How Can Women's Education Aid Economic Development?

The Effect on Child Stunting in Papua New Guinea

John Gibson

Abstract

It is claimed that improving the education of women may be the most efficient way for Melanesian countries to attain economic development goals but the necessary empirical evidence has been lacking. This paper uses nationally representative household survey data to compare the effect of mother's and father's education on the risk of child stunting. Stunting is the major nutritional problem is Papua New Guinea and contributes to inferior health and labour productivity. The results show that mother's education is at least three times more productive than father's education. Thus, under-investment in women's education appears to contribute to the problems of poor health and economic performance in Papua New Guinea.

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HOW CAN WOMEN'S EDUCATION AID ECONOMIC DEVELOPMENT?

THE EFFECT ON CHILD STUNTING IN PAPUA NEW GUINEA

It has recently been claimed that improving the education of women may be the most efficient way for Melanesian countries to attain development goals such as economic growth, improved health, longer life expectancy and lower population growth (Gannicott and Avalos, 1994).[1] However, this claim is based on studies in the international literature, rather than empirical research in Melanesia, and the international literature is not always in agreement. For example, King and Hill (1991) find that the lower the rate of female school enrolments to male enrolments, the lower the national income level, but Barro and Lee (1994) find that economic growth in a cross-section of countries is positively related to male schooling but negatively related to female schooling.

The purpose of this paper is to report empirical evidence from Papua New Guinea that can help to support the claims made by Gannicott and Avalos. The relationship studied is between women's education and the stunting (i.e., short stature due to poor living environments) of young children. Stunting is an indicator of chronic protein-energy malnutrition (PEM), which is considered to be the most important form of malnutrition in Papua New Guinea (Marks, 1992). Approximately one-quarter of children measured by the 1982-83 National Nutrition Survey (NNS) were considered stunted according to one widely used criteria.[2] The stunted growth of children has a number of adverse consequences, which are described below, so the widespread prevalence of stunting in Papua New Guinea is an

[1] A similar claim is made by Summers (1992).

[2] This criteria is having a recumbent length that is below 90 percent of the median length-for-age in the Harvard sexes-combined reference data of Jelliffe (1966). Note that the NNS was restricted to rural areas and the reported proportion is unweighted because the population sampling weights are unavailable.

important social problem, which has been reflected in the goals of the National Nutrition Policy (Marks, 1992).

In this paper I use household survey data collected in 1996 as part of a World Bank-sponsored assessment of poverty in Papua New Guinea to compare the effect of mother's and father's education on the risk of stunting in young children. The results suggest that mother's education has a powerful effect – and one that is at least three times larger than the effect of father's education – on reducing the risk of stunting in children, even after controlling for household economic resources and parental health. This is in contrast to previous evidence from Papua New Guinea that neither mother's nor father's educational level have any effect on a child's nutritional status (Jenkins, 1992). Despite the high productivity of maternal education, girls in Papua New Guinea receive less schooling than boys, so the low priority given to women's education is likely to impose a high social cost, in terms of inferior health for children.

Stunting: Consequences and Importance

The study of child stunting has traditionally been a concern of nutritionalists, but economists are increasingly interested in the height (and weight) of young children. One reason for this interest is that child anthropometric measurements provide useful information about living standards: weight (conditional on height and sex) typically varies in the short-run so is used as a measure of current health status whereas height, given age and sex, is an indicator of longer-run health and welfare (Thomas, *et. al.*, 1991). Thus, it is sometimes suggested that child stunting should replace economic measures like income or expenditure as an indicator of poverty since the multiple determinants of stunting are all integral to the quality of life (Gross, *et. al.*, 1996).

Stunting is also an important economic issue in its own right, affecting over 200 million young children (below age five) in developing countries (Frongillo, 1999). The consequences of stunting include increased risk of sickness and death (Chen, *et. al.*, 1980) and poor mental development (Grantham-McGregor, *et. al.*, 1996), both of which contribute to decreased future work capacity. These problems can persist across generations because young girls who grow poorly usually become stunted women who are more likely to give birth to undersized babies, and these babies have a higher risk of being stunted in their own adulthood (UNICEF, 1998). The impacts on sickness, mental development and work capacity are obvious pathways through which stunting can affect future economic growth and development.

Causes of Stunting and the Role of Parental Education

The model used by economists to understand the influences on child nutritional status assumes that households maximise a utility function, which depends on the consumption of commodities and leisure as well as on the quality and quantity of children. Households are constrained by budget and time endowments and by a production function relating health outputs (e.g., stunting) to inputs (e.g., nutrient intakes, utilisation of health facilities and antenatal health care) and exogenous individual and household characteristics (Thomas, *et. al.*, 1991). The inputs are endogenous, so instruments such as prices and service quality are needed to purge the estimates of simultaneity bias, but most socio-economic surveys lack this required information (Sahn and Alderman, 1997). Therefore, attention is usually restricted to the reduced form demand equations for child health, which come from the household's solution to its constrained maximisation problem:

$$D_h = h\left(x_j, x_h, x_c, e_j\right)$$

where x_j are child characteristics such as age and sex, x_h are household characteristics such as income and indicators of parental human capital (e.g. schooling and stature), x_c are community-level variables such as the prices of consumption goods, and e_j is a child-specific random error reflecting heterogeneity in individual healthiness and unobservable factors.[3]

These reduced form demand equations suggest several pathways through which parental education can affect child health, and hence stunting (Handa, 1999). First, there is an *income* pathway, where education may help to increase parent's incomes, allowing extra spending on food and health care for the child. Second, there is an *efficiency* or *information processing* pathway, where education may improve understanding of health and nutrition so that even with a given income a household is able to produce taller, heavier and healthier children. The efficiency pathway can be distinguished from the income effect by seeing what happens to the estimated impact of schooling when income variables are added to a model of child height (Thomas, *et. al.*, 1991). Gender differences in educational attainment will have an influence on child health when there are efficiency effects because mothers tend to spend more time caring for children than do fathers.

The education of mothers may also affect child health by altering the intrahousehold allocation of resources, which can be thought of as a *power* pathway. Bargaining models of household decision making emphasize the fact that preferences may differ within the household and that education improves the outside opportunities of individuals, thereby increasing their bargaining power within the household (Handa, 1999). If women have greater concern for children's growth and nutrition than men do, increasing women's education relative to men may lead to more

[3] These reduced form demand equations may also suffer from some endogeneity bias because income and child health could be jointly determined if time spent in market work subtracts from time spent caring for children.

resources being allocated to the children. Finally, parental education may simply be a proxy for unobserved background variables, such as parental health or other household or community characteristics (Wolfe and Behrman, 1987). In this case, there may be no gains to closing educational gender gaps, seeing as they only reflect the influence of variables that have been excluded from the analysis.

Gender Gaps in Education in Papua New Guinea

There are a wide range of estimates of educational gender gaps in Papua New Guinea, but all of them suggest a substantial disadvantage for women. Gannicott and Avalos (1994) report that in 1990 average years of schooling for females in PNG were only one half of the average for males (0.6 versus 1.2 years)[4] while the female adult literacy rate was only 58 percent of the male rate. The Census of Population in 1990 found that 46.3 percent of males aged 10 years and over had completed at least Grade 3 schooling (which was assumed to be sufficient for reading and writing) but only 34.8 percent of similarly aged females had completed this level of schooling (NSO, 1994).

The estimates of the educational gender gap reported here are from a 1996 national household survey which asked respondents to report the highest educational level of each resident in the selected households. The survey also asked about enrolments in school in 1995 and whether each respondent could read a newspaper. [5] In common with the 1990 Census, there was no literacy test so respondents were not required to demonstrate that they could read.

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[4]Although the authors do not specify, these figures are likely to refer to the mean for the whole population, rather than just over adults because mean schooling years are lower than other estimates for the same period.

[5] This definition of literacy is more restrictive than definitions based on reading or writing in the local vernacular (*Tok ples*) because newspapers are mainly written in the three official languages of PNG (English, Motu, and Pidgin). However, these official languages are the ones that are most useful for commerce, and for understanding health and nutrition information.

The survey found that 49 percent of adult females (aged 15 years and above) had never attended school, while only 31 percent of adult males had never been to school. Only 35 percent of adult females had completed community school (Grade 6), while 49 percent of males had achieved this. The average length of schooling across all adult females was 3.1 years, which was only two-thirds as high as the average for men (4.7 years). As a consequence of these differences in schooling levels, there was almost a 20 percentage point gap in the literacy rate between adult males (63.1 percent) and females (44.4 percent).

To what extent are current school enrolments closing these gender gaps? The survey data were used to generate the distribution of school enrolments in 1995, by gender, for each year of age from 6 years to 20 years (age in 1995 was derived from age at time of the survey). The results suggest that by the time a boy reaches 20 years of age, the probability that he has ever attended school is over 90 percent, but for a similarly aged girl the probability is only 75 percent. There does not appear to be a significant lag in girls starting school compared with boys, but girls drop out earlier and more quickly. The enrolment rate for boys peaks at age 10 (at 68 percent) but stays above 60 percent until age 15 years while for girls the enrolment rate drops from 68 percent at age 11 to 40 percent at age 15. At age 18 years, male enrolment rates are twice as high as female rates (27 percent versus 13 percent).

The 1996 Papua New Guinea Household Survey

Data used in this paper come from the Papua New Guinea Household Survey (PNGHS), which is the first national survey of living standards in Papua New Guinea. The survey covered a random sample of 1200 households, residing in 120 rural and urban communities (“clusters”), who were interviewed between January and December 1996. The clusters were selected from the enumeration areas of the 1990 Census and came from all provinces except North Solomons. A set of sampling weights, based on variation between the 1990 Census estimates of the size of each cluster and the actual size found during the survey and on the deviation of the actual number of households surveyed in each cluster from the target number, allow the results reported to be representative of Papua New Guinea in 1996.

Each household was visited twice over a two-week period and on each visit anthropometric measurements (height and weight) were made on all children age five years and under, and on the parents of these children. This duplication allowed the average of the two measures to be used, which should reduce the effects of measurement error. The age of the children was determined from documentary evidence (e.g., birth cards, baptismal records) if held by the parents or by health or church facilities and otherwise from parental recall. The height-for-age (conditional upon gender) of the children was compared with international growth reference curves and a child was defined as stunted if height-for-age was more than two standard deviations below the median of the reference group, which is a common criteria used by nutritionalists (Dean, *et. al.*, 1995).[6] Extreme values of height-for-age was checked by using the multiple anthropometric measures of each child and in some cases were discarded if associated with apparent measurement error or unreliable records of age.

In addition to the anthropometric measurements and reports of parental education, the survey also gathered data on the total number of residents and the total expenditures of each household. These variables are used here to measure household permanent income because

[6] The reference standards come from North American multiethnic data of the National Center for Health Statistics (NCHS) but they are applicable to developing countries (and recommended by the World Health Organization) because children from high-income households in those countries show the same age-related body stature (Gross, *et. al.*, 1996).

expenditures tend to be less volatile than current incomes (Anand and Harris, 1994). The expenditure estimates include all food and other frequent expenses during the two-week interview period,[7] plus infrequent expenses (obtained from a 12-month recall) and an estimate of the flow of services from durable assets and owner-occupied dwellings.

Details of the Analysis

The data collected from the 1996 survey were used to estimate a multivariate model of the risk of child stunting. The logit estimator, which is appropriate for dichotomous data (i.e., is the child stunted or not) was used. The estimation strategy was to first use a variable measuring the average years of education of the child's parents. This variable was then disaggregated into years of education for the mother and years of education for the father. Additional variables, whose (excluded) effects might be picked up by the education variables were then added to the model.

Descriptive statistics for the main variables used in the analysis are reported in Table 1 for the sample of 614 children for whom there was full data available on both parents. On average, the height of young children in Papua New Guinea is only 92 percent of the median height in the U.S. for the same age and sex, and almost one-half of the children in PNG are defined as stunted.[8] Although the average level of schooling for each parent is four years, for mothers it is only three years while for fathers it is five years. It is this lower educational level of mothers which, potentially, harms the nutritional status of young children.

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[7]Self-produced foods, net gifts received and food stock changes were given imputed values based on respondent reports but estimates of average expenditure are unchanged if these respondent-reported unit values are replaced with average market prices (Gibson and Rozelle, 1998).

[8] According to the criteria of being more than two standard deviations below the median in the NCHS sample of U.S. children. Note that this is not the same criteria as used by the earlier National Nutrition Survey in PNG, so the trend in stunting rates cannot be established.

Table 1 **Data definitions and description**

Variable	Unit	Mean	Standard deviation
Standardized height of children	Percent	92.17	6.24
Stunting rate	Percent	49.63	50.03
Average schooling of parents	Years	3.97	3.48
Mother's schooling	Years	2.95	3.70
Father's schooling	Years	4.98	4.49
Mother's height	Cm	152.78	6.62
Father's height	Cm	162.77	6.87
Household total expenditure	Kina	4515	3996
Household size	Persons	7.19	3.08

Notes: 1. *N*=614. 2. The means and standard deviations are weighted, with weights reflecting the number of households represented by each observation. 3. Standardized height is the percentage of the median height for children in the United States of the same age and gender. 4. Stunting is defined as height-for-age more than two standard deviations below the median in the reference population. 5. Household expenditure is in national average prices, where the value of the regional poverty line is used as the spatial price deflator.

Source: Author's calculation from the results of the 1996 Papua New Guinea Household Survey.

The analysis also uses a number of control variables which are not reported in Table 1. The household survey showed that the incidence of stunting varies considerably according to the age of the child, with growth retardation worsening in the early years of life. This is similar to the pattern found in other developing countries (Sahn and Alderman, 1997). Therefore, dummy variables for five different age groups were included in the model. There were also regional differences in the incidence of stunting, which is consistent with the reduced form demand models of child health which include effects controlling for regional variation in the prices of consumption goods. Therefore, four regional dummy variables were also included in the equation predicting whether or not the child was stunted. However, the model does not include control variables for the sex of the child because preliminary analysis showed no gender difference in stunting rates, either unconditionally (t=0.63) or conditioning on other variables (t=0.88).

Estimation Results

The estimation results are reported in Table 2, and include coefficient estimates, heteroscedastically-robust standard errors, and "probability derivatives".[9] These probability derivatives are needed because the logit coefficients give the effect of each independent variable on the logarithm of the "odds ratio" – the ratio of the probability that a child is stunted to the probability that it is not – and are therefore not directly interpretable. The probability derivative shows the percentage point change in the risk of a child being stunted after a one-unit increase in the independent variable, and so is more like the slope coefficient from the usual linear regression model. These derivatives are calculated as:

$$\partial P/\partial X = \hat{P}(1-\hat{P})\hat{b}$$

where $\hat{P}$ is the predicted probability of stunting and $\hat{b}$ is the estimated coefficient (Gujarati, 1988).

[9] All of the reported estimates take account of the clustered, weighted and stratified nature of the data.

The first result, contained in column (i) of Table 2, is that each extra year of education completed by the parents decreases the risk of the child being stunted by almost four percentage points. Given that almost 50 percent of children were stunted, having parents who had both completed community school (six years of education) would almost halve the risk of being stunted, compared with similar children whose parents had never attended school.

The results in column (ii) show that most of this effect comes from the education of women, rather than of men. An extra year of education for the mother reduces the risk of child stunting by three percentage points. This effect is three times larger than the effect of an extra year of education for the father. Thus, raising the schooling level of mothers to equal that of fathers (an addition of two years, on average) could reduce the proportion of children who are stunted by six percentage points. Not only is the payoff to men's schooling -- in terms of improved child health -- lower, it is also less precisely estimated. In fact, the hypothesis that father's education has no effect on the risk of stunting would not be rejected at usual confidence levels (p=0.11).

Table 2 **Logit Estimates of the Effect of Parent's Education on Risk of Child Stunting**

	(i)	(ii)	(iii)	(iv)
Average years of Schooling of parents	-0.1535 (0.0380) [-3.8%]	--	--	--
Years of schooling of mother	--	-0.1192 (0.0311)	-0.0989 (0.0339)	-0.0707 (0.0354)

		[-3.0%]	[-2.5%]	[-1.8%]
Years of schooling	--	-0.0460	-0.0255	-0.0174
of father		(0.0281)	(0.0297)	(0.0301)
		[-1.2%]	[-0.6%]	[-0.4%]
ln (total household expenditure)	--	--	-0.4000	-0.1924
			(0.1567)	(0.1702)
			[-10.0%]	[-4.8%]
ln (total household size)	--	--	-0.1506	-0.2676
			(0.2463)	(0.2613)
			[-3.8%]	[-6.7%]
Mother's height	--	--	--	-0.0615
				(0.0211)
				[-1.6%]
Father's height	--	--	--	-0.0536
				(0.0147)
				[-1.4%]
F-statistic for overall model	$F_{(9,77)}$=7.92	$F_{(10,76)}$=7.30	$F_{(12,74)}$=5.87	$F_{(14,72)}$=6.07

Notes: 1.Numbers in ( ) are standard errors (corrected for population weights, stratification and clustering). Numbers in [ ] are probability derivatives which gives the change in the probability of the child being stunted given a unit change in the independent variable. 2.Each equation also includes an intercept term, four age group dummy variables for the child (12-23 months, 24-35 months, 36-47 months, ≥48 months), and four regional dummy variables. 3.Dependent variable is binary, taking a value of 1 if the child is stunted and 0 otherwise.

Source: Author's calculation from the results of the 1996 Papua New Guinea Household Survey.

What is the pathway through which mother's schooling has this effect on child stunting? The model in column (iii) of Table 2 controls for household income levels by adding variables measuring household total expenditure and household total size (the ratio of the two variables – *per capita* expenditure – is not used because there may be economies of scale in nutrient intakes which are obscured when a per capita measure is used). There is a slight fall in the size and statistical significance of the coefficients on both parents education, but mother's schooling now appears four times more effective than father's schooling. The significant effect of mother's education on stunting probabilities, even when household economic resources are controlled for, suggests that most of the effect of education on child growth does not come through the income pathway. Instead, it may work either through the efficiency pathway, with mother's education most effective because they spend more time caring for children than fathers do, or through the power pathway, with children benefiting from the bigger say that educated women have in household decision-making.

Although not directly apparent from the results in column (iii), it appears that raising mother's schooling has a larger effect on reducing stunting than does raising household income. A unit increase in (log) household expenditures, which is equivalent to almost a tripling in the initial level of expenditures, would reduce the probability of stunting by 10 percentage points. In contrast, a tripling in the average years of schooling of mothers would be an increase of six years, which would reduce the risk of stunting by approximately 14 percentage points.

To test whether the coefficients on schooling are picking up excluded household characteristics, parental height is added to the model whose results are reported in column (iv). These height measures should proxy for parental health, household human capital levels and excluded genetic effects. The results show that parental height is highly relevant to the risk of a child being stunted (with no difference between the effect of mother's height and father's height). Adding parental height to the model has most impact on the measured effect of household economic resources: the coefficient on (log) total expenditure falls to one-half its previous value and the null hypothesis that economic resources have no effect on the risk of stunting is not rejected (p=0.26). The lower coefficients on schooling in column (iv) suggest that the previous results were picking up some excluded effects of maternal health but even with that addition to the model, mother's education still exerts a powerful effect on the risk of child stunting.

Moreover, the significant effects of both mother's height and mother's education on stunting probabilities indicates that there is a long-run, intergenerational, effect of women's education on child health, which is consistent with the view of UNICEF (1998). Educating the current generation of girls will reduce the risk that their own children are stunted. Those children are likely to become taller adults which will then reduce the risk of the next generation of children being stunted.

A final test of the robustness of the results was to change the estimation method to allow for the possibility that household expenditure is an endogenous variable. The most likely source of this endogeneity is that both income and child health are jointly determined if time spent in market work subtracts from time spent caring for children. Table A1 contains two-stage logit estimates that replace (log) expenditure with its predicted value, where the instruments used for the predictions include dwelling characteristics and variables measuring the ownership of capital goods. These results show very little change in the coefficient estimates on mother's and father's schooling, compared with their values in Table 2. Thus, it appears to be a robust finding that mother's education is 3-4 times more powerful than father's education in reducing the risk of child stunting in Papua New Guinea.

Summary and Implications

This paper has used nationally representative household survey data to compare the effect of mother's and father's education on the risk of stunting in young children. Child stunting is associated with the major form of malnutrition in Papua New Guinea and has effects on sickness, mental development and future work capacity. The prevalence of stunting reflects a failure to achieve key economic development goals such as improved health and faster economic growth.

The empirical results suggest that an extra year of schooling for a mother significantly reduces the risk that her child is stunted. The effect of an extra year of schooling for the father is less than one-third as large, yet paradoxically father's have much higher educational levels than do mother's in the surveyed households. Raising the educational level of mothers would therefore substantially reduce the prevalence of child stunting in Papua New Guinea. However, an analysis of current enrolment patterns from the survey data shows that girls continue to receive less schooling than boys. Thus, this under-investment in women's education is likely to impose a high social cost, in terms of inferior health and labour productivity, well into the future.

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Table A1 **Two-Stage Logit Estimates of the Effect of Parent's Education on Risk of Child Stunting (Household Expenditure Treated As Endogenous)**

Years of schooling of mother	-0.1005	-0.0658
	(0.0434)	(0.0375)
Years of schooling of father	-0.0273	-0.0128
	(0.0410)	(0.0369)
Predicted ln (total household expenditure)	-0.3375	-0.2742
	(0.4405)	(0.3608)
ln (total household size)	-0.1731	-0.2127
	(0.3610)	(0.3273)
Mother's height	--	-0.0597
		(0.0225)
Father's height	--	-0.0531
		(0.0153)
F-statistic for overall model	$F_{(12,74)}$=6.81	$F_{(14,72)}$=7.25

Notes: 1.See the notes to Table 2 for the list of other variables in the model that are not reported here. 2.The first stage regression predicting ln (total household expenditure) uses all of the exogenous variables reported in the model in Table 2, and as instruments includes variables measuring the floor area, number of rooms and type of toilet facility in the dwelling, the value of all household durable goods owned, the number of pigs owned and indicator variables for whether the household was engaged in agriculture and owned any major agricultural capital goods (e.g., coffee pulper, copra drier, sprayer, truck). The R^2 from the first stage regression was 0.47 and the *F*-test for dropping the instruments from the equation predicting ln (total household expenditure) was 13.33 ($p<0.000$).