An application of propensity score matching to assessment of the impact of unintended childbearing on children's growth in Northern Malawi.

Baschieri, A. Floyd, S. Cleland, J. Dube , A., Molesworth A, Chihana M, Glynn, J.R. . Crampin, A.C. French, N

Abstract

Although there is wide agreement that the promotion of family planning lowers fertility, it is not clear to what extent greater contraceptive use and smaller family sizes will enhance investment in human capital and economic growth or what are the consequences of unwanted or unintended childbearing on children's life chances.

We inform this debate by analyzing data on fertility intentions and children's anthropometric measures collected as part of an on-going Demographic Surveillance Site (DSS) in Karonga District in Northern Malawi. We applied Propensity Score Matching to assess the effect of 'unintendedness' on child growth.

The study shows that having an unintended birth has an effect on the probability of being stunted on the siblings of the index child but not on the probability of being stunted on the index child themselves. We also found that this effect is stronger for children who have other siblings born less than 2 years apart. [150].

Introduction

Although there is wide agreement that the promotion of family planning lowers fertility, it is not clear to what extent greater contraceptive use and smaller family sizes will enhance investment in human capital and economic growth or what are the consequences of unwanted or unintended childbearing on children's life chances (Lloyd, 1994; Montgomery and Lloyd, 1997; Lloyd and Montgomery, 1996; Rosenzweig, 1990; Rosenzweig and Everson, 1977; Strauss, 1990, Schultz, 2005; National Research Council, 1986). Unintended births include those births occurring whilst parents are intending to delay pregnancy and births to parents who wish to have no (more) children. The accumulation of human capital is thought to be one of the key elements of sustainable economic growth (Becker, 1965; Becker et al, 1990, Barro, 1991).

The importance of an educated workforce for economic growth has been widely documented and demonstrated (Denison, 1962; Denison and Chung, 1976; Psacharopoulos, 1981). The role of health has received much less attention, but convincing evidence exists of the importance of investment in public health for positive economic performance (Strauss, 1986; Fogel, 1994). Early childhood health influences the achievement of traits that are rewarded in the labour market such as improved cognitive performance, higher educational attainment, and positive personality attributes (Palloni, 2006).

In Sub-Saharan Africa, the lack of attention to this issue has been detrimental to the development of sound economic policy. Reproductive health issues are routinely overlooked by the Poverty Reduction Strategy Papers supported by the World Bank and other international donors. Furthermore, only recently has "universal access to reproductive health" been included as one of the Millennium Development Targets. A lack of investment in future generations is one of the factors keeping African economies in a 'poverty trap'.

We inform this debate by analyzing data collected as part of an on-going Demographic Surveillance Site (DSS) in Karonga District in Northern Malawi. Malawi is one of the poorest countries in the world; it has high fertility, with a TFR, according to the preliminary report of the 2010 Demographic and Health Survey, of 5.7, with 46 per cent of women using any method of contraception. It is estimated that 27.6 per cent of women have an unmet need for either spacing or limiting (NSO, 2005). Furthermore, close to half of women with six or more children said that ideally they would have liked fewer than six children (NSO, 2005). Around 50 per cent of children under 5 years old in Malawi are moderately stunted, or too short for their age, and more than 20 per cent severely stunted (NSO, 2005). The DSS data of Karonga district provides the ideal setting to study the relationship between family planning and fertility and investment in children's schooling and nutrition as it provides detailed longitudinal data on a range of demographic and socio-economic characteristics of both the household and individual.

We applied a Propensity Score Matching methodology to assess to what extent the birth in the preceding three years of a wanted, unwanted or mistimed child (henceforth termed the index child) will have an effect on the nutritional status of the elder siblings. We will also assess whether being 'unwanted' or 'mistimed' has an effect on the nutritional status of the index child.

This method allows to control for the fact that 'exposed' children (exposed to one of the events described above or being 'unwanted' or 'mistimed' for the index child) are also more likely to be from lower socio-economic groups, hence in order to establish the 'true' effect of exposure on child health outcomes, one needs to control for this 'selection effect'. The Propensity Score Matching creates a propensity score for each child to be in the 'exposed' group (given a set of background characteristics) and then it matches the child to a control, those not exposed to the event with a similar score. We then can compare the outcome (child nutritional growth – stunted, wasted, underweight) for the 'exposed' and 'unexposed' children.

In addition, this study will assess whether these effects are enhanced by shorter birth intervals between siblings. Some studies have found that the effect of family size are mediated by the spacing between siblings and that adequate spacing between siblings can offset the negative effects of family size or birth order (Zajonc, 1976; Hobcraft et al 1985). Other studies have found that probability of negative child health outcomes increase for children with short preceding birth intervals (Espeut, 2002; Rustein, 2005; Boerma, 1992). In addition, the birth of a younger sibling within two years adversely affects survival between ages one and five (Hobcraft et al 1983). Thus a body of literature stresses the importance of optimal birth intervals and concludes that birth intervals of less than 2 years have negative outcomes on the growth pattern of children.

There are a number of potential pathways through which short birth intervals between children could affect their health outcomes, one pathway being that 'clustered' children (children with siblings less than 2 years apart, older or younger) have an enhanced competition for family resources. This study will add to this literature by testing whether the effect of having an additional child in the family in the last 3 years is greater for ‘clustered’ sibling than for ‘non-clustered’ siblings.

This analysis aims to answer the following questions:

Aims:

1. Are siblings who experience an index child born in the past 3 years more likely to be stunted, wasted or underweight?
2. Are any effects of an index child on older siblings conditioned by whether the index child is wanted, unwanted or mistimed?
3. Are any effects on older siblings greater when the gap between the older sibling is less than two years?
4. Is the risk of being stunted, wasted or underweight for index children themselves affected by whether they were wanted, unwanted or mistimed?

Data

This study uses data collected between October 2008 and September 2010 from a module on fertility intentions linked to an on-going DSS, and anthropometric data of children under 10 years of age collected in two rounds in 2008-2009 and 2009-2010. The DSS baseline census was conducted in 2002-2004 following which the population has been under continuous surveillance. Using the DSS, a population-based adult HIV and sexual behaviour survey started in the DSS area in September 2007, as part of a work programme which is focused on HIV and infectious disease control in a rural African population supported by the Wellcome Trust grant n. 079828 (see Jahn et al. (2007) for details on the demographic data collection procedures).

As part of a study funded by the Hewlett Foundation and the UK Economic and Social Research Council “Unintended Childbearing and family welfare in rural Malawi” a set of questions to measure retrospective and prospective fertility intentions of couples was designed in July and August 2008 and piloted from September to October 2008. During the pilot the questionnaire was modified in order to improve clarity and to ensure that the meaning of the questions were appropriately conveyed in the local language (Chitumbuka). The questionnaire was then back-translated from Chitumbuka to English during the pilot stage and further amendments made. The data collection began on October 28th 2008.

Women were asked questions on their current fertility (including total number of children ever born and surviving), their marital status (including how they got married; for example church/ traditional wedding, inherited, eloped). A section on prospective fertility intentions was introduced in order to assess whether or not the husband and wife separately wish to have another child and the preferred timing of the next birth. This will enable analysis of the effect on the growth of a newly born child as well as that of their siblings, and how this relates to whether or not the new child was intended.

However, the data used in this paper are restricted to the baseline information on retrospective fertility intentions and the first year of data on child anthropometry collected for all children under 10 in the DSS area. The retrospective information on fertility intentions was available for all children born to mothers who were not currently pregnant and had at least one child in the last 3 years. Our sample contains all children under 10 years old living in a household at the time of the first round of data collection. For the children born in the last 3 years we have information on whether or not the birth was wanted at that time, unwanted or mistimed. We have 2414 index children born in the last 3 years and 8340 older siblings under 10 years old, giving a total of 10,754 children.

Results

We calculated the probability of being stunted, wasted and underweight for all the children under 10 years old using the 2000 US CDC Growth Reference (The Stata Journal, 2005). 28.5 per cent of all children were stunted, and 20.6 per cent of the children born in the last 3 years were stunted compared with 30.8 per cent stunting amongst the older siblings. We found that 4 per cent of children born in the last 3 years were wasted and 16.8 per cent underweight, and amongst the older children 4.7 per cent were wasted and 23.2 per cent were underweight. We linked mothers' retrospective fertility intentions collected in the first round 2008-2009 for children born in the past 3 years (2005-2009) with anthropometric measures in the 1st round.

In our sample we had 59 births which were classified as unwanted, 701 births classified as mistimed and 1654 which were wanted according to the retrospective information on fertility intentions. The bi-variate analysis (Table 1) suggests that there is a significant association between the birth of an index child and the probability of older siblings being stunted, and a stronger association if the birth of the index child was 'unwanted'. Siblings with any index child born in the last 3 years were 3 per cent points more likely to be stunted than siblings who did not have an index child born in the last 3 years. In addition, siblings of unwanted index children are more likely to be stunted (38.3%) than other siblings (30.7%) . We found no similar effects on the probability of older siblings being wasted or underweight.

Table 1: Percentage of children stunted, wasted and underweight by exposure.

	Percentage Stunted	Percentage Wasted	Percentage Underweight	Number of children
All children	28.5	4.6	21.8	10.754
Index children born in the last 3 years	20.6	4.0	16.8	2414
Wanted	21.5	3.9	17.7	1654
Unwanted	23.7	3.4	15.2	59
Mistimed	18.3	4.1	14.8	701
Siblings	30.8	4.7	23.2	8340
With an index child born in the last 3 years	32.4 **	4.9	22.9	4446
Without an index child born in the last 3 years	29.0	4.5	23.5	3894
With an unwanted index child	38.3**	1.8	24.7	162
Without an unwanted index child'	30.7	4.7	23.2	8178
With a mistimed index child	32.3	4.7	23.5	1227
Without a mistimed index child	30.6	4.7	23.2	7083
Siblings with a brother/sister (older or younger) less than 2 years apart – clustered children	36.5***	5.0	24.5	673
With an index child born in the last 3 years	41.00***	4.3	24.7	461
Without an index child born in the last 3 years	26.9	6.6	24.0	212
With an unwanted index child	56.5 **	4.3	26.1	23
Without an unwanted index child	35.8	5.1	24.5	650
With a mistimed index child	34.0	4.0	20.1	147
Without a mistimed index child	37.0	5.3	24.0	526
Sibling without a brother/sister (older or younger) less than 2 years apart – NOT clustered children	30.4	4.7	23	7667
With an index child born in the last 3 years	31.4*	4.3	23.2	3985
Without an index child born in the last 3 years	29.7	5.0	22.0	3682
With an unwanted index child	35.2	1.5	24.5	139
Without an unwanted index child	30.3	4.7	23.1	7528
With a mistimed index child	32.1	4.8	24.4	1110
Without a mistimed index child	30.1	4.7	22.9	6557

Note: *** significant at 1% level; ** significant at 5% level; * significant at 10% level.
Note: the sample of 'clustered' do not contain siblings with an index child born in the last 2 years but only other siblings born less than 2 years apart.

As discussed, a number of studies have highlighted the importance of child spacing. Children who have siblings less than two years apart are more susceptible in case of household economic hardship. We assess in a bi-variate analysis whether or not siblings who had a brother or sister (older or younger) born less than 2 years apart were significantly more likely to be stunted. We found that 35% of children with a sibling less than 2 years apart were stunted compared to 29% of other children. In addition, for children with sibling less than 2 years apart we found that their likelihood to be stunted increases if they also experienced an index child born in the last 3 years (41%) and increases further if that index child was unwanted (56%). We found no effect on the probability of being stunted, wasted or underweight if the index child was mistimed.

To summarize, the bi-variate analysis shows no significant differences in the likelihood of wanted, unwanted or mistimed index children themselves being stunted. Conversely, siblings who had an index child born in the last 3 years were more likely to be stunted and the probability of being stunted increases for those children whose index child was unwanted. In addition, the bivariate analysis also shows that the effect of having an index child is inflated for those 'clustered' children (who had siblings born 2 years apart, older or younger). These effects could be due to the underlying differences in demographic and socio-economic characteristics of the two subgroups. Table 2 below shows some selected descriptive statistics comparing those 4 subgroups of children.

Table 2: Descriptive characteristics of all siblings.

	All siblings	**Siblings who had an index child**		**Siblings who had an unwanted index child**		**'Clustered' children who had an index child**		**'Clustered' children who *<u>had an unwanted index child</u>***	
	All siblings	**YES**	**NO**	**YES**	**NO**	**YES**	**NO**	**YES**	**NO**
Gender									
Female	51.1	51.0	51.2	48.1	51.2	52.3	50.9	47.8	52.0
Male	48.8	48.9	48.7	51.8	48.8	47.7	49.0	52.2	48.0
Children with siblings (younger /older) less than 2 years apart	16.9	19.8	13.5	16.7	16.9	-		-	
Children with siblings (younger /older) less than 2 years apart	83.1	80.2	86.5	83.3	83.1	-		-	
<u>Mother characteristics</u>									
Mother's education									
DK	15.5	4.4	28.3	0.6	15.9	3.5	13.7	0	6.9
None/Primary 1-5	15.0	17.0	12.7	13.6	15.0	19.3	15.1	17.4	18.0
Primary 6-8	52.4	60.6	43.0	69.7	52.1	60.3	52.3	60.9	58.3
Secondary 1-3	13.3	15.0	11.4	13.6	13.3	14.9	11.3	17.4	13.3
Secondary 4/Higher	3.6	2.9	4.5	2.5	3.7	2.6	5.6	4.3	3.5
Mother previous experience of child death	19.9	22.3	17.3	28.4	19.7	22.1	17.5	17.9	21.2
Mother with NO previous experience of child	80.1	77.7	82.7	71.6	80.3	77.9	82.5	82.1	78.8
Mother in polygamous union	19.4	23.0	15.3	23.5	19.3	21.9	19.3	17.4	20.7
Mother in a monogamous	80.6	77.0	84.7	76.5	80.7	78.1	80.6	82.6	79.3
<u>Father's occupation</u>									
DK	28.2	15.5	43.2	22.2	28.3	10.2	30.6	8.7	16.9
Farmer	44.3	54.5	32.6	53.7	44.1	56.8	37.7	52.1	50.7
Professional	5.2	4.3	6.3	5.6	5.2	5.5	7.5	0	5.7

Skilled Manual	10.2	12.0	8.1	11.1	10.2	15.8	12.3	30.4	5.2
Unskilled manual	4.2	4.8	3.5	0.6	4.3	5.4	4.3	0.0	5.2
Trader	7.8	9.2	6.2	6.7	7.8	6.7	7.5	8.7	6.9
Household SEC									
Dwelling score									
1	16.6	15.1	18.3	25.9	16.4	12.8	19.3	21.7	14.6
2	16.6	18.3	14.6	11.7	16.7	19.7	21.7	17.4	20.5
3	47.3	42.3	53.0	32.1	47.6	40.7	45.2	21.7	42.9
4	19.5	24.2	14.1	30.2	19.3	26.7	13.7	39.1	22.0
Phone	55.9	53.7	58.5	57.4	55.9	50.1	46.3	56.5	48.6
No Phone	44.1	46.3	41.5	42.6	44.1	49.9	53.7	43.5	51.4
Difficult to buy soap in the	76.0	72.4	80.1	70.9	76.1	35.4	25.0	43.5	31.7
Could buy soap in the past 4	24.0	27.6	19.8	29.0	23.9	64.6	75.0	56.5	68.3

The results of the bi-variate analyses shows how the different sub-groups of children differ in demographic or socio-economic characteristics. We are interested to assess whether a higher probability of stunting is associated with having an index child in the last 3 years (with a focus on whether that child was wanted or not) or whether these higher probabilities to be stunted were due to some underlying difference in socio-economic characteristics. In order to unravel these effects we apply propensity score matching (PSM) and see whether by matching children with similar characteristics we can remove the difference in the sub-samples and assess whether the difference in probability of being stunted is due to the exposure to an additional child born in the family or an additional unwanted child. The PSM analysis is not done for the effect of having a sibling mistimed or for the effect of being unintended or mistimed on the index child, nor the probability of being wasted or underweight as the bi-variate analysis does not reveal a significant effects. We will analyze the sample of siblings and assess whether exposure to the events will affect the probability of being stunted:

1) Having an index child born in the last 3 years
2) Having an unwanted index child in the last 3 years.

Using the PSM methodology we will test these hypotheses:

1) *An additional child born into a family increases the probability of stunting of existing siblings.*
2) *An additional child who was '<u>unwanted'</u> born in a family will increase the probability of stunting in siblings.*
3) *An additional child born in a family will increase the probability of stunting in siblings especially for those children who have already other siblings of similar age with whom they compete for family resources.*
4) *An additional child who was '<u>unwanted'</u> born in a family will increase the probability of being stunted of their siblings especially for those children who have already other siblings of similar age with which they compete for family resources.*

In order to measure the "true" effect of these exposures we compare the anthropometric status of the siblings with an index child in the last 3 years (exposed) to those children with similar characteristics who did not have an index child in the past 3 years (unexposed). We repeated the analysis for siblings who were in a family with an unwanted birth and for the subgroup of 'clustered' children. To achieve this, the propensity score matching technique uses a logistic regression based on a set of background characteristics to calculate the probability or propensity of each respondent of being exposed (Rosenbaum and Rubin, 1984). These propensity scores are probabilities and thus range between 0 and 1. At any value of the propensity score, the distribution of the specific covariates may vary among those exposed. Individuals with similar propensity scores are considered to be comparable in respect to all measured background characteristics.

After assigning the propensity score to each individual, we match people with similar propensity score using alternative matching method such as radious matching, kernel matching. We then estimate the Average Exposure Effect which is the difference in the outcome of interest amongst the exposed group and a similar group of children who were not exposed (Rosembaum and Rubin, 1984). In order to assess whether the effect is significant we estimated bootstrapped standard errors around the estimates (Lechner 2002; Oakes & Kaufman 2006).

We checked the PSM procedure's underlying assumptions. Firstly, covariates included in the model for creating the score have to create balanced propensity amongst the entire distribution of scores (Smith and Todd, 2001; Dehejia 2005; Laupacis et al. 2005; Yanovitzky, Zanutto et al. 2005); this is checked via the pscore command in STATA. Secondly, the covariates used in the overall model balance the difference between the exposed and unexposed group; in other words when the difference in characteristics between the matched treated and untreated group is not statistically significant (Dehejia 2005; D'Agostino 1998; Caliento 2005). This further check is done by applying the command ptest in STATA. We used STATA version 11 for all analyses.

The PSM model matched individuals on a range of demographic and socio-economic characteristics which were selected considering the association with the probability of being stunted and exposure. We matched the exposed and unexposed samples on child's age in months, the sex of the child, the mother's education status, whether or not she was in a polygamous union, the total number of children, father's occupational status, household dwelling characteristics, whether or not the household had a phone or whether the father was a fisherman and whether or not they have difficulties in buying soap in the past month.

Table 3 below shows the results of the PSM procedure. The proportion of children stunted amongst those exposed to an index child (first row, first column) can be compared to the proportion of children stunted among the matched sample of non- exposed individuals (first row, second column). The average exposure effect is shown in the second row of results which is the difference in proportion of children stunted (column 1-2). Row 4 and 5 show the bootstrap standard error and its significance level. Row 6 show whether we achieved model balance, hence whether we can trust the validity of our results. Just to remind the reader, the model is said to be balanced when the selection of covariates for the propensity score model significantly reduces the difference in the sample characteristics between the exposed and unexposed groups.

We found a difference of 4 per cent points between the probabilities of being stunted between exposed and unexposed groups. This result is significant at 1 per cent level. However, overall model balance was not achieved and thus we are unable to make any clear statement about the difference between these two groups.

We found a 6 per cent difference in the probability of being stunted for siblings who had an unwanted index child born in the last 3 years and those who did not.. We found that this difference was statistically significant at 5 % level and our model achieved balance; the selection of our covariates and the propensity score matching methodology allowed us to remove the difference between the two samples and we obtained two comparable groups from which we could base our assessment of differential probability of being stunted in the two groups.

We also ran the same analysis for the subgroup of children who were born within two years of an older or younger sibling, the 'clustered' children. We found that clustered children who had an index child had 8 per cent higher probability to be stunted compared to clustered children who did not have an index child. However, when we tested the overall model balance the PSM procedure was not able to remove all the differences between the two groups. Finally, we found that 'clustered' children who had an unwanted index child had 22% point higher probability to be stunted compared with 'clustered' children who did not have an unwanted index child.. The results were significant and we achieved overall model balance.

Table 3: Results of Propensity Score Matching analysis.

	Siblings *with* an index child	Siblings *without* an index child	Siblings with an unwanted index child	Siblings without an unwanted index child	'Clustered' children *with* an index child	'Clustered' children *without* an index child	'Clustered' children *with an unwanted index child*	'Clustered' children without an unwanted index child
Percentage	32.9	28.7	38.3	31.7	40.9	32.9	56.5	34.0
Difference	4.2		6.5		8.1		22.5	
Bootstrap SE	0.042		0.030		0.040		0.077	
P-value	0.000		0.030		0.046		0.004	
Obs	8430		8430		673		673	
Overall model balance	X		√		X		√	

Discussion and Conclusion

In the United States a large, complex and inconclusive literature exists on the possible disadvantages that children whose conception was unintended may be disadvantaged in comparison to children who were intended (Brown and Eisenberg 1995). In view of the high incidence of unintended pregnancies in developing countries, together with a high prevalence of poverty, it is surprising how few relevant studies have been reported in such populations. Montgomery et al (1997) used Demographic and Health Survey data from five countries to assess the effects of unwantedness on child survival, nutrition and education. Unwantedness was weakly linked to mortality in three countries and to nutrition in one country. Marston and Cleland (2003) also used Demographic and Health Survey data from five countries to assess whether pre- and post-natal health outcomes differed between children classified by mothers as wanted, unwanted and mistimed. Only in one country did they find a link between unwantedness and childhood stunting. This impression of scarcity of evidence and mixed results is confirmed by a review (Gipson et al 2008).

This study was conducted in a poor rural setting where under-nutrition is common. Nevertheless, no difference was found in the nutritional status according to whether the child's conception was wanted at that time, was mistimed or not wanted at all by the mother. The most plausible interpretation of this result is that unintended children suffer no subconscious or conscious discrimination in terms of food allocation or health care.

The main purpose of the study was not to examine whether the intention status of children is linked to their growth but rather to assess whether the advent of a recent additional child (either wanted, unwanted or mistimed) has an adverse effect on older siblings, because of increased competition for scarce resources. The results suggest that the growth of older siblings is unaffected by the advent of a recent child in the family when no account is taken of the intention status of the new child. However, there does appear to be an adverse effect when the new child is reported as unwanted by the mother and this effect is greater when the older sibling is already closely spaced. This result, though it conforms to expectations, must be regarded with caution for three reasons. First, only a very small minority of children were reported as unwanted. Second, no effect of mistimed children was found. Third, retrospective fertility intentions may be subject to post facto rationalisations in ways that might yield misleading findings.

This paper represents a first exploration of the data, based only on the baseline survey. When data from all three rounds are available, a much more thorough examination will be possible. We will be able to use prospective fertility intentions of both husbands and wives and have available information on growth of children as well as cross sectional measures of nutrition.

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