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When Are Children from Large Families Disadvantaged? Evidence from Cross-National Analyses*

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Population policies in less developed countries are frequently based on the assumption that sustained high fertility poses a threat to national development and to the welfare of families with large numbers of children. Although once considered self evident, this assumption has been increasingly challenged, as is shown by an extensive review of the empirical evidence sponsored by the National Research Council[1]. This paper is focused on the second part of the argument, the relationship between family size and the welfare of individual members of the family, particularly children. Previous research on the consequences of high fertility for the well-being of children in less developed countries has been inconclusive. Some authors have found a strong negative impact of family size on child-outcomes;[2] others have found it to be less important[3] or even positive,[4] particularly for the oldest and youngest child.

Since the methods used in these studies differ considerably, and few have examined more than one society, relatively little empirical research has been directed to explaining these contradictory findings. Although some scholars[5] have suggested that the relationship between family size and child outcomes may depend on the level of socio-economic development, no theoretical framework for examining the conditions under which high fertility limits children's options has been fully developed.

THEORETICAL FRAMEWORK

The explicit or implicit assumption on which much of the research on the consequences for child welfare of having many siblings has been based is a model of the family in which parental resources available for children's consumption are more or less fixed, so that the

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[1] D. G. Johnson and R. D. Lee (eds.) *Population Growth and Economic Development: Issues and Evidence.* (Madison, University of Wisconsin Press, 1987).

[2] J. Knodel, N. Havanon and W. Sittitrai, 'Family size and the education of children in the context of rapid fertility decline'. *Population and Development Review*, **28** (1990), pp. 31–67; N. Birdsall, 'A cost of siblings. Child schooling in urban Colombia', *Research in Population Economics*, **2** (1982), pp. 115–150; G. Psacharoupoulos and A. M. Arrigada, 'The determinants of early age human capital formation: Evidence from Brazil', *Economic Development and Cultural Change*, **37** (1989), pp. 683–708; S. H. Cochrane and D. T. Jamison, 'Educational attainments; achievements in rural Thailand'. In A. Summers (ed.) *New Directions for Testing and Measurement. Productivity Assessment in Education* **15** (1982).

[3] P. R. Mock and J. Leslie, 'Childhood malnutrition and schooling in Terai region of Nepal'. *Journal of Development Economics*, **20**, 1986, pp. 33–52.

[4] D. Chernochovsky, 'Socioeconomic and demographic aspects of school enrolment and attendance in rural Botswana', *Economic Development and Cultural Change*, **33** (1985) pp. 319ff.; M. Gomes, Family size and educational attainment in Kenya'. *Population and Development Review*, **10** (1984) pp. 647–660.

[5] See particularly E. Mueller, 'Income aspirations and fertility in rural areas of less developed countries'. In W. Schutjer and C. S. Stokes (eds). *Rural Development and Human Fertility* (New York, Macmillan, 1984).

number of siblings determines the level of resources available for each child, and consequently affects their early life chances. The assumptions on which this relationship is based are, however, rarely stated explicitly, and are almost never systematically examined. Hence, a first step towards a theoretical framework for the analysis of the relationship between family size and outcomes for children is to articulate clearly why we expect the two to be related, and to outline the assumption on which this expectation is based.

Our expectation is based on three crucial assumptions: (1) Parents, rather than the state or extended kinship groups, provide the bulk of economic and non-economic resources available to children; (2) Parental resources, rather than external social institutions, are important determinants of children's well-being; (3) The resources available for consumption by children within the family are fixed, and do not depend on the total number of children.

The last assumption has received considerable attention among economists,[6] but with a few notable exceptions[7] the first two assumptions have rarely been examined in detail. Since the institutional setting which affects the realization of the first two assumptions listed above does not vary substantially within a specific society, cross-sectional analysis based on a single society is not always illuminating. Instead, it is important to compare different societies in order to examine the role played by the socio-cultural context.

Parental responsibility

Although an increase in the number of siblings increases the competition for parental resources, it will have a substantial negative effect on children only if parents bear the primary responsibility for providing resources to their offspring. In many cultures, however, children receive considerable support from members of an extended kinship network.[8] In sub-Saharan Africa, children are frequently fostered with members of an extended kin network, and sometimes even with non-kin. Child fostering serves a variety of functions, including the socialization of the child, deepening the relationship between all concerned, and financial help during times of distress.[9] Whatever the initial motivation, one consequence of this arrangement is to spread the benefits and costs of children over a larger group than just the biological parents. In societies in which fostering is widespread, it cannot always be assumed that parental resources are all that are available to the child and, conversely, that parents invest all their resources in their natural children. Similarly, government subsidies for education, health care, or food attenuate children's dependence on their biological parents, and as a result an increase in sib-size may not substantially alter the resources available to a child.

[6] For a review see E. King, 'The effect of family size on family welfare: what do we know?' in Johnson and Lee (eds.), *op. cit.* in fn. 1.

[7] J. C. Caldwell and P. Caldwell, 'The cultural context of high fertility in sub-Saharan Africa', *Population and Development Review*, **13** (1985), pp. 409–437; G. McNicoll 'Consequences of rapid population growth. An overview and assessment'. *Population and Development Review*, **10** (1984), pp. 177–240; S. Desai, 'Children at risk: The role of family structure in Latin America and West Africa', *Population and Development Review*, **18**: pp. 689–717. (1992).

[8] R. Sanjek, 'The organization of households in Adabraka. Toward a wider comparative perspective'. *Comparative Studies in Society and History*, **24** (1982) pp. 57–103; E. Jelin (ed.), *Family Households and Gender Relations in Latin America* (Paris, Kegan Paul International for UNESCO, (1991).

[9] H. Page, 'Childrearing versus childbearing; Co-residence of mother and child in sub-Saharan Africa', in R. Lesthaeghe (ed.) *Reproduction and Social Organization in sub-Saharan Africa.* (Berkeley, University of California Press, 1989); E. Goody, *Parenthood and Social Reproduction: Fostering and Occupational Roles in West Africa.* (Cambridge, Cambridge University Press 1982); C. Bledsoe and U. Isiugo Abanihe, 'Strategies of child-fosterage among Mende grannies in Sierra Leone' In Lesthaeghe (ed.), *op. cit.* above; U. C. Isiugo Abanihe, 'Child fosterage in West Africa'. *Population and Development Review*, **11** (1985) pp. 53–73.

When we examine the role of parents as providers of resources for older children, this issue is further complicated by the fact that in many societies children become productive at an early age.[10] Although young children may not be able to engage in heavy agricultural labour, they frequently take on a variety of domestic tasks, such as child care, fetching water and fuel, and caring for farm animals. Thus, children's reliance on parental resources will depend on their age, and the age profile of production in any given society. Additionally in many societies siblings – particularly older siblings – may help with children's educational expenses[11] or share in household chores that release the index child to attend school[12]

Relative importance of parental resources

Even when parents bear a large proportion of the costs of child rearing, a large number of siblings may not automatically result in a substantial adverse effect on a given child's education, nutrition, or health. Sibling competition will only become relevant if a moderate addition to parental resources directed toward the child is sufficient to bring about substantial improvement in child outcomes. For example, in communities without a school, having one or two fewer siblings may have little impact on the probability of a child attending school, since a reduction in family size may not be sufficient to pay for the children's board and lodging. Similarly, children who succumb to a variety of chronic diseases are less likely to eat well, and a low nutrient intake raises their vulnerability to disease.[13]

Resources available for child related expenditure

Research on the relationship between family size and resources available for children can be divided into two broad categories: (1) Studies based on the assumption that the size of the cake (representing the total resources a family is able and willing to allocate for consumption by children) is fixed, and hence the larger the number of children, the smaller the size of each portion, and (2) Studies in which it is argued that the size of the cake and the number of children a family has, are jointly determined, and hence, that an exogenously induced decline in fertility may also mean a reduction in the amount of resources devoted to children, leaving the amount available for each child unaltered.

The latter approach suggests that although high fertility is associated with lower investment in children, it cannot be said that it *causes* low investment.[14] Improvements

[10] M. Cain, 'The economic activities of children in a village in Bangladesh'. *Population and Development Review*, **3** (1977), pp. 201–227; 'Perspective on family and fertility in developing countries', *Population Studies*, **36** (1982), pp. 159–175; B. White. The economic importance of children in a Javanese village, in M. Nag (ed.) *Population and Social Organization* (Mouton, The Hague, 1975); J. C. Caldwell, 'Toward a restatement of demographic transition theory'. *Population and Development Review*, **2** (1976), pp. 321–366.

[11] Gomes, *loc. cit.* in fn. 4.

[12] S. J. Jeejebhoy, 'Family Size, Outcomes for Children and Gender Disparities. The Case of Rural Maharashtra'. Paper prepared for the Population Council Seminar on Fertility, Family Size and Structure. Consequences for Families and Children 9–10 June 1992; Chernichovsky, *loc. cit.* in fn. 4; E. Mueller, 'The value and allocation of time in rural Botswana'. *Journal of Development Economics*, **15** (1984), pp. 329–360; D. de Tray, 'Children's economic contributions in peninsular Malaysia'. WD-1471-AID (The Rand Corporation, Santa Monica, 1982).

[13] M. John and A. Foster, 'A Dynamic Model of Nutrition-Infection Synergism in Developing Countries'. Paper presented at the annual Meeting of the Population Association of America, Denver, Colorado, 1992; L. Mata, 'A public health approach to the "food-malnutrition–economic recession" complex'. In D. Bell and M. R. Reich (eds.), *Health Nutrition and Economic Crises* (Dover: Auburn House, Publishing Company, 1988).

[14] King, *loc. cit.* in fn. 6.

in child welfare due to declining fertility are conditioned by parental motivation. Children of parents who choose to have smaller families, because they value high-quality offspring, will benefit from small family size, but this is not necessarily true for children whose parents have smaller families as a result of exogenous factors, such as high mortality or government policies.

Family size and children's nutritional status

The preceding discussion suggests a number of conditions in which high fertility may reduce (and sometimes improve) children's well being. To examine these conditions empirically, however, poses a formidable challenge. In this paper, I explore a relatively narrow dimension of child welfare: the nutritional status of children aged between six and 36 months. A focus on the nutritional status of very young children provides a good starting point for a study of the impact of family size on child welfare, since it simplifies some of the issues discussed above, in particular: (1) In almost all societies investment in children's health and nutrition is considered valuable; this simplifies the consideration of parental motivation across different countries; (2) Very young children are solely dependent on resources provided by adults: this eliminates the consideration of children's contributions to their own sustenance.

However, although the limited focus simplifies some considerations, it also introduces new complications. In articulating the relationship between family size and children's nutritional status, we have emphasized the issue of competition for parental resources. The literature also suggests another explanation; negative consequences for health due to crowding and greater exposure to diseases, such as measles, chickenpox, or diarrhoea.[15] Although research in this area has been limited, repeated exposure to some organisms that cause infectious disease, which is more likely to occur in crowded households with numerous children, especially of similar ages, appears both to increase the child's risk of contracting the infection and the severity of the infection among those who do become ill.[16] In the following analysis it is not possible to separate the issue of competition for resources from that of crowding: the analysis of the effects of family size on nutritional status in this paper incorporates both these potentially negative factors. Thus, some caution is needed in interpreting the results.

Data and method

Our results are based on data collected in the Demographic and Health Surveys around 1986–90. I have used data relating to Bolivia, north east Brazil, Colombia, the Dominican Republic, Guatemala, and Trinidad and Tobago in Latin America and the Caribbean region; Egypt, Morocco, Sri Lanka, and Thailand in Asia and North Africa, and Burundi, Ghana, Mali, Senegal, and Zimbabwe in sub-Saharan Africa.[17]

In these surveys a fairly standard questionnaire and data collection strategy was used in different countries. Information was collected on women's reproductive histories and their socio-economic background, and children under three years old were weighed and measured. The sample of children used here is limited to those aged between six and 36

[15] P. Aaby, 'Malnutrition and overcrowding. Exposure in severe measles infection. A review of community studies'. *Review of Infectious Diseases*, no. 10, 1988.

[16] P. Aaby, P. J. Bukh, I. M. Lisse and A. J. Smits, 'Overcrowding and intensive exposure as determinants of measles mortality'. *American Journal of Epidemiology*, **120** (1984) pp. 49–63.

[17] Note that anthropometric information was not collected in all DHS surveys. This analysis is limited to countries for which this information was available.

Table 1. *Sample description*

Country	No. of children born 6–36 months ago	Per cent surviving	No. of children for whom both height and age data are available	Mean height for age	Per cent stunted
Latin America and Caribbean					
Bolivia	3079	91	2402	−155	14
Brazil (Northeast)	759	87	603	−138	12
Colombia	1435	97	1236	−129	9
Dominican Republic	2481	93	1945	−100	9
Guatemala	2400	92	2005	−240	33
Trinidad and Tobago	1034	97	793	−28	0
Asia and North Africa					
Egypt	4403	93	1712*	−145	12
Morocco	3099	92	2728	−127	11
Sri Lanka	2045	97	1846	−149	9
Thailand	1908	97	1692	−110	4
Sub-Saharan Africa					
Burundi	2039	91	1708	−188	20
Ghana	2242	90	1672	−144	11
Mali	1746	85	825	−118	9
Senegal	2261	88	626*	−118	8
Zimbabwe	1748	94	1394	−145	9

* Only a sub-sample of eligible children were measured.

months, who lived with their natural mothers at the time of interview.[18] Only children of mothers between the ages of 15 and 49 at the time of interview were included, and in countries with relatively low rates of extra-marital fertility, the sample was further restricted to children of ever-married women. Given the extremely low fertility rates for women outside this age range, the data provide a reasonably representative sample of children aged three years or less.[19]

Anthropometric research suggests that, although a variety of factors such as genetic potential, environmental factors, and individual variation affect growth, children's heights and weights are also related to the availability of food, and freedom from chronic gastrointestinal diseases.[20] Thus, anthropometric measures, such as height-for-age, weight-for-age, and weight-for-height are good indicators of the resources available for very young children. The DHS data contain two measures of nutrition for children less than three years old that have been widely used in the literature: *stunting* based on height-for-age as a measure of long-term malnutrition, and *wasting*, based on weight-for-height as a measure of acute recent malnutrition. In this paper we focus on height-

[18] The age range for children for whom anthropometric information was collected in the surveys differed in different countries. Most frequently, children aged between three and 36 months were weighed and measured, and in some instances, children under five years old were included in the sample.

[19] For a discussion of sample selectivity in data on children in the DHS see C. B. Lloyd and S. Desai, 'Children's living arrangements in developing countries'. *Population Research and Policy Review*, **11** (1992), pp. 193–216, for a discussion of the limitations of the anthropometric data, see Desai, *op. cit.* in fn. 7.

[20] R. Martorell and J. P. Habicht, 'Growth in early childhood in developing countries'. In F. Falkner and J. Tanner (eds), *Human Growth, A Comprehensive Treatise*, vol. 3. (Plenum Press, New York, 1986); D. L. Pelletier, 'Issues in the collection, analysis and interpretation of anthropometric data in sample surveys'. In *Proceedings of the Demographic and Health Surveys World Conference*, Washington, D.C. IRD Macro International (1991).

for-age, which is a measure of long-term growth and is not affected by short-term fluctuations, such as recent episodes of diarrhoea.

The dependent variable in all analyses in this paper is the child's height, measured in terms of the standard deviation from the mean for children of the same sex and age in the international reference population. The averages of this variable and the proportions of children severely stunted (three or more standard deviations away from the mean) are shown in Table 1. The sample is restricted to children between three and 36 months old, for whom information on height was collected, and whose birth dates (in months and years) were known. Children whose age had to be imputed were excluded. Children who did not live with their mothers were also excluded, and this may be a source of potential bias.

The effect of family size on children's height-for-age is examined by using multivariate regression. I have focused on three independent variables collected from the mothers' fertility histories: the number of living children aged five years or younger, the number of living children aged between six and 12 years, and the number of living children aged 13 to 15 years.[21] Siblings more than 15 years old were excluded because they are unlikely to compete for the resources needed by a very young child. Since both fertility and health are affected by a variety of socio-economic background factors, I also controlled for the education of the mother and her partner, urban residence, and mother's marital status. Although no information on income was collected in the DHS surveys, I have constructed an index of household wealth by using data on type of housing and the possession of certain consumer durables, and have included this as one of the regressors.[22] Additionally, I have controlled for the child's age and included a squared term for age.

Focusing on the nutritional status of living children introduces a selection bias. As the figures in Table 1 show, this bias differs in different countries. Between 85 and 97 per cent of children born between six and 36 months before the survey were alive at the time of the survey. Since family size and birth-spacing have been shown to be related with higher infant and child mortality[23] focusing on living children omits particularly vulnerable children. The omission of children who have died will underestimate the effect of family size on the child's nutritional status.

This bias can be dealt with by a statistical technique, first explored by Heckman,[24] and described in Appendix 1. This estimation is done using STATA[25] and results are shown in Tables 2 and 3.

[21] This approach underestimates sib-size in societies in which men have children with more than one woman. See C. B. Lloyd and A. J. Gage Brandon, 'Does Sib-Size Matter? Implications of family size for children's education in Ghana'. Population Council Research Division. Working Paper 45 (1992).

[22] The index of household possessions is the sum of the following: Possession of radio, living in a house with a permanent (non-thatched) roof, having some toilet facilities available inside the house; septic toilet in the house, living in a house with a non-dirt floor, and possession of some form of transport (bicycle, motor cycle, or car). When information on one of these items was not collected for a specific country, it was omitted from that country's index. Following a variety of economic studies, it was assumed that an index of household wealth reflects long-term income and purchasing power. Note that the measure does not include ownership of any electric item, since this would depend on electricity being available in the village. The index is similar to the DHS-based index, used by Knodel and Wongsith for Thailand in 1991. See J. Knodel and M. Wongsith, 'Family size and children's education in Thailand: Evidence from a national sample'. *Demography*, **28** (1991), pp. 119–132.

[23] J. N. Hobcraft, 'Child spacing and mortality' in *Proceedings of the Demographic and Health Surveys World Conference* Washington, D.C. (1991).

[24] J. J. Heckman, 'The common structure of statistical models of truncation, sample selection, and limited dependent variables, and a simple estimator for such models.' *Annals of Economic and Social Measurement*, **5** (1976), pp. 475–492.

[25] STATA Corporation, *STATA Reference Manual, Version 3.1*. College Station, Texas: STATA Corporation (1993).

Table 2. *Effect of an additional sibling*[1] *on index child's height-for-age standardized score, results from OLS regression and Heckman Selection Model*

	OLS regression			Heckman selection model		
Country	Sibling aged 0–5	Sibling aged 6–12	Sibling aged 13–15	Sibling aged 0–5	Sibling aged 6–12	Sibling aged 13–15
Latin America and Caribbean						
Bolivia	−10**	−1	12*	−11**	−2**	12*
Brazil (Northeast)	−20**	−12**	24*	−27**	−11**	26*
Colombia	−28**	−5	3	−29**	−5	3
Dominican Republic	−17**	0	10	−22**	−1	10
Guatemala	−12**	−6	8	−15**	0	9
Trinidad and Tobago	−2	−8*	24*	−5	−8*	24*
Asia and North Africa						
Egypt	−13**	−2	7	−19**	−3	6
Morocco	−8*	0	6	−11**	−0	7
Sri Lanka	−14**	−10**	9	−18**	−10**	8
Thailand	−8*	2	9	−10*	2	9
Sub-Saharan Africa						
Burundi	−6	4	10	−11*	5	10
Ghana	−10*	4	5	−17**	5	4
Mali	7	0	12	6	−0	11
Senegal	6	3	−3	−2	3	−0
Zimbabwe	−9*	2	1	−13**	2	2

[1] Results from multivariate analyses controlling for child's age, squared term for age, mother's age, urban residence, mother's and her partner's literacy and post-primary education, father's (or father substitute's) occupation, mother's marital status and index of household possessions.

* $P \leqslant 0.05$ in one-tailed test. ** $P \leqslant 0.01$.

Empirical results

Results from ordinary least squares regression and Heckman's selection model are shown in Table 2. In the majority of countries, mother's education, urban residence, and the index of household wealth have a strong positive impact on child's height-for-age (results not reported here).

Table 2 shows that the change in the standardized score of height-for-age associated with the addition of a sibling aged less than five years has a statistically negative impact on the child's height-for-age standardized score. The impact of older siblings is much weaker. The results suggest that in this sample of children aged less than three years, the greatest competition is posed by children close in age. Other siblings, aged between six and twelve years, provide competition in some instances, but in others their presence actually benefits the index child. Siblings aged 12 and older almost always seem to have a positive impact on the index child's physical growth, though this effect is not statistically significant in all instances. Since children in many less developed countries tend to become economically productive at a very early age, it is not surprising that competition for parental resources is strongest from children less than five years old, well before the age when they can be self-supporting. In addition, a comparison of the first three columns of the table with the last three indicates that although results from Heckman's selection model are similar in statistical significance and direction to those

Table 3. *Effect of an additional sibling and birth interval*[1] *on index child's height-for-age standardized score, results from Heckman Selection Model*

Country	Sibling aged 0–5	Sibling aged 6–12	Sibling aged 13–15	First birth	Short prec. birth interval
Latin America and Caribbean					
Bolivia	−8**	−2	13*	−4	−30**
Brazil (Northeast)	−18*	−11**	26*	7	−22
Colombia	−23**	−4	3	9	−21*
Dominican Republic	−24**	0	10	3	28**
Guatemala	−8	1	8	8*	−15
Trinidad and Tobago	−11*	−14**	22*	−41**	−17
Asia and North Africa					
Egypt	−14	−4	6	−4	−13
Morocco	−9	0	7	4	−16
Sri Lanka	−20**	−15**	7	−18*	−24**
Thailand	−16**	−3	7	−17*	−2
Sub-Saharan Africa					
Burundi	−14*	3	9	−16	−15
Ghana	−15*	5	5	0	−9
Mali	6	−0	10	−5	1
Senegal	7	5	0	24	−1
Zimbabwe	−17**	−1	2	−21*	−14

[1] Results from multivariate analyses controlling for child's age, squared term for age, mother's age, urban residence, mother's and her partner's literacy and post-primary education, father's (or father substitute's) occupation, mother's marital status and index of household possessions.
* $P \leqslant 0.05$ in one-tailed test. ** $P \leqslant 0.01$.

obtained by OLS, and, the negative effect of family size is greater in Heckman's model. It should be noted, however, that the substantive conclusions regarding cross-national variation in the effect of family size remain qualitatively similar in both models.

Number of siblings and birth spacing

Interpretation of the results presented in Table 2 is complicated by the fact that the number of siblings is closely related to birth order and birth spacing. The preceding birth interval for children with two or more siblings less than five years old is likely to have been shorter than that for their peers with fewer siblings. In contrast, children without a sibling less than five years old are more likely to have been first-born children.[26]

Research on birth order and infant mortality suggests that pregnancy and birth-related complications are more common among primiparae than among women of higher parities,[27] and that their children may experience poorer growth *in utero* and be of low birth weight.[28] Similarly, a number of authors have associated short preceding

[26] M. Desai, 'Children at risk. The role of family structure in Latin America and West Africa'. *Population and Development Review*, **18** (1992), pp. 689–717.

[27] J. Bongaarts, 'Does family planning reduce infant mortality rates?' *Population and Development Review*, **13** (1987), pp. 323–334.

[28] J. Haaga, 'Mechanisms for the association of maternal age, parity, and birth spacing with infant health'. In A. M. Parnell (ed.), *Contraceptive Use and Controlled Fertility: Health Issues for Women and Children* (Washington, D.C. National Academy Press, 1989); M. S. Kramer, Intrauterine growth and gestational age determinants'. *Pediatrics*, **80** (1987), pp. 502–511.

birth intervals with higher infant mortality, although the biological mechanism responsible for this relation is not fully clear.[29] To some extent a short preceding birth interval may be regarded as a proxy for premature births.[30] Admittedly, shorter birth intervals may also be associated with greater maternal depletion, although authors who have attempted to investigate this relationship have not been successful in finding persuasive evidence.[31] Thus, it may be their initial disadvantage, rather than resource competition by siblings that leads to lower height-for-age among children with many siblings less than five years old.

It has been shown that infants of low birth weight who are born prematurely or suffered from retarded growth *in utero* catch up with others rapidly during the first six to eight months of their lives.[32] We have, therefore, omitted children under the age of six months from our sample in order to minimize the effect of low birthweight. In addition, this equation was re-estimated after introducing controls for first-order births, and a preceding birth interval of 18 months or less. These results are reported in Table 3.

As in Table 2, the regression in Table 3 includes such independent variables as parental education, urban residence, mother's marital status, and the wealth index. Controlling for both birth interval and first birth changed the size of the coefficient for the number of siblings less than five years old, but an independent impact of the number of siblings remained in nine of the eleven countries shown in Table 2 in which family size had a statistically significant effect. The results for variables that indicate a short birth interval and a first-parity birth are interesting. With the exception of the Dominican Republic, children born within 18 months or less of the previous birth are likely to be less tall than children born after longer intervals, although the effect is not always statistically significant. The effect of birth order is more ambiguous.

We shall focus discussion on the interpretation of the coefficient for siblings less than five years old, shown in Table 3. The results parallel those of a number of other studies in which a decline in children's height or other anthropometric measures was reported to have been associated with increased family size[33] at least for siblings who were close in age.

The variation in these coefficients for different countries presents an interesting picture. The dependent variable is a standardized score with mean 0 and standard deviation 100 in a well-nourished American population.

The results presented in Table 3 show that the decline associated with the addition of one sibling less than five years old varies substantially in different countries, and ranges from a decrement of 24 points in the Dominican Republic to a positive (but not significant) increase of seven points in Senegal. In countries, such as Sri Lanka, Colombia, and the Dominican Republic, the impact made by an additional sibling is

[29] National Research Council, *Contraception and Reproduction. Health Consequences for Women and Children in the Developing World.* (Washington, D.C. National Academy Press, 1989); Hobcraft, *loc. cit.* in fn. 23.

[30] J. E. Miller; 'Is the relationship between birth intervals and perinatal mortality spurious? Evidence from Hungary and Sweden'. *Population Studies*, **43** (1989), pp. 479–495; 'Birth intervals and perinatal health. An investigation of three hypotheses'. *Family Planning Perspectives*, **23** (1991) pp. 62–70.

[31] B. Winnikoff, 'The effects of birth-spacing on child and maternal health'. *Studies in Family Planning*, **14** (1983), pp. 231–245.

[32] P. Pinstrup Andersen, S. Burger, J. P. Habicht and K. Peterson, Protein energy malnutrition'. In D. T. Jamison, W. H. Mosley and J. L. Bobadillo, (eds.), *Disease Control Priorities in Developing Countries.* (Oxford, Oxford University Press, 1993); P. S. Heller and W. D. Drake, 'Malnutrition, child morbidity and the family decision process'. *Journal of Development Economics*, **6** (1979) pp. 203–235.

[33] S. Horton, 'Child nutrition and family size in the Philippines'. *Journal of Development Economics*, **6** (23) (1986), pp. 161–176.

strongly negative; in others, such as Burundi, Zimbabwe, and Trinidad and Tobago, the coefficient is only modest. In contrast, the effect of an additional sibling on child growth in Guatemala, Morocco, Mali and Senegal is not statistically significant, and is slightly positive in the last two.

In this paper we have not distinguished between different ethnic groups within countries, nor have we controlled for some of the other characteristics (such as region of residence) which may have been included in studies of a single country. Nonetheless, the results are interesting, particularly when taken in the context of the broader institutional considerations mentioned above. As the discussion is limited to 15 data points provided by regression coefficients within 15 countries, it is difficult to provide a conclusive test of any of the theoretical issues discussed above. However, some broad patterns are of interest.

Parental responsibility

It has been suggested that child fostering may weaken the link between the number of siblings and the resources available to each child by spreading the cost of children over a wider kin group and over the parental life cycle.[34] Fostering is widely recognized in sub-Saharan Africa, and seems also to operate in a variety of other cultures. Thus, nearly 12 per cent of children less than 15 years old in the Dominican Republic did not live with their parents.[35] In Figure 1 we present a graph which shows the coefficient on

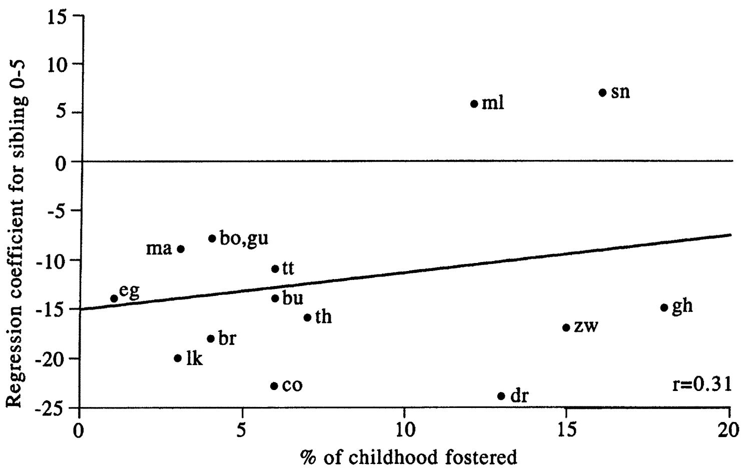

Figure 1. Relationship between the regression coefficient indicating the impact of an additional sibling aged 0 to 5 and per cent of childhood spent away from mother.

child stature associated with an additional sibling under five years old, obtained from the country-specific regressions on the Y-axis. On the X-axis the proportion of childhood (the first 15 years of life) spent away from their mothers is shown for a synthetic cohort of children in these countries.

The solid line is a regression fitted to these points, and regression estimates are shown below the figure. Although the points are not tightly clustered around the regression line

[34] A. K. Blanc and C. B. Lloyd, 'Women's Childbearing Strategies in Relation to Fertility and Employment in Ghana'. Population Council Research Division Working Paper 16. (New York, 1990).
[35] Lloyd and Desai, *loc. cit.* in fn. 20.

and the regression coefficient is not significant statistically, there appears to be overall an inverse relationship between the two variables, with the negative impact of sib-size being greater in countries with a low level of fostering. The correlation coefficient (Appendix to Table 1) is 0.31.

Just as an extended kin network can alleviate some of the resource competition generated by a large number of siblings, so can the state by subsidizing some child-related expenditures. However, it is difficult to quantify these expenditures, and even more difficult to obtain cross-national data. Different methods of subsidizing food are used in different countries. Some rely primarily on subsidizing fertilisers, others provide direct subsidies through price supports, yet others invest in targeted rationing programmes. I have therefore used the amount of assistance per head given to the agricultural sector as a proxy for the government's attitude towards individual food consumption.[36] These figures provide a broad measure of central government expenditure, but do not always measure expenditures by local government accurately. However, a graph which shows the regression coefficient on an additional sibling (Table 3) and official assistance per head to agriculture shown in Figure 2, presents an

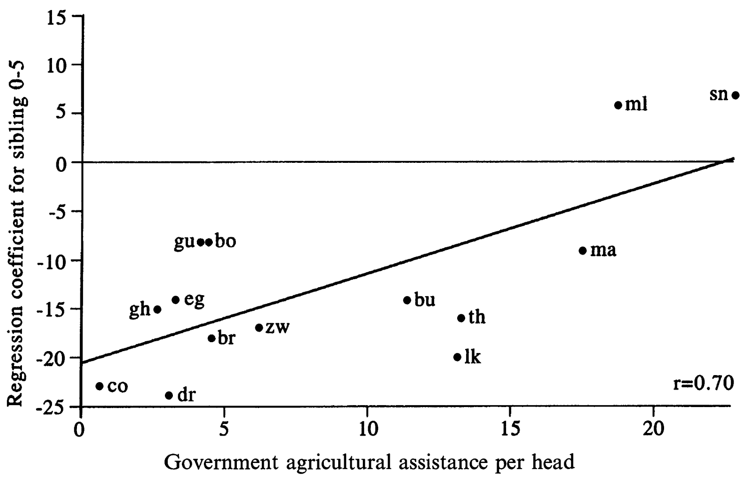

Figure 2. Relationship between the regression coefficient indicating the impact of an additional sibling aged 0–5 and government agricultural assistance per head (in 1989 US $).

interesting broad pattern. The regression line fitted to these data suggests that an increase in the amount of assistance to the agricultural sector is associated with a reduction in the negative impact of family size on child growth, and that this relationship appears to be very strong ($r = 0.70$). Thus, in countries with greater subsidies to and investment in agriculture through governmental transfer programmes the consequences of large families at the individual level seem to be minimized.[37] These results depend on rather broad measures of extra-parental responsibility in a society, and are based on fewer than 15 countries. Hence, though provocative, they should be interpreted with caution.

[36] Food and Agriculture Organization, *The State of Food and Agriculture* (*Rome, FAO, 1991*).

[37] It may be argued that government assistance to agriculture is a proxy for the level of economic development. However, as the date in Appendix Table 1 indicate, the correlation between government assistance and GNP per head is only moderate.

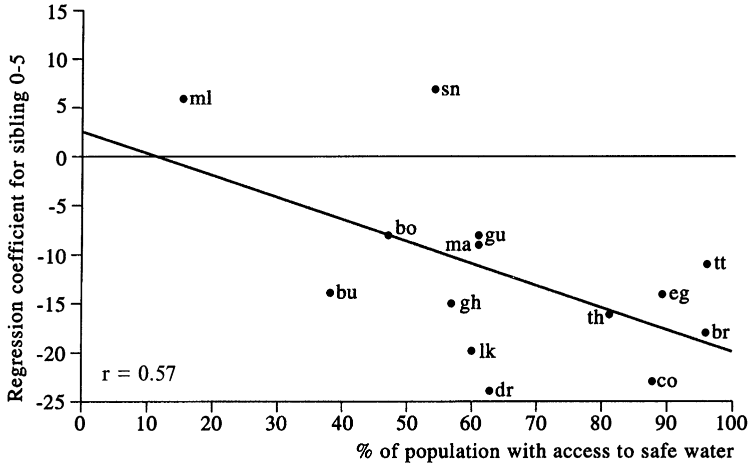

Figure 3. Relationship between the regression coefficient indicating the impact of an additional sibling aged 0–5 and per cent of population with access to safe drinking water.

Relative importance of parental resources

As discussed in the previous section, the negative impact of family size on children's well being is likely to depend on the level of socio-economic development. In countries with relatively low levels of development, relatively few families have access to safe drinking water or health care facilities within a reasonable distance. Children's physical growth depends on the availability of food, as well as absence of gastro-intestinal disease. Children who suffer from recurrent bouts of disease are unlikely to eat well, and malnutrition, in turn, increases the propensity to succumb to disease. Thus, the nutrition-disease synergism is likely to retard children's physical growth,[38] and environmental factors rather than parental resources dominate the variation in child growth. As the basic infrastructure for the maintenance of good health and economic development increases, parental resources become more important in determining children's health.

In Appendix 1 we show the correlation matrix of variables of interest. Figures 3 and 4 show scatter plots which examine the relationship between two aspects of economic development expected to affect child health – the percentage of the population with access to safe drinking water, and the percentage with access to health facilities which can be reached within one hour by local mode of transport – and the decrement in children's height associated with the addition of one sibling less than five years old.

The negative impact of family size increases with average GNP, but this relationship is not particularly strong, with a correlation coefficient of 0.16 (Appendix Table 1). However, it is much more strongly related with more health-specific measures of development. For example, Figure 4 shows that in Guatemala, Mali, and Senegal where fewer than half the population lived within one hour's travel to primary health care facilities, the presence of an additional sibling less than five years old had a smaller effect on children's nutritional status than in Colombia, the Dominican Republic, or Thailand. Thus, Figures 3 and 4 suggest that in countries in which one would normally expect better health, high fertility plays a greater role in determining children's growth. The relationship appears to become weaker as economic development increases. These

[38] John and Foster, *loc. cit.* in fn. 14.

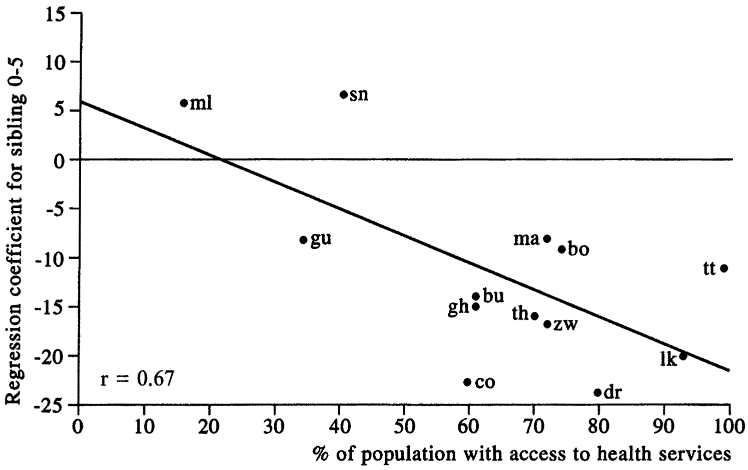

Figure 4. Relationship between the regression coefficient indicating the impact of an additional sibling aged 0–5 and per cent of population with access to health services.

findings suggest that high fertility, in conjunction with a moderate[39] level of socio-economic development is important in increasing inequality between families, as some children gain access to the benefits of development, whilst others do not.

Resources available and parental motivation

As discussed earlier, one problem in interpreting regression results is that parents may make joint decisions on the amount of resources they plan to devote to their children, the quality of children they desire, and their number. We cannot therefore use the observed negative relationship between number of children and resources available to each child to extrapolate that exogenously caused fertility will necessarily increase the resources devoted to each child.

This is a complex issue with no easy solution. Some economists have treated family-size decisions as endogenous and then applied an appropriate statistical technique to model the impact of family size on child welfare. Finding an appropriate instrument, however, is not easy.[40]

To examine the role of parental motivation, we have used an alternative strategy. In the DHS surveys in which women's reproductive histories were collected, some of the questions related to fertility preferences. This information makes it possible to construct a dummy variable which divides women into those who have exceeded their desired family size, and those who have not. For women who have not completed family building, having a small family is a matter of chance determined by their age at interview, duration of marriage, fecundity, and infant and child mortality. Some of them will end up by having large families, even though they did not have large families at the time of

[39] Note that the countries included in this study are mainly at the lower end of the income distribution. With the exception of Trinidad and Tobago, where average GNP amounted to $3350, in all the other countries average GNP was less than $2000 in 1988. In Brazil, GNP per head was slightly higher at $2160 in 1988, but the data for our analysis were collected in northeast Brazil, which is considerably poorer.

[40] In this study we have attempted to endogenize family size, by using an instrumental-variables approach, the instruments being duration of marriage, proportion of women in the local community with an unplanned birth, and change in infant mortality during the previous ten years, Hausman's test, however, showed that far from improving the model's fit, these instruments introduced noise in 13 out of the 15 countries studied.

interview. Thus, if the impact of small family size on child welfare were related to parental motivation it should be greater among women who have exceeded their desired family size than among those still engaged in family building. Conversely, if the sheer presence or absence of siblings mattered irrespective of parental motivation, the impact of family size should not differ between the two groups. Therefore, a dummy variable indicating no unwanted births was added to the regression. It was coded 1 when the mother had not exceeded her desired family size, and 0 otherwise. An interaction term was also obtained by interacting the dummy variable with the number of siblings less than five years old. When these two variables were added to the regression, the interaction term turned out to be significant in four of the 15 countries. In each case, the negative impact of family size was greater among families which had exceeded their desired size than among families that were planned. However, in most cases there remained a statistically significant negative main effect of family size among all families, planned and unplanned. Thus, we find only limited support for the hypothesis that the effect of family size on child health depends on parental motivation.

This observation suggests that a small family does benefit children, at least as far as their physical growth is concerned, regardless of whether the family was planned or unplanned. Most parents view improved health and nutrition as beneficial and would like to provide them for their children, if they could afford it. Parental attitude to children's health is much more altruistic than to other aspects of child welfare, such as education, which they may or may not consider to be important.

The results in Tables 2 and 3 also suggest that even where the effect of family size is statistically significant, it is rather modest. The largest negative effect is observed in the Dominican Republic; even there the addition of a sibling under five years old reduces the height of the index child by around 24 points. Since the standard deviation of this index is 100, the effect is not very large.

Implications

Before discussing the implications of my results, I would again stress that the analysis in this paper is based on results from only 15 countries (in some cases where data are missing, even fewer), most of which are located at the low to moderate end of the developmental spectrum. Also, some of the socio-economic characteristics of interest are highly correlated (Appendix, Table 1). The results presented in Figures 1–4 are dominated by some of the outliers, such as Senegal, Mali and Colombia. It is, therefore, important to replicate the results by using data from the second round of the Demographic and Health Surveys, because the patterns presented here are thought-provoking and have important implications for public policy, provided they are supported by further research.

During the 1980s and 1990s the crushing burden of external debt has changed the attitudes of many governments. With the stress on privatization and reduction in state support for food, health care, and education, parents are becoming increasingly responsible for their children's welfare. If this trend is accompanied by increasing nuclearization of the family, there will be few sources of support left for large families. The burden of high fertility is, therefore, more likely to be felt by parents, and as a result, by their children. Although it is possible that this may lead to a decline in fertility in the long run, in the short run it is likely to increase the vulnerability of children in large families.

Similarly, regardless of the speed of development, most governments can be expected to invest in infrastructure, such as safe drinking water and better access to health and educational services which make it possible for parents to nurture and educate their children. However, large families are less likely to be able to take advantage of these opportunities than smaller ones. Sustained high fertility in some sections of the society during the period of economic development may, therefore, increase inequalities between families, as some children capture the gains from development, whilst others do not. Taken in conjunction with the observation that parents of large families are more likely to discriminate against some children, particularly girls, than parents of smaller families,[41] it would appear that high fertility may be one of the mechanisms which deny the benefits of economic development to some social groups and to some members within the family.

APPENDIX 1

The bias can be treated by a statistical technique, originally developed by Heckman[42] which is based on the assumption that the coefficients in the traditional regression models are biased because severely undernourished children are more likely to die, and their height-for-age cannot, therefore be observed. If large family size were correlated with malnutrition, then a larger proportion of the sample will be lost through death among children from larger families than among those from smaller families. This loss of the most vulnerable children through death would bias the average for children from larger families upwards, and moderate the negative effect off family size on child nutrition.

Heckman's two-step procedure corrects for this selection bias by first estimating a probit model with the full sample of children, i.e. all children born between six and 36 months before the DHS interview. The probability of surviving to interview is treated as the dependent variable in a probit regression, the independent variables include, among others, family size. Based on this probit regression, a new variable that reflects the hazard rate (λ_c) given by:

$$\lambda_i = \frac{f(\varphi_i)}{1-F(\varphi_i)},$$

where f and F are density and distribution functions of the standard normal distribution. F is given as the complement of the predicted probability of being alive, and f is given by

$$f(\varphi_i) = \frac{1}{\sigma\sqrt{2\pi}}\exp\left\{\frac{-(Bx_j-\mu)^2}{2\sigma^2}\right\}.$$

The hazard rate (λ_j) is then included as one of the regressors in the regression equation of interest with height-for-age as the dependent variable.

Note that, given the probit-linear-regression combination, the regression equation will be formally identified even if the same regressors are included in both equations. In practice, however, this has been shown as a very fragile basis for estimation, which typically results in high variance estimates. It is, therefore, recommended that the selection equations should include some variables which strongly affect chances of survival, but not height-for-age. In this paper I have included the number of sibling deaths, calculated from the mother's fertility history as a regressor in the survival equation, but not in that for height-for-age. Previous research has shown that child mortality is highly clustered within families.[43] Survival status of a child has also been shown to be significantly related to that of its older sibling.[44] This may be due to a specific genetic frailty.

The problem of biased parameter estimates due to selectivity is more readily apparent than the problem of inefficiency introduced by heteroscedasticity, or the correlation of the error term with such independent variables as family size. Even if the expectation of the error term for each

[41] Lloyd and Gage-Brandon, *loc. cit.* in fn. 30.

[42] Heckman, *loc. cit.* in fn. 24.

[43] M. Das Gupta, 'Death clustering, mother's education and the determinants of child mortality in rural Punjab, India'. *Population Studies*, **44** (1990), pp. 489–505.

[44] A. K. Majumdar, 'Child survival and its effect on mortality of siblings in Bangladesh'. *Journal of Biosocial Science*, **22** (1990), pp. 333–347.

Appendix Table 1. *Correlation between various socio-economic indicators and the regression coefficient on siblings aged 0–5 from Table 2*

Regression coefficient on siblings aged 0–5	1.00					
Per cent of childhood spent away from mother	0.23	1.00				
Official assistance to agriculture (per head)	0.70	0.14	1.00			
GNP per head	−0.16	−0.25	−0.29	1.00		
Per cent population with access to safe drinking water	−0.56	−0.38	−0.49	0.72	1.00	
Per cent population with access to health services (travel time < 1 hour)	−0.67	−0.30	−0.29	0.47	0.62	1.00
Daily caloric supply (as per cent of requirement)	−0.48	−0.56	−0.30	0.72	0.75	1.00

observation were zero in the original population, it is no longer zero in the sample of surviving children. In this instance, the expected value of the error term is likely to be larger for children from larger families than for those from smaller ones, since the selectivity introduced by mortality is greater for children from larger families. Higher efficiency is obtained by full maximum likelihood estimation, using their results from the two-step procedure discussed above for starting values.