATION AND RESIDENCE ON FERTILITY: METHODOLOGICAL ISSUES

Measuring Education's Effect

To measure the effect of education on fertility, one must first eliminate spurious correlations between education and other fertility determinants, most obviously age and residence. In developed countries, younger women are generally more educated than older women, and of course age is highly correlated with number of children ever born. Therefore, if age is not controlled, the effect of education on fertility will be overestimated. Likewise, education tends to be higher in urban than in rural areas, and fertility is generally higher in rural than urban areas. Thus if residence has effects other than those through education and if it is not controlled, education's effect will be overestimated. Beyond these generalizations, however, there is not even agreement on how to control appropriately for residence or exposure to childbearing. Moreover, although other background variables such as caste probably determine both education and fertility and therefore need to be controlled, these factors vary among countries so that generalizations cannot can be made.

There is also considerable disagreement about which effect of education one wishes to estimate, depending on the objective of the research. This paper focuses on the total effect of education. As noted above, education acts through many other variables, such as age at marriage, lactation, and contraceptive use. If these intervening variables (IV) are included in the analysis, then education's total effect on fertility will be biased. Therefore, education's effect on fertility through these variables must be added to its "direct" effect. Table 1 lists a number of these variables; the effect of education on each; the effect of the IV on fertility; and the resultant bias in estimating education's total effect if the IV is controlled but the effect of education on that IV is not added.[1] These variables have been arranged under the three broad determinants of fertility: the supply of children, the demand for children, and fertility regulation.

In most cases (14 of 15), the inclusion of an intervening variable will bias the education variable positively (i.e., toward zero if the effect is negative). On the other hand, while the direction of the bias can be determined in most instances, the magnitude can not, since it depends on how strong an effect education has on the intervening variable. For example, if mass media exposure includes mainly written communication, education will have a strong effect on exposure; inclusion of exposure in the analysis will then lead to a serious underestimate of education's effect (assuming that mass media exposure has a strong effect on fertility). On the other hand, if mass media

TABLE 1 Education--the Intervening Variables Through Which It Affects Fertility, and the Biases Introduced by Including these Variables with Education in Regression Models

Intervening Variable (IV)	Effect of Education on IV	Effect of IV on Fertility	Bias in Estimating Education's Effect if Controlling for IV Without Adding Indirect Effects
<u>Supply of Births</u>			
Age of marriage	+	-	+
Breastfeeding	-	-	-
Abstinence (noncontraceptive)	-	-	-
<u>Demand for Children</u>			
Income[a]	+	?	?
Wealth	+	?	?
Female wage	+	-	+
Mass media	+	-	+
Female labor participation[a]	+	?	?
Child labor participation[a]	-	+	+
Child schooling[a]	+	-	+
Child survival[a]	+	-	+
Perceived cost of children	+	-	+
Perceived benefits of children	-	+	+
Migration[b]	+	-	+
<u>Fertility Regulation</u>			
Contraceptive use	+	-	+
Knowledge of birth control	+	-	+
Access to birth control	+	-	+

[a] Variables affected by as well as affecting fertility. Income is included in the list since it depends on labor participation, which in turn is affected by fertility; income is also affected by education independently of labor participation as a result of assortive mating.

[b] Education may affect migration, but migration's effect on fertility is uncertain. Most of its effect is probably captured by residence.

exposure represents primarily radio, the bias resulting from inclusion of this variable will be less serious.

These points can be illustrated by Mason and Palan's (1980) Malaysian study. Starting with the basic controls of age and marital duration,[2] they estimate the coefficient of education for six racial-residence groups and then successively show the effect on these estimates of the following variables: occupation prior to marriage, residence when growing up, husband's education, a sanitary and amenities scale, family income, and the minimum education for sons. When these variables are added, significant inverse (linear or nonlinear) relationships are eliminated in four out of five groups; in the fifth group--rural Malays--for whom the positive effects of education were initially strongest, the negative effect of education is increased. (In the sixth group, the coefficient was not significant initially.) The neutralizing effect of the variables differs from group to group. This variation among groups in the channels through which education operates makes it impossible to formulate a priori statements about the size of the biases introduced (or eliminated) by introducing variables.[3]

The indirect effects of education can be easily adjusted for if sufficient information is available and causation is unidirectional. However, if causation runs in two directions, it is much more difficult both conceptually and empirically to determine the effect of education on fertility. Two kinds of problems may arise here. First, education and some other variable may be simultaneously determined. The most important example is the education of husband and wife. Assortive mating will result in more educated women being married to more educated men. To the extent that the husband's education also affects fertility, it would be a mistake to attribute all of education's effect to either the wife or the husband. If the wife's education is used alone, its effect will be biased away from zero; if both the husband's and the wife's education are included, then the effect of each education measure will be biased toward zero. Although there is no clear-cut solution[4] to this problem, it helps to be aware of the upper and lower limits on "education's" effect (see Hermalin and Mason, 1980).

A second kind of problem arises if fertility, rather than education, is jointly determined with some other variable. For example, if fertility and female labor participation are interdependent, then the inclusion of the latter causes the coefficients of other explanatory variables such as education to be biased. Since the importance of this bias is a matter of degree, there is considerable disagreement over which variables should be treated as simultaneous with fertility.[5]

In Table 1, those variables most commonly considered to be simultaneous with respect to fertility have been marked. There are no variables on this list which might be considered to have feedback effects on education, primarily because these variables are measured in adulthood, generally long after education has already been completed. The one important exception might be age at marriage if there is overlap between marriage ages and levels of education.

To summarize, residence and age are necessary controls if one is to avoid overestimating the negative effect of education.[6] Inclusion of other variables determined by education may bias the effect of education (usually toward zero). Inclusion of husband's and wife's education together will reduce the measured effect of each individual measure, while exclusion will lead to an overestimate (unless they differ in the sign of their effect); the "proper" specification will depend on the use to be made of the model. Finally, inclusion of simultaneous variables will cause biases of unknown direction and magnitude.

Measuring Residence's Effect

The effect of education on fertility cannot be studied separately from that of residence. The reason for this is that many of the factors affecting individual decision making are determined at least in part by the community of residence. These factors include presence in the community of contraceptive services; schooling opportunities and health facilities; economic opportunities and costs, such as the demand for labor of men, women, and children; the costs of food and housing; and the less easily defined factors of social milieu, climate, and exposure to disease. All of these factors vary between urban and rural areas. Ideally, one would control for these factors individually; however, sufficient data are rarely available. Therefore, residence is used as a control to approximate these factors. This is at best a very gross control, especially if a dichotomous variable is used for residence.

The effect of residence on fertility operates through all these intervening factors. As in the case of education, if these factors are included with residence in a model of fertility determination, a bias will be introduced in estimating residence's effect. Table 2 shows the direction of such biases. It should be recognized that because the intervening community variables (ICV) will in turn affect intervening family variables (IFV), the inclusion of the latter will affect estimates of the effect of residence. One major advantage of ICVs over IFVs in an analysis is that, unlike the ICVs, the IFVs may be simultaneously determined with family fertility. Thus although both introduce biases, the ICVs are exogenous to the family, and the biases are of known direction.

Interactions, Nonlinearities, and Measurement Problems

To this point, residence and education have been discussed separately. However, it is important to recognize that interactions may exist. These interactions can arise from (1) the effects of one variable on the other; (2) the fact that education operates differently in various environments; and (3) a combination of nonlinear effects and different levels of education in different areas.

The first of these possibilities depends on whether place of birth

TABLE 2 Urbanization--the Intervening Variables Through Which It Affects Fertility, and the Biases Introduced by Including these Variables with Urbanization in Regression Models

Intervening Variable	Effect of Urbanization on ICV or IFV	Effect of ICV or IFV on Fertility	Bias in Estimating Residence's Effect if Controlling for ICV or IFV Without Adding Indirect Effects
Intervening Community Variables (ICV)			
Presence of family planning facilities	+	-	+
Presence of schools	+	-	+
Presence of health facilities	+	-	+
Demand for labor of			
Men	+	+	-
Women	+	-	+
Children	-	+	+
Housing costs	+	-	+
Food costs	+	-	+
Sociocultural milieu	+	-	+
Disease exposure	?	-	?
Intervening Family Variables (IFV)			
Income[a]	+	?	?
Female wage	+	-	+
Mass media	+	-	+
Knowledge of birth control	+	-	+
Access to birth control	+	-	+
Female labor participation[a]	+	?	?
Child labor participation[a]	-	+	+
Child schooling[a]	+	-	+
Child survival[a]	+	-	+
Cost of children	+	-	+
Benefits of children	-	+	+
Modernism	+	-	+

[a]Endogenous variable.

or place of current residence is used as the residence variable. In the former case, the places of birth, childhood, and adolescence can affect educational opportunities and thus determine educational achievement; thus the total effect of place of birth on fertility would have to include its effect through educational achievement. If current residence is used, education may affect residence through migration; thus education's effect would have to include its effect through migration. (Migration is included in Table 1. However, there is little evidence on whether migration per se or residence before and after migration affects fertility, although those who migrate from rural to urban areas generally have lower fertility.)

The second of these possible interactions, the fact that education operates differently in urban and rural areas, has frequently been discussed, but with little certainty. One possible interaction is through labor markets. Increased education opens modern-sector employment opportunities for women in urban areas; it does not generally have this effect in rural areas. Of course, migration would allow rural women to avail themselves of urban opportunities, but at higher cost than that incurred by urban women.

Although such behavioral interactions between education and residence are not precisely defined, a statistical interaction clearly exists. The evidence that urban areas have a different educational distribution from rural areas is very convincing. In addition, it is fairly clear that education's effect on fertility is nonlinear in some environments. Therefore, if linear estimates of education's effect are made, that effect will appear different in urban and rural areas; if the correct nonlinear specification is used and no other interactions exist, that effect will not differ between urban and rural areas.

In addition to these considerations of interaction and nonlinearity, there are problems of measurement. Both education and residence can be measured as either dichotomous or continuous variables. It is much more common, however, to use an urban/rural dichotomy for residence than to use a literate/nonliterate dichotomy for education. Therefore, the measurement of education is usually more detailed than that of residence. This point will be raised in the following review of the literature on the effects of education and residence on fertility.

LITERATURE REVIEW

As noted earlier, only studies having a direct or indirect age control will be included in the present review. This review is also limited to studies having a minimum sample size or degrees of freedom of over 150 in the relevant age-residence group. Moreover, because of the nonlinearities noted above, studies based on regional aggregates of data will not be included. Finally, if the same methodology were used in all studies, the results would be easy to summarize; however, studies differ substantially in how they analyze fertility determinants. Therefore, this review will be restricted to studies in which the dependent variable is a measure of completed fertility, either children ever born or the total fertility rate, and in which age or marital duration is implicitly or explicitly used as a control.

The subsections below first review a study that uses a common methodology to estimate the effects of education and residence on fertility for several countries. This study, prepared by Rodriguez and Cleland for the 1980 World Fertility Survey (WFS) Conference in London, addresses the separate effects of education and residence, as well as their interaction. Next, two other types of studies of education's effect on fertility are examined: Hermalin and Mason's meta analysis, and a number of multivariate studies within countries. Finally, two important considerations in studying the effects of education and residence on fertility are examined: the issue of the stability of educational differentials over time, and evidence on urban-rural differences in fertility.

Comparative Analysis of WFS Data

The Rodriguez and Cleland paper (1980) is a comprehensive report on the effects of education, residence and a number of other explanatory variables on fertility for 22 countries in which WFS surveys have been conducted. This paper is extremely useful in illustrating the points discussed above, as well as in quantifying the relationships between education and residence and fertility.

Rodriguez and Cleland use regression analysis both to create their primary dependent variable--marital fertility--and to estimate the effects of education and residence on fertility. The dependent variable is constructed by estimating the effect of marital duration and duration squared on fertility in the last 5 years (weighted by exposure), and then predicting total fertility over 25 years of marriage using the estimated effects of duration. Thus the dependent variable, an approximation of completed fertility based on recent fertility, resembles the total fertility rate in its characteristics.[7]

Education

Rodriguez and Cleland estimate the effects of education and other variables on fertility using dummy variables and regression. Average marital fertility can be determined for every category of education (see Table 3). Other variables can also be introduced, and average marital fertility determined controlling for these factors.

Table 3 shows the relationship between fertility and the education of the wife (or woman) and that of the husband. In Panel A, fertility is estimated, using total fertility rates, for all women in the household; in Panel B, only ever-married women are included, and fertility is estimated at marital durations of 25 years. Before reviewing the data in Panel B, it is important to determine if restricting the sample to ever-married women causes any bias. If

TABLE 3 Effect of Education on Predicted Completed Fertility

	Panel A. Total Fertility Rate (all women)				Panel B. Adjusted for Marital Duration (ever-married women)							
	Woman's Education				Wife's Education				Husband's Education			
Country	No School	Lower Primary	Upper Primary	Secondary	No School	Lower Primary	Upper Primary	Secondary	No School	Lower Primary	Upper Primary	Secondary
Bangladesh	6.2	6.5	6.9	5.0	6.2	6.6	7.1	6.1	6.0	6.9	6.6	6.8
Fiji	--	--	--	--	4.8	5.2	4.8	4.1	4.9	5.3	4.7	4.3
Indonesia	--	--	--	--	4.9	5.5	5.6	5.4	4.5	5.4	5.3	5.7
Korea	5.8	5.2	4.5	3.3	6.2	5.5	5.0	4.0	6.1	6.1	5.5	4.5
Malaysia	5.2	5.1	4.6	3.2	6.3	6.0	5.4	4.6	5.9	6.3	5.8	5.1
Nepal	--	--	--	--	6.1	6.5	6.1	2.8	6.1	5.4	6.2	5.4
Pakistan	6.6	(5.9)	(5.7)	3.6	7.0	6.7	7.1	5.8	7.0	6.6	7.3	6.8
Philippines	5.2	6.9	6.0	3.8	6.4	7.1	6.6	5.3	6.5	7.2	6.6	5.5
Sri Lanka	--	--	--	--	5.3	5.1	5.3	4.8	5.4	5.3	5.2	5.0
Thailand	--	--	--	--	5.5	5.7	5.3	3.6	5.1	6.8	5.5	4.0
Colombia	6.4	5.5	3.5	2.5	6.7	5.9	4.1	3.3	6.7	6.1	4.3	3.3
Costa Rica	(4.9)	4.5	3.3	2.7	5.2	4.5	3.4	3.3	4.7	4.5	3.6	3.3
Dominican Republic	(6.6)	6.4	4.1	(2.3)	6.9	6.7	4.9	3.7	6.6	7.1	5.1	3.5
Guyana	--	5.4	5.3	4.0	6.0	5.1	4.8	4.4	4.6	5.3	5.0	3.9
Jamaica	--	5.4	5.1	3.2	6.6	5.3	5.0	3.4	6.0	5.4	4.9	3.4
Mexico	7.6	6.6	4.7	3.3	7.4	7.2	5.5	4.6	7.6	7.2	5.9	4.7
Panama	--	6.1	4.3	2.9	6.7	6.2	4.5	3.6	6.6	6.2	4.5	3.7
Peru	7.0	6.4	3.7	3.4	7.7	6.9	5.4	4.5	7.2	7.4	6.3	5.1
Jordan	9.2	6.8	5.4	(3.6)	9.3	7.7	6.7	5.6	9.3	9.1	7.9	6.8
Kenya	8.4	8.9	8.0	5.5	7.4	8.1	7.7	7.8	7.2	8.2	7.9	7.8
Average of all available countries	6.6	6.1	5.0	3.5	6.4	6.2	5.5	4.5	6.2	6.4	5.7	4.9
Average for countries with data in Panel A only	6.6	6.1	5.0	3.5	6.8	6.4	5.6	4.7	6.5	6.6	5.8	5.0

Note: Dash indicates not available or n less than 250; parentheses denote n less than 500.

Source: Rodriguez and Cleland (1980:Tables 4, 7, A-2).

education has an effect on age at marriage, as many studies have shown, then this restriction, used in most fertility surveys, will result in an underestimation of the effect of education on fertility. Panel A offers some guidance in making this determination because it includes education and total fertility data for married and unmarried women combined. On average, the difference between the effects of education shown for all women and only married women are substantial (compare Panel A with the effects of wife's education in Panel B). Over the entire education range, the difference in fertility is 3.1 when all women are included, but only 2.1 if only married women are included.[8] Thus, a priori, surveys of married women will tend to underestimate the effect of education on fertility substantially, depending on the importance of education in determining age at marriage. This point needs to be considered in reviewing any comparative analysis of data drawn from surveys of ever-married women.

These data for ever-married women show that the relationship between education and fertility is monotonically inverse for women in Latin America; outside Latin America, female education is monotonically related to fertility only in Jordan, Korea, and Malaysia. (Sri Lanka is a marginal case.) For males, the relationship is monotonic only in five of the eight Latin American countries, Jordan, and Sri Lanka.

This irregular relationship between female education and fertility outside Latin America is not inconsistent with the pattern found in Cochrane (1979). The nonlinearities differ according to the education level at which the highest fertility is observed, the regularity of the increases and decreases in fertility on either side of the peak, and the magnitude of the differences in fertility among those with no education and those with maximum education. In Sri Lanka and Pakistan, the overall pattern is irregular, showing two peaks; in the other countries, only one peak is evident, and the fertility differences between the extreme education categories are typically at least one-half a child. Although these irregularities defy simple description, they are sufficiently persistent and based on adequately large samples that they cannot be dismissed as mere flukes.

In an attempt to determine if such nonlinearities are regionally determined or a function of development, some additional analysis was done for this paper: literacy, urbanization, caloric intake, income, and total fertility rates were compared for countries with and without monotonic fertility-education relationships. Simple comparisons show that only for per capita income is there a clear separation between the two groups of countries: all countries with 1978 per capita income at or below $510 have a pattern of increased fertility with education prior to a decline; all countries with an income of $740 or above have monotonic inverse relationships.

However, income is not the only important variable for some very low-income countries, such as Sri Lanka, that have small increases in fertility, or for richer low-income countries, like the Philippines, that have large increases in fertility before a decline is observed. A test of the relative importance of variables in explaining the shape of the education-fertility relationship is shown in Table 4. The

TABLE 4 Relationship Between Fertility at Different Education Levels and Aggregate Characteristics

	$F_{LP}-F_{NO}$	$F_{UP}-F_{NO}$	F_S-F_{NO}	$F_{UP}-F_{LP}$	F_S-F_{LP}	F_S-F_{UP}
<u>Wife's Education</u>						
GNP	--	-.002 (3.99)	--	-.001 (2.60)	--	--
TFR	--	--	--	--	--	--
Urbanization	-.020 (1.98)	-.044 (5.53)	-.047 (2.31)	-.025 (2.95)	--	--
Literacy	--	--	--	--	--	--
Daily calories	--	-.002 (2.83)	--	-.002 (2.34)	--	--
Constant	-.0495	-3.43	-6.82	-2.94	--	--
R^2	.39	.88	.38	.67	--	--
d.f.	12	12	12	12	--	--
<u>Husband's Education</u>						
GNP	--	-.001 (2.92)	--	-.001 (3.24)	--	--
TFR	--	.254 (2.03)	--	--	--	--
Urbanization	-.023 (2.39)	-.043 (5.57)	-.054 (3.77)	-.020 (2.95)	-.031 (2.35)	--
Literary	.022 (2.25)	.017 (2.08)	--	--	--	--
Daily Calories	--	.002 (2.90)	--	.003 (4.63)	.003 (2.77)	--
Constant	.555	-4.49	-4.62	-4.99	--	--
R^2	.38	.83	.71	.77	.66	
d.f.	13	12	12	12	12	--

Note: The dependent variable is the difference in fertility between education groups: those with lower primary school and no education ($F_{LP}-F_{NO}$), upper primary and no education ($F_{UP}-F_{NO}$), etc. Only significant coefficients are shown; t values are in parentheses.

Source: Regressions based on data in Table 3 and World Bank (1980).

differences in fertility between particular levels of education were regressed on per capita income, the total fertility rate, urbanization (proportion urban), the literacy rate, and per capita calories. Urbanization is the most consistent variable explaining the differences in fertility between education groups. For the first four steps of education given in Table 4, the greater the degree of urbanization, the more likely it is that fertility will fall with each increment in education, and the larger these decreases will be. GNP behaves similarly for the differences between no schooling and upper primary, and between lower primary and upper primary. Caloric intake is also significant at these steps in education. Rather surprisingly, neither aggregate education (literacy) nor total fertility rate is significant in explaining the changes in fertility between particular levels of education. This suggests an important interaction between poverty (GNP and caloric intake) and urbanization and the effect of education on fertility. It is interesting to note that, for husband's education, urbanization and GNP have the same relationship as for wife's education; however, caloric intake, literacy, and total fertility rate have perverse signs. Of these, caloric intake is the most interesting in that it is significant in three equations.

In Cochrane (1979), it was shown that female education was much more likely than male education to be inversely related to fertility. This is confirmed in the WFS data by the unweighted average fertility for males and females in each education group. These average values, given at the bottom of Table 3, show that there is a difference of 1.9 children over the education spectrum from no education to secondary schooling for females, and a difference of only 1.3 for males. In addition, males with some education have higher fertility on average than those with no schooling--6.4 versus 6.2 (these values are reversed for females). In considering the extent to which these differences accurately reflect the effect of education, several adjustments need to be considered. Adjustments for residence and for spouse's characteristics are addressed by Rodriguez and Cleland, and are discussed in the subsections below.

Residence

Table 5 summarizes Rodriguez and Cleland's urban-rural fertility estimates. The difference between urban and rural areas is greater for the data on all women (1.6 children) than for those on married women only (1.2). This is similar to the finding for education. However, the residential differential using either group of women is smaller than the educational differential, perhaps because residence is measured dichotomously, whereas education is classified into four groups.

A particularly interesting finding is that urban fertility is always lower than rural fertility when all women are included, but not when only married women are sampled. In Bangladesh, Indonesia, and Pakistan, the marital fertility of urban women is higher than that of rural women. In Indonesia and Pakistan, this difference is large,

TABLE 5 Effect of Residence on Predicted Completed Fertility

	Total Fertility (all women)		Marital Duration Adjusted (ever-married women)	
Country	Rural	Urban	Rural	Urban
Bangladesh	6.2	6.0	6.3	6.5
Fiji	4.6	3.6	5.2	4.3
Indonesia	4.8	4.6	5.1	5.6
Korea	5.1	3.7	5.9	4.5
Malaysia	--	--	6.1	5.5
Nepal	6.2	--	--	--
Pakistan	6.4	6.2	6.8	7.3
Philippines	6.0	3.9	6.8	5.4
Sri Lanka	3.8	3.2	5.3	4.8
Thailand	4.9	2.9	5.5	4.3
Colombia	6.6	3.5	7.2	4.2
Costa Rica	4.7	2.9	4.8	3.3
Dominican Republic	7.1	4.1	7.6	5.0
Guyana	5.1	4.3	5.1	4.1
Jamaica	5.3	3.9	5.4	4.1
Mexico	7.3	4.8	7.7	5.7
Panama	5.7	3.3	5.9	3.9
Peru	7.0	4.6	7.6	5.8
Jordan	9.8	7.1	9.7	8.5
Kenya	8.4	6.1	8.0	6.5
Total	6.0	4.4	6.4	5.2

Note: Dash indicates not available.

Source: Rodriguez and Cleland (1980).

one-half a child. This implies that, particularly in these two countries, age at marriage is very important in explaining residential differentials.

Multivariate comparisons of urban-rural differences in fertility, similar to those in Table 4 and using the same variables, show that only the degree of urbanization is significant. The higher the level of urbanization in a country, the greater the difference between rural and urban fertility. Findley and Orr (1978) also found the percentage of the population urban significant in explaining urban-rural differentials in fertility.[9] These findings suggest that in countries with greater degrees of urbanization, those classified as urban are more likely to be from large cities where fertility is in fact lower than in rural areas.

Interaction of Residence and Education

The question of interaction between residence and education was also addressed by Rodriguez and Cleland. Although they found that such interactions were not statistically significant in most instances, their test of interaction was not symmetrical for husband's and wife's education.

Husband's education was adjusted for residence by the inclusion in the regression of a dummy variable for residence. In many cases, there was no perceptible difference in education's effect before and after this adjustment. In those cases where the interaction term was significant, the residential adjustment reduced the impact of husband's education in all cases except Kenya, where education's effect became more positive, and in Guyana, where there was no change. Overall, the average (unweighted differential) before adjustment was -1.9; after adjustment the average was -0.85.

On the other hand, wife's education was adjusted not only for residence, but also for husband's characteristics (education, occupation, and work status).[10] These adjustments reduced female education's average effect from -1.9 to -0.955, making it less negative in most cases, although in one case (Indonesia), it made that effect negative rather than positive. Adjustment for residence seems desirable to estimate the "true effect" of education; however, adjustment for husband's work status and occupation is not desirable since these are at least partially the effect of the wife's education through assortive mating.

Residence's effect was also measured by Rodriguez and Cleland, adjusting for all other variables (husband's education, occupation, and work status, and wife's education and work status). Again, such adjustments generally reduced the effect of residence from an average of -1.2 to -0.66.

The effects of these various adjustments are summarized in Table 6. After controlling for other variables (some of which are endogenous to education, residence, or both), the effect of female education is still to reduce fertility by almost one child; the effect of male education is one-third as large; and the effect of urban residence is about two-thirds of a child. Although these figures support a strong negative effect of female education, this effect is not linear, as was noted above. After all other variables have been controlled, the difference in fertility for married women is only a tenth of a child between no and some primary education, and the negative effect increases thereafter. In contrast, the fertility of husbands with some primary education is one-third of a child <u>larger</u> than that of husbands with no education after controlling for all other factors, including residence, wife's education, and work

TABLE 6 Differences in Predicted Completed Fertility Between Specific Education-Residence Groups

	Wife's Education			Husband's Education			Residence
	$F_{LP}-F_{NO}$	$F_{UP}-F_{NO}$	F_S-F_{NO}	$F_{LP}-F_{NO}$	$F_{UP}-F_{NO}$	F_S-F_{NO}	F_U-F_R
All women	-0.5	-1.6	-3.1	--	--	--	-1.6
Married women	-0.2	-0.9	-1.9	0.0	-0.5	-1.3	-1.2
Controlling for residence	--	--	--	0.6	-0.3	-0.9	--
Plus husband's characteristics	-0.9	-0.4	-1.0	--	--	--	--
Plus all other variables	-0.1	-0.4	-0.9	0.3	0.0	-0.3	-0.7

Source: Summarized from Rodriguez and Cleland (1980) using unweighted averaging of results.

status. Thus adjustment for other variables does not eliminate the nonlinear relationship between education and fertility.

Other Studies of Education's Relationship to Fertility

Meta Analysis

Another study using WFS data from several countries was done by Hermalin and Mason (1980). This paper, which addressed strategies for comparative analysis of WFS data, used an approach falling between micro and macro analysis. Instead of using individual or countrywide data to estimate regressions between education and fertility, it used as the dependent variable the average fertility of women of various education and marital duration groups from WFS tabulations. The independent variables were education and marital duration, and their values were estimated by the approximate midpoints for each group.

Using these data points from WFS tabulations in each of 10 countries, Hermalin and Mason fitted a nonlinear model to the data. The model used was $\ln (P + .5) = a + bE + c \ln D$, where P is parity, D is duration, and E is education.[11] This formulation implies that the higher the level of education, the stronger its effect. In all cases except Nepal, the coefficients for education were negative, although they varied in size from -0.0077 in Sri Lanka to -0.04085 in Panama and +0.02531 in Nepal. These variations in the effect of education were then studied at the national level to determine what macro characteristics affect the relationship between education and fertility.

The analysis most relevant to this review is that which relates the effect of education on fertility in a country, B_1, to that country's level of development and to characteristics of the education system. Generally, the more "modern" the country, the more negative was education's effect. Five correlations were significant at the 5 percent level for a two-tailed test: (1) 1957/58 per capita expenditures on education, in U.S. dollars; (2) percentage rural; (3) females in teacher training as a percentage of all students in teacher training, secondary and higher, 1960; (4) percentage of economically active females aged 14 to 65 in occupations other than agriculture in the early 1960s; and (5) females as a percentage of total school enrollment at first, second, and third levels. The most interesting finding is the robustness of the effect of the percentage rural:

> We would conclude on the basis of the analysis thus far that the effect of education on fertility is weaker in more rural settings. Whether this is due to the content of education or to the opportunity of individuals to use education remains to be studied and the general hypothesis needs to be further tested with more observations (Hermalin and Mason, 1980:116).

The summary of Hermalin and Mason's work presented here is very abbreviated. However, it does illustrate the pattern of nonlinearity in the education-fertility relationship, as well as the interaction of education and residence.

Multivariate Studies Within Countries

A great number of multivariate studies of fertility determinants have been done on micro data within countries. For this reason, the present discussion must be selective. For comparability, only studies using children ever born as the dependent variable and a sample size of over 150 will be included. Estimates of both linear and nonlinear relationships between education and fertility will be examined.

The Appendix Table summarizes the results of 30 multivariate studies of the effect of education on fertility. These studies vary substantially in their methodology. However, in all cases but five, both husband's and wife's education are included, and most use linear estimation of the relationship between education and fertility. Of these, 19 include husband's education. In six cases, the relationship is negative and significant, whereas in two cases it is positive and significant; in the rest it is insignificant. The two perverse cases are for a group of urban men in Brazil in 1960 and for 717 heads of household in Sierra Leone in 1966-67.

For women's education, 13 of the 26 estimates are negative and significant, and two cases are positive and significant. The two atypical cases are the rural Laguna survey, in which a matching analysis of the same data revealed a negative significant value, and a rural Bangladesh sample of 265 women in 1968-69. In the latter case, the positive relationship would be reduced from +0.13 to +0.03 if the effect of female education on child mortality and of child mortality on fertility were considered in the ordinary least squares estimates; it would be reduced from +0.42 to +0.26 if the mortality effect were adjusted for in the two-stage least squares estimates.[12]

These linear estimates can also be used for other analyses. For example, Table 7 (Panel A) shows a very clear relationship between sample size and significance: for small samples (under 300) only 13 percent of the results are negative and significant; for samples 300 to 1,000, 36 percent; and for samples over 1,000, 54 percent.

Another conclusion to be drawn relates to the effect of controlling for age at marriage.[13] Table 7 (Panel B) shows that, if age at marriage is included, 45 percent of the cases are inverse for males

TABLE 7 Significance of Linear Estimates of the Effect of Education on Fertility, by Methodology Used

Panel A. Results by Sample Size

Statistical Significance	Sample Size: Under 300		300-1,000		Over 1,000		
	Male	Female	Male	Female	Male	Female	Total
Negative significant	0	2	0	5	6	9	22
Not significant	5	5	6	2	5	7	30
Positive significant	1	2	0	1	1	0	5
Percent negative significant	0	29	0	63	50	56	39

Panel B. Results by Inclusion of Age at Marriage in Regression

Statistical Significance	Age at Marriage Included			Age at Marriage not Included		
	Male	Female	Total	Male	Female	Total
Negative significant	6	11	17	0	6	6
Not significant	9	10	19	7	4	11
Positive significant	1	1	2	1	1	2
Percent negative significant	38	50	45	0	55	32

and females; if age at marriage is not included, none of the male and 55 percent of the female results are negative and significant. Thus inclusion of age at marriage has a different effect on the sign and significance for males and females.

To summarize, with the best methodology and the largest sample sizes, most studies show inverse results. However, even with the best methodology, the proportion of inverse results does not rise above 60 percent. This confirms what was suggested earlier: in an important number of cases, education is not monotonically, much less linearly, related to fertility.

In 11 studies, the authors explore the nonlinearity in the relationship between education and fertility. Anderson (1979) uses a semilog specification, four authors use a quadratic term, and six authors use dummy variables for various levels of education. To briefly summarize these results, Anderson's formulation showed that the negative impact of female but not male education increased as education rose. Studies using a quadratic specification find that fertility first increases with education and then decreases. The level of education with maximum fertility (obtained by solving for the maximum point on the quadratic curve) varies from 2.8 years in the Philippines to 10 in Sierra Leone. In studies using dummy variables for the different levels of education, the patterns observed vary among age groups and regions within countries. In general, the impact on fertility is more negative at higher education levels. In some cases, no level of female education has a significantly negative impact (women over 45 in Korea, landless households in India, urban households in Kenya, rural households in Egypt); in one case, education has a significantly positive effect (male primary education in rural Egypt). Part of this uneven pattern of significance may be due to small sample sizes in particular age and education groups.

It is not easy to get an overall picture of the education-fertility relationship from these studies. Averaging the coefficients is inappropriate because of the nonlinearity of the relationship. In addition, given the variety of methodologies used, most estimates are "biased" in one direction or another from some ideal effect. To explore the true relationship further in a multivariate context would require some explicit causal modeling of the channels through which education acts. Mason and Palan (1980) have done this for Malaysia, and Smock (1980:87) for Kenya. Both studies show that, as more channels are included, the direct effect of education diminishes to zero; however, neither goes through the final step of adding up the effect of education through various channels.

Several papers have carried out rather complete path analyses of fertility. Loebner and Driver (1973) have done such a study with data from Central India. In this study, although neither husband's nor wife's education was directly related to children ever born, both affect fertility indirectly. Husband's education operates through occupation (0.267), husband's income (0.275), wife's age at marriage (0.130), family structure (0.131), and absence of husband and wife (-0.12 and 0.08). Among these, only age at marriage affects fertility (0.052); therefore, husband's education has a small indirect positive path of 0.130 x 0.052 = 0.0068. The path between wife's education and fertility is more tortuous: direct through age at marriage 0.191 x 0.052 = 0.0099, and more indirect through marriage duration 0.191 x -0.272 x 1.032 x 0.721 = -0.0387. Thus the net effect of female education through these indirect paths is -0.0288.

Another study traces the effects of education on current fertility (rather than children ever born) for a sample of Colombian women (Chi and Harris, 1979). The analysis is done separately for women of zero parity, parities one to three, and parities of four or more. The direct effects of education are not significant for those of zero parity, -0.109 for those of parities one to three, and -0.099 for those of higher parities; the indirect effects are +0.025, -0.001, and -0.062 for the three groups. Thus the total effects are +0.025, -0.110, and -0.161, respectively. The principle channels through which education acts indirectly are spouses' discussion about family size; contraceptive attitudes, knowledge, and use; and infant mortality experiences. This study illustrates the shift in education's effects as family size increases, as well as the importance of indirect effects.

Other Considerations

Stability of Educational Differentials Over Time

It is important to determine the stability of educational differentials in fertility across time. Unfortunately, in very few countries is this possible. Many censuses do not report fertility differentials by education controlling for age; even more rarely are there two such censuses for one country. Since most WFS data are standardized by marital duration rather than age, the educational differentials cannot be directly compared with census data.

Three countries do provide data of this kind: the Philippines, 1968 and 1973; Jordan, 1972 and 1976; and Egypt, 1960 and 1976. The results of these comparisons are given in Table 8, showing that education has a more negative effect on fertility at the later point in all three cases. Although this is a very small amount of evidence, it does seem to be confirmed by much more tenuous comparisons of census (age) data with duration data from comparable WFS surveys.[14] Comparisons of CELADE data with WFS data for urban areas (or specifically for city or metropolitan areas where available) also confirm this pattern if women 25-44 are compared with women of all marital durations in the WFS. Any attempt at a finer breakdown (women 35-44 and durations 10-19 and 20-29), yields confirmation for the longer durations only.[15]

Although these data are suggestive, retabulation of WFS data by age would considerably increase our ability to make these comparisons across time. This would permit testing of the hypothesis that education's impact increases over time until fertility is relatively low, at which point the absolute but not the relative differentials decrease.

TABLE 8 Relationship Between Education and Fertility at Two Points in Time: The Philippines, Egypt, and Jordan

Panel A. Philippines, Children Ever Born to Women 40-44 (ESCAP, 1978)

Education	CEB 1968	Percentage Difference from CEB of Uneducated	CEB 1973	Percentage Difference from CEB of Uneducated
No school	6.11		6.85	
1-4 years	6.49	+6.0	7.04	+2.8
5-7 years	6.77	+10.8	6.75	-1.5
High school	5.93	-2.9	6.09	-11.1
College	4.27	-30.1	4.57	-33.0

Panel B. Egypt, Standardized Average Parity (World Bank, 1981)

Education	Parity 1960	Percentage Difference from Parity of Uneducated	Parity 1976	Percentage Difference from Parity of Uneducated
Illiterate	4.21		4.21	
Read and write	4.53	+7.6	4.37	+4.2
Elementary	4.26	+1.2	3.66	-13.1
Secondary	3.59	-14.7	2.80	-33.5

Panel C. Jordan, Children Ever Born Among Women Married over 20 Years (Rizk, 1977; Jordan WFS, 1979)

Education	CEB 1972	Percentage Difference from CEB of Uneducated	CEB 1976	Percentage Difference from CEB of Uneducated
Illiterate	8.79		9.00	
Primary and secondary	7.86	-10.6	7.23	-19.7
Secondary+	4.70	-46.5	4.50	-50.0

Other Evidence on Urban-Rural Differences in Fertility

A number of country-specific studies specifically address or indirectly control for residence in the analysis of fertility. In addition to these studies and the WFS data used by Rodriguez and Cleland, there have been a number of other fairly comprehensive studies of urban and rural differences in fertility.

Kuznets (1974) reviewed data on urban-rural variations in fertility for the late 1950s and early 1960s, and Findley and Orr (1978) reviewed data from the period around 1970. These two studies use different methodologies, though they do share two similarities: (1) they examine the fertility of all, not just married, women; and (2) they introduce no controls except for age. Although differences in methodology prevent close comparison, these studies agree on some points that give considerable insight into urban-rural variations.

Findley and Orr found that the average total fertility rate was 4.95 for urban areas and 6.35 for rural areas, yielding a difference of 1.4 and a ratio of 1.28. This absolute difference falls between the two estimates found using data from Rodriguez and Cleland,[16] but the ratio of fertility rates indicates much larger differences than those found by Kuznets. Kuznets found a ratio of 1.09 for developing countries as a whole, this ratio varying from 1.03 for sub-Saharan Africa to 1.12 for Asia and 1.15 for Latin America. At least some of the contrast with Findley and Orr is due to differences in methodology. Kuznets used children under 5 per 1,000 women of reproductive age as his measure of fertility. Using this measure, differences between urban and rural areas would result from differences not only in fertility, but also in age structure and child mortality, although it is possible that these latter two factors cancel each other out somewhat. To the extent that Kuznets' results are accurate for the period around 1960, it is also quite possible that urban and rural differences in fertility widened over the decade. Further support for a widening gap is found in the fact that, in Western Europe, residential differences widened during the period of fertility decline and then began to narrow in the post-World War II period (United Nations, 1973:97).

Additional findings of interest from these two studies concern regional differences. Findley and Orr found that the larger the city, the lower the level of fertility in Asia and Latin America; however, this relationship did not hold for Africa. Kuznets found greater urban-rural differences in Latin America than elsewhere in the developing world, whereas in Africa urban fertility was in some cases higher than rural. This pattern can be checked against the Findley and Orr data from the 1970s, showing that African differentials (1.29-1.39) are midway between those of Latin America (1.56-1.43) and Asia (1.20-1.12). This change in pattern may arise from differences in measurement, actual changes in differentials, or the effect of selecting particular countries for study. Unfortunately, the latter point can not be checked on a country-by-country basis since Kuznets did not report country-specific data. These varying results may also arise not from regional factors per se, but from differences in the degree or pattern of urbanization in different regions. Thus one must interpret these regional patterns cautiously.

Relatively little insight into the effect of urbanization on fertility is gained from the multiple regression studies reviewed above (see the Appendix Table) since they were not designed for that purpose. Only 11 of the 26 studies include residence or a proxy in their analysis.[17] In these studies, significant negative effects of urbanization are shown in five cases and positive significant effects in one; the rest are insignificant. Given the relatively small number of cases, it is impossible to derive patterns of significance and nonsignificance from these data.

On the other hand, three multivariate studies yield some insight into the channels through which residence operates. A study of Costa Rica by Michielutte et al. (1975) shows that adding other variables (education, income, age at first conception, and church attendance) significantly reduces the effect of residence. Of these variables, the addition of income has the greatest effect on the association, reducing the correlation coefficient from -0.32 to -0.24; no other variable had an effect even a third this size. Ketkar's (1979) study also shows that fairly large urban-rural differentials in fertility (0.85) are reduced to statistical insignificance when income, education, infant mortality, size of extended family, religion, and occupation are added to a regression. The Loebner and Driver (1973) path analysis of fertility in India examines residence as well as education and shows no direct effect of residence. Although residence affects husband's income, family structure, and education, its only indirect effects on fertility are those through education, which is itself an indirect effect. Residence's effect is thus much smaller than education's. It is somewhat surprising that residence does not have an effect more directly through age at marriage; however, for this particular sample, no significant effect of this kind exists. On the other hand, this sample is perhaps atypical in that even the zero-order correlations between residence and children ever born are very small (0.039).

There are other studies giving some fragmentary evidence on the channels through which urbanization may operate. However, it seems more efficient to examine broader issues in addressing the effects of changing socioeconomic circumstances on fertility. The propositions below summarize these issues.

PROPOSITIONS

Education and Fertility

1. The effects of education on fertility vary according to whether male or female education is considered and whether all or only married women are included, and with the degree of urbanization.

2. A major effect of education on fertility is through age at marriage; thus the observed negative effect of education on fertility is smaller in samples including only ever-married women than in those

including both married and unmarried women.

3. Monotonic inverse relationships between education and fertility are much less likely to be observed in countries having low levels of urbanization, per capita income, and daily caloric intake. Of these three factors, urbanization appears to be the most important. This may explain the stronger observed negative relationship between education and fertility in Latin American than in Asia.

4. Female education is more often inversely related to fertility than is male education: the negative effect across the total range of female education is about three times greater than that of male education after adjusting for many other factors, including spouse's education, occupation, and residence. Male education at low levels is more likely to be positively related to fertility than is female education; however, this may well reflect a positive income effect of education since income is more closely related to male than to female education.

5. In multiple regression studies, the observed magnitude of the relationship between education and fertility is highly dependent on whether or not the regression equation includes variables through which education operates. Although several recent studies have illustrated this by including these variables, the relative importance of the different channels is still unclear and probably varies among countries.

6. The cross-section effect of education on fertility is more negative at later than at earlier points in time, at least until fertility levels become very low. This topic needs more research, which would be facilitated by a simple retabulation of WFS data in more comparable form to those of earlier surveys and censuses. In addition to comparing differentials at various points in time, research should attempt to determine what aggregate factors, such as development or income growth, affect the changes in differentials over time.

7. Reanalysis of the Value of Children data could provide insight into the extent to which education's effect operates through differential values.

Residence and Fertility

8. Differences in fertility between urban and rural areas are smaller than those between the least and most educated; however, this may result from the dichotomous classification of residence and may thus be an artifact.

9. The greater the degree of urbanization in a country, the greater the urban-rural differences in fertility. This may arise in part from measurement problems since, as urbanization increases, those classified as urban generally come from larger cities.

10. The mechanisms through which residence operates are less clear than those through which education operates. The former are more difficult to identify because of the need to separate out factors

specific to location (place factors), as well as those specific to individuals and themselves correlated with place factors. The WFS analysis of such community variables as access to markets and average education levels offers some hope of eventually disentangling these channels; reanalysis of Value of Children data could also provide insight into the extent to which residence operates through the perceived costs and benefits of children.

NOTES

1. For example, if education affects age at marriage, then the inclusion of age at marriage (M) in a regression between age-controlled fertility (F) and education (E) will have the following bias. Let $F = a + bE + cM$ and $M = d + eE$. The effect of education on fertility cannot be measured by b alone, but must be measured by $b + ec$. If c is negative and e is positive, then the coefficient of b will be biased upward. This explains the plus in column 3 of Table 1.
2. Including age and marital duration is equivalent to including age at marriage; this will cause a positive bias in the education coefficient.
3. It is interesting to note that in no case was husband's education the most important variable in reducing the negative effect of wife's education, and that, for rural Malays, controlling for husband's education had the most important impact on increasing the negative effect of wife's education.
4. Studies using the total education of husband and wife introduce other problems--such as nonlinearities and the differential effects of husband's and wife's education.
5. Two solutions to the problem of variables determined simultaneously with fertility are two-stage least squares and reduced-form equations.
6. Other background variables, such as religion, caste, and parental status and education, cause less well-defined problems because the direction of bias depends on the effect of the background variable on education and fertility.
7. Therefore, in countries where the timing of fertility is undergoing significant change, these variables will be an inaccurrate reflection of completed fertility.
8. The value obtained for countries in which both estimates are available is 2.1; for all countries, the average difference is 1.9 for married women.
9. Rather surprisingly, Findley and Orr also found that the percentage of the population in small cities (under 20,000) was significantly related to larger urban-rural differentials.
10. Rodriguez and Cleland give no explanation for the asymmetrical treatment of male and female education in this respect.
11. This description glosses over very detailed, careful discussions of the measurement of the variables and the choice of model specification.

12. If income or wealth is controlled, female education is significantly inverse to fertility in 46 percent of the cases, and male education in 29 percent. If there is no control for income or wealth, female education is inversely related 58 percent of the time and male education 20 percent. If wealth, income, or husband's education is controlled, wife's education is inversely related in 49 percent of the cases.
13. If age and marital duration are both in the equation, this is equivalent to including age at marriage.
14. The approximate comparisons are as follows: for Kenya, women 45-49 in 1962 and over 45 in 1977-78; for Indonesia, women 45-49 in 1971 and marital duration over 20 in 1976; and for Malaysia, women 35-44 in 1966-67 and duration over 20 in 1974.
15. This is not surprising since in most cases, the negative impact of education increases over the life cycle.
16. For all women, the average difference was 1.6 and for ever-married women 1.2.
17. Many control for residence by having samples restricted to urban or rural areas.

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APPENDIX TABLE Multivariate Studies of Education and Children Ever Born in Developing Countries, by Region

Region and Study	Sample: Location, Year, Size	Estimation Technique	Education Measure	Education's Effect and Significance (t values in parentheses) [elasticities in brackets]		Other Variables Included (sign if significant)	Comments
LATIN AMERICA							
Iutaka et al., 1971	Brazil (1959-60) 1,280 urban males	OLS	Husband's levels	.077 (2.46)		Age +, age at marriage −, city size +, migratory status +, color −, social status +, father-in-law's status +, father's status.	Major bias due to inclusion of age at marriage and social status.
Kogut, 1974	Brazil (1960 census) 2,083 NE 3,287 S 2,872 E	OLS	Years	HE −.088 (2.93) −.065 (5.66) −.059 (3.85)	WE −.035 (0.87) −.030 (1.84) −.058 (2.68)	Age −, marital duration +, income (varying sign), type of marriage consensual − (NE and S), rural +, suburban.	Major bias due to marital duration, which affects the coefficient of wife's education more than husband's.[a]
Davidson, 1973	Mexico Mexico City (1963-64) 269 women 35-39	Stepwise	Wife's years	−.096 (0.80)		Age at marriage −, desired number of children +.	Age at marriage causes education to be underestimated, as does desired size. Author recognizes former effect in text.
	Venezuela Caracas (1963-64) 192 women 35-39	Stepwise	Wife's years	−.101 (0.76)		Age at marriage −, desired number of children +, wife's work status, husband's occupation.	
Michielutte et al., 1975	Costa Rica (n.d.) 292 women 35-49 (clinic and control)	OLS	Wife's years	−.38[b]		Residence −, income, church attendance −, age at first conception −.	Bias probably introduced by age at first contraceptive use; also perhaps by sample design.

Stycos, 1980	Costa Rica (1978) 966 women over 35	OLS	Wife's years	-.16[b]		Years married +, mass information -, modern psychology.	Since mass information depends on education, education is underestimated. Adjustment not possible with given data.
	<u>Sterilized</u>			<u>HE</u>	<u>WE</u>	Years since union +, consumer durables -, siblings +, urban church attendance, work history, parent's education, current work.	No residence control.
	No (550)			-.05	-.05		
	Yes (267)			.00	-.17[b]		
Anderson, 1979	Guatemala (1974-75) 657 households	OLS (in CEB)	Years	<u>HE</u> -.008 (1.00) [-.021]	<u>WE</u> -.029 (3.22) [-.054]	Wealth, location, wife's age +.	Does not include imputed wage for husband.[c]
<u>EAST ASIA</u>							
Kiranandana, 1977	Thailand (1969-70)	OLS	Levels	<u>HE</u>	<u>WE</u>	Age +, marital duration +, ideal family size +, contraceptive use +, proportion dying +, proportion male +, (urban) -.[d]	If husband's education is deleted, wife's is negative and highly significant.
	1,546 women			-.155 (4.05)	-.059 (1.31)		
	478 rural			-.097 (0.95)	.049 (0.43)		
	1,068 urban			-.162 (4.09)	-.073 (1.70)		
Lee et al., 1978	Korea (1971) 2,334 women 35-49	OLS	<u>Age 35-39</u>	<u>HE</u>	<u>WE</u>	Mortality +, mortality squared -, surviving sons -, wife urban -, modern objects owned, family structure, children in agriculture, children in nonagriculture +, regional mortality, children enrolled, children under 6 +, regional unemployment, demand for female labor, husband's unemployment.	Education underestimated due to the inclusion of mortality, child enrollment, and employment.
			0	0.29 (2.17)	0.23 (2.27)		
			7-9	-0.08 (0.66)	-0.52 (3.58)		
			10-12	-0.22 (1.79)	-0.64 (3.17)		
			12+	-0.26 (1.47)	-0.45 (0.88)		
			<u>Age 40-44</u>				
			0	0.01 (0.07)	0.39 (2.51)		
			7-9	-0.20 (1.10)	0.08 (0.28)		
			10-12	-0.17 (0.77)	-1.07 (3.00)		
			12+	-0.18 (0.56)	-0.95 (1.41)		
			<u>Age 45-49</u>				
			0	-0.36 (1.59)	0.20 (0.84)		
			7-9	-1.15 (3.87)	0.05 (0.10)		
			10-12	-0.31 (0.79)	-0.24 (0.45)		
			12+	-0.96 (1.99)	-0.85 (0.69)		

APPENDIX TABLE (continued)

Region and Study	Sample: Location Year, Size	Estimation Technique	Education Measure	Education's Effect and Significance (t values in parentheses) [elasticities in brackets]		Other Variables Included (sign if significant)	Comments
Mason and Palan, 1980	Malaysia (1974) 6,147	OLS	Years Race Malay Chinese Other Malay	Urban E .095 −.117[b] −.180[b] E^2 −.015[b]	Rural E .127 −.096[b] .034 E^2 −.016[b]	Age, marital duration.	Biased due to marital duration, but see text for expanded discussion.
Chernichovsky and Meesook, 1980	Indonesia (1976) 60,000 households	OLS	Wife Elementary Jr. Hi. Voc. Jr. Hi. Gen. Sr. Hi. Voc. Sr. Hi. +	Java-Bali −.076 (1.79) [−2.0] .023 (0.16) −.133 (1.38) −.479 (3.61) −.960 (7.92)	Outer Islands .083 (1.75) [1.9] .061 (0.44) −.313 (3.42) −.663 (4.70) −.888 (6.72)	Age +, age at marriage −, marital status −, religion, work in home +, work outside +, modern durables −, household expenditure +, expenditure squared −, knows contraception +, rural − (Java-Bali).	Education's effect probably biased positively by age at marriage, but knows contraception has a perverse sign, as does work outside the home. Thus overall direction of bias is unclear.
Encarnacion, 1974	Philippines (1968 NDS) 3,629 women under 50	OLS	Wife's years	WE = .214 (3.05)[e] WE^2 = −.040 (3.56)		Age at marriage −, duration (nonlinear), family income (nonlinear) +/−.	Biased due to inclusion of age at marriage.
Rosenzweig, 1978	Philippines (1968 NDS) 1,830 women 35-49	OLS	Years	HE = .022 (0.65) WE = −.091 (3.51)		Age of husband +, age of wife +, child wage +, regional infant mortality +, religion, contraceptive knowledge, predicted husband's wage, farm.	Husband's education may be biased slightly due to predicted wage; wife's education may be biased due to contraceptive knowledge.
Banskota and Evenson, in press	Philippines Laguna (1977) 320 rural households	OLS	Years	HE = −.049 (1.43) WE = .172 (3.31)		Infant deaths +, 1963 husband's wage, predicted wife's wage −, predicted child wage +, full income, land, home technology −, year married −, father's farm background +, mother's farm background, mother's nonfarm.	Compare results with next study. This specification has far more variables endogenous with respect to education so results are more biased.

Navera, 1978 (in Evenson et al., 1979)	Philippines Laguna (1977) 320 rural households	OLS	Years	HE = -.131(1.58) WE = -.182(2.07)		Wife's age at marriage, duration of marriage +, household income, wealth.	Wife's education underestimated due to age at marriage and duration.
<u>SOUTH ASIA</u>							
Chernichovsky, forthcoming	India (1968-69) 213 rural households (one village)	OLS	Husband's years Wife's literacy	HE = .058(0.85) WE = .341(0.952)		Log mother's age +, age at marriage -, agricultural income +, unskilled income +, skilled income -.	Wife's education biased positively by age at marriage; husband's education biased downward due to effect of his education on income.
Sarma, 1977	India (1970-71) 1,111 landed households 505 landless	OLS	<u>Wife</u> Some primary Above primary Matriculated <u>Husband</u> Primary or above	<u>Landed</u> -.247(0.89) [-.0029] -.599(1.66) [-.0040] -1.44 (2.57) [-.0039] .95 (6.90) [.1401]	<u>Landless</u> -.165(0.48) [-.0038] -.431(0.82) [-.0036] -.464(0.72) [-.0026] 1.19 (5.36) [.1726]	Age of wife +/0, child death rate +/+, value of livestock, cultivated area +, intensive development program, health center in village +/+, school in village, factory in village, household electricity -/0, distance to town 0/-, value of farm instruments	Careful effort to exclude endogenous variables. However, if education affects landownership, some selectivity bias may exist.
Chaudhury, 1977	Bangladesh Dacca (n.d.) 1,130 women	OLS	<u>Years</u> 1-5 6-9 Secondary BA MA	<u>HE</u> -1.03 (2.60) -0.64 (1.22) -0.548(1.00) -0.446(0.78) -0.39 (0.67)	<u>WE</u> -0.675(2.05) -0.953(3.32) -1.25 (5.04) -1.50 (5.56) -1.83 (6.67)	Duration of marriage, age at marriage, labor force status, income, exposure to mass media.[f]	Husband's, wife's education entered separately. Underestimates wife's education due to inclusion of age at at marriage.
Khan, 1979	Bangladesh (1968-69) 265 rural women 35-49 who want no more children	OLS	Years	HE = -.06 (1.00) WE = .13 (2.17)		(Dead children) +/+, (monthly income) +/+, (wife worked), land owned -/0, income adequacy -/-, age of wife, aware of family planning, nuclear family, age of wife at marriage 0/+, education of children +/0.[d]	See comments on next study.

APPENDIX TABLE (continued)

Region and Study	Sample: Location, Year, Size	Estimation Technique	Education Measure	Education's Effect and Significance (t values in parentheses) [elasticities in brackets]	Other Variables Included (sign if significant)	Comments
Khan and Sirageldin, 1979	Pakistan (1968-69) 269 women 35-49 who want no more children	TSLS	Husband's years Wife's literacy	HE = .04(0.10) WE = -.48(0.68)	(Number of dead children) -, (income), (wife worked) -, urban +, nuclear +, land owned -, house owned +, wife's age +, age at marriage -, know of family planning -, income adequacy -, education of children -.[d]	Wife's education underestimated due to other variables. Also possible bias due to selection of those who want no more children. See text.
De Tray, 1979	Pakistan (1968-69) 861 women 35-49	OLS	Years	HE = .38(2.00) HE^2 = -.09(2.10) WE = -.33(3.30)	Electricity +, house type +, rural, wife born urban, current age +, mortality +.	Only child mortality is likely to bias results.
Afzal et al., 1976	Pakistan Lahore (1973) 674 women	OLS	Levels	HE = -.037 (0.87) WE = -.234 (3.68)	Mortality rate, age of mother, marital duration +.	Age and marital duration are implicit control for age at marriage and bias may exist.
Sathar, 1979	Pakistan (1975) 4,949 women 15-49	OLS	Years Total Urban Rural	HE / WE -.017(2.10) / -.058(3.85) -.022(1.83) / -.052(2.83) -.012(0.99) / -.070(2.07)	Age +, age squared -, age at marriage -, mortality +, use of contraception +.	Wife's education probably underestimated due to age at marriage, mortality, and use of contraception.
MIDDLE EAST						
Zurayk, 1977	Lebanon (1976) 16 villages 1,050 women 15-44	OLS	Levels	HE = -.08(1.82) WE = -.06(2.73)	Duration of marriage +, number of child deaths +, religion -.	Education's effect probably underestimated due to mortality.
Kelley et al., 1980	Egypt (n.d.) 3,812 rural households	OLS	Wife Some primary (19%) Primary + (4%) Husband Some primary (23%) Comp. primary (6%) Above primary (8%)	 .05(0.71) .02(0.15) .16(2.48) .15(1.35) .17(1.52)	Wife's age +, age squared -, age at marriage -, electricity +, child death +, personal assets, real assets +.	Age at first marriage and child deaths cause education coefficient to be biased.

Snyder, 1974	Sierra Leone (1966-68) 228 women 35-49	OLS	Levels	HE = .21(3.71) WE = -.19(2.17) HE = .19(1.56) WE = -.19(1.40)	Wife's working age, child survival -, age +. Wife's wage if working, labor participation, survival of children -, age, age squared -, child education.	Probable bias upward by child survival.
Ketkar, 1978 1979	Sierra Leone (1966-68) 1,999 women	OLS	Years	HE = .016(1.11) WE = -.011(0.61) WE = .06 (1.03) WE^2 = -.006(1.17)	Wife's age +, number of adult females +, community infant mortality +, religion, residence, occupation, migration.	Careful use of reduced form.
Knowles and Anker, 1975	Kenya (1974) 1,073 women	OLS	Years	WE = .0256(0.697)	Years married +, urban -, nonfarm employment +, breastfeeding, household income, land owned +, other wife, community family planning.	None of the independent variables that are dependent on education are significant.
Kelley et al., 1980	Kenya (n.d.) 401 urban nuclear households	OLS	<u>Husband</u> Comp. primary Secondary <u>Wife</u> Comp. primary Secondary	 -0.32(-0.67) -2.82(1.83) -0.29(0.70) -3.88(2.72)	Child death +, income +, age +.	Probable bias due to child deaths, but female education is not significant in child death equation.

[a]Age at marriage is highly dependent on education, but more dependent on wife's education. The coefficients of husband's and wife's education on age at marriage in each region are shown below:

	<u>NE</u>	<u>S</u>	<u>E</u>
Husband's	.144	.214	.244
Wife's	.325	.322	.305

All values are highly significant, but adjustment of education coefficients is not possible given the specification.

[b]t values not reported, but result is significant at 5 percent level.

[c]This is the third specification. With an imputed wage added, husband's education has a positive coefficient and is marginally significant if the imputed wage is a reservation wage. In another paper, the author also used an imputed wage for the wife. In that case, wife's education had a value of -0.956, but a t value of only 1.55 (Anderson, 1978:146).

[d]Variables in parentheses are endogenous.

[e]This is not the regression equation focused on by Encarnacion. His focus was on a more complex equation (p. 125) which uses a threshold treatment. That treatment confirms the above: at low levels of education, there is a positive effect of education; at high levels, there is a negative effect. The threshold value is 2.75 years.

[f]Significance not reported for any of these variables.