The potential role of family planning interventions on improving child survival outcomes in developing countries

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Abstract

The association between birth spacing and child mortality has been known for some time, but despite this interventions aimed at increasing the interval between births have never been directly categorized as a potential tool for achieving goals in reducing child mortality. In addition family planning policy has historically been set apart from the public health agenda due to its greater complexity and the wider implications implicit in intervening. Using data on preceding birth interval and child mortality from Demographic Health Surveillance studies we have estimated the potential cost-effectiveness of family planning interventions on reducing preventable child death in resource poor settings. We then compared them with widely accepted ranges for other child survival interventions in the three WHO regions where burden is highest. This paper argues that given the inexorable movement towards a more holistic approach to reducing preventable child deaths worldwide, and the need to influence decision behavior, that in some places a strategy of increasing access to family planning may be a cost-effective and complimentary tool to use alongside the more familiar child survival interventions.

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Introduction

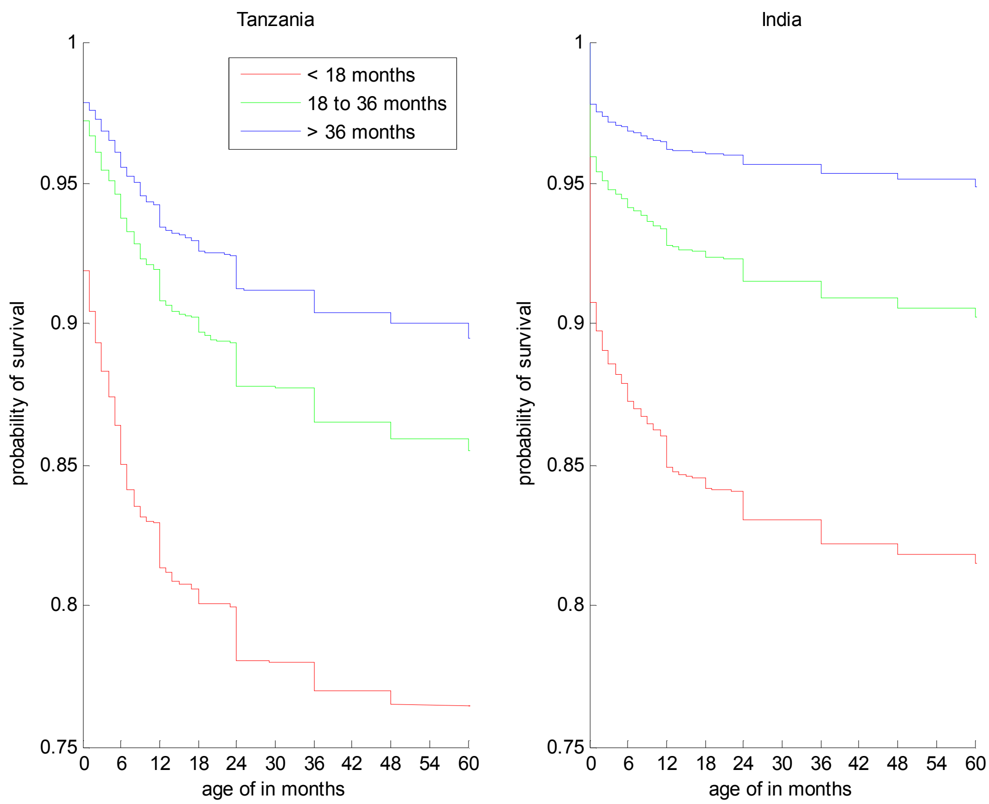
The association between birth spacing and child mortality has been known for some time, but despite this interventions aimed at increasing the interval between births have never been directly categorized as a potential tool for achieving goals in reducing child mortality. Most policies aimed at addressing the large numbers of preventable child deaths in developing countries have been centered on increasing access to interventions that address direct causes of child mortality, such as insecticide treated nets, immunization and community management of childhood illnesses. In addition family planning policy has historically been set apart from the public health agenda due to its greater complexity and the wider implications implicit in intervening. It is often framed in the context of women's rights and population control, which sits uncomfortably in the theoretically apolitical world of medicine and health. This paper argues that given the inexorable movement towards a more holistic approach to reducing preventable child deaths worldwide, and the need to influence decision behavior as well as improving systems of delivery that in some places a strategy of increasing access to family planning may be a cost-effective, sustainable and complimentary tool to more familiar child survival intervention strategies.

Background

There is a considerable amount of evidence that suggests a strong correlation between the interval between births of a mother and the probability of survival of both infants and children (Koenig et al, 1990; Rutstein, 2005; Makepeace et al, 2006; Rao et al, 2006; De Vanzo et al 2004). Arguments for this association range from biomedical, related to lactation and immunity or nutrition (De Vanzo et al, 2004) through to more socio-psychological effects of the greater burden on the mother in times of stress and resources (Koenig et al, 1990), but most conclusions seem to rest with the consensus view that all these reasons play a role. For example in India 33% of all deaths of children under the age of five years are to mothers with a preceding birth interval (PBI) of less than 18 months, despite the fact that these make up just 17% of all births. The same figures for birth interval of under 36 months are 86% of deaths from 54% of births. Figure 1 shows Kaplan Meier curves of survival data for the under 5's taken from recent demographic surveillance studies in India (171,360 births) and Tanzania (22,615 births), with children grouped by PBI of under 18 months, 18-36 months and over 36 months (DHS, Multiple Years).

The policies aimed at addressing the large numbers of preventable child deaths in developing countries have been centered on direct causes of child mortality, such insecticide treated nets, immunization and community management of childhood illnesses (Black et al, 2003; Bryce et al 2003; Jones et al, 2003). This is understandable in that burden of disease estimates have traditionally been dominated by the bio-medical one-disease; one-death rule (Anand & Hanson, 1998; Ora A 2009). The most widely accepted theory remains that in order to reduce deaths from malaria we must improve malaria prevention and treatment. In order to reduce deaths from diarrhea we must improve sanitation and hygiene and improve case management of diarrhea (Jones et al, 2003). This is not to say that that these points are not valid, but they are prone to ignore the true complexity of health systems and all the agents that are in play. You can have the best diagnostic and treatment services in the world but it cannot impact on child health if the mother of the child has not the strength, the will or the resources to seek care for that child, as health inequity statistics from industrialized countries point out (Collinson et al, 2007).

Figure 1: Kaplan Meier plot of three birth interval groups for child under 5 years



The key issue here is the importance of the role of causation. We can accept that this increase in risk of death is not directly attributable to the length of birth interval but that it acts as a defining agent in terms of its attribution to the relative risk of death. This is something that doesn't fit neatly into a traditional epidemiological model of burden of disease, but it is not without precedent as seen with recent work looking at the population attributable fraction methodology (Scott et a 1999) used to estimate the burden of conditions such as nutritional status on deaths attributed to infectious diseases (Fishman et al 2004; Black et al 2008). Here a more obvious causal association between nutritional status and severity of outcome from infectious disease is used to show the relative role of nutrition in each child death.

Outside of the complexity of the attribution of the burden of an individual child death to multiple agents we have the more political problem of incorporating a political-moral set of policies that are more traditionally associated with questions of choices and human rights, where there is a less straightforward consensus as to the value of intervening. Saving the lives of innocent children is a policy that rarely finds criticism, but managing population growth does not suffer from the same lack of ambiguity (Caldwell, 2005). Conveniently we have chosen to limit ourselves to the question of estimating the relative cost-effectiveness of different types of intervention, so these questions will remain open to interpretation.

What follows is a description of a mathematical agent based model that uses multiple country specific demographic and health surveys to estimate the impact of increasing the access and utilization of family planning products across these populations. These models are used alongside the actual distribution and utilization data from family planning interventions provided by an international NGO working in these countries to generate cost-effectiveness ratios (CER). These estimates are then compared to estimates of CERs for other child survival interventions in these respective WHO regions taken from the WHO CHOICE database of cost-effectiveness estimates (WHO CHOICE, 2009).

Methods

The model used for this exercise was developed initially as part of an exercise to try and generate a more complete picture of the impact of family planning interventions on the burden of disease resource poor communities. Traditional estimates had on the whole been limited to a reduction in adverse pregnancy and childbirth related outcomes such as, but not limited to abortion, anemia, post-partum hemorrhage and infections (Khan et al, 2006). This methodology is limited in that it looks at the potential burden of each pregnancy in isolation. Yet in a wider context much of the burden of pregnancy and childbirth is generated through a cumulative effect related to both regularity and increasing family size. These effects are often much more acute in resource poor households.

A series of papers looking at the relationship between a key indicator of this context; preceding birth interval, and child mortality have illustrated a significant association between the time between a child's birth and the birth of a previous sibling and the probability of a child dying before the age of five years (Rutstein, 2005; Rao et al Makepeaces et al 2006). These associations remained strong despite efforts to weight for other potential contributing factors such as wealth, education and season (Makepeace et al, 2006).

In order to translate this association into an estimate of effect of family planning intervention, we began with an accepted proxy of all family planning intervention, the couple year of protection, or CYP. Each different type of birth control intervention when combined with relative efficacy and likely wastage rates can be translated into an equivalent couple year of protection, so that estimates of the relative effectiveness of different products and services, and combinations of products and services can be assessed. We took the CYP as our starting point with the intention of estimating the potential impact of each CYP on the probability distribution of birth interval in different sub sets of the population, and hence the potential impact on child mortality rates within these populations.

The proportion of deaths attributable to a birth spacing of less than 36 months is calculated as:

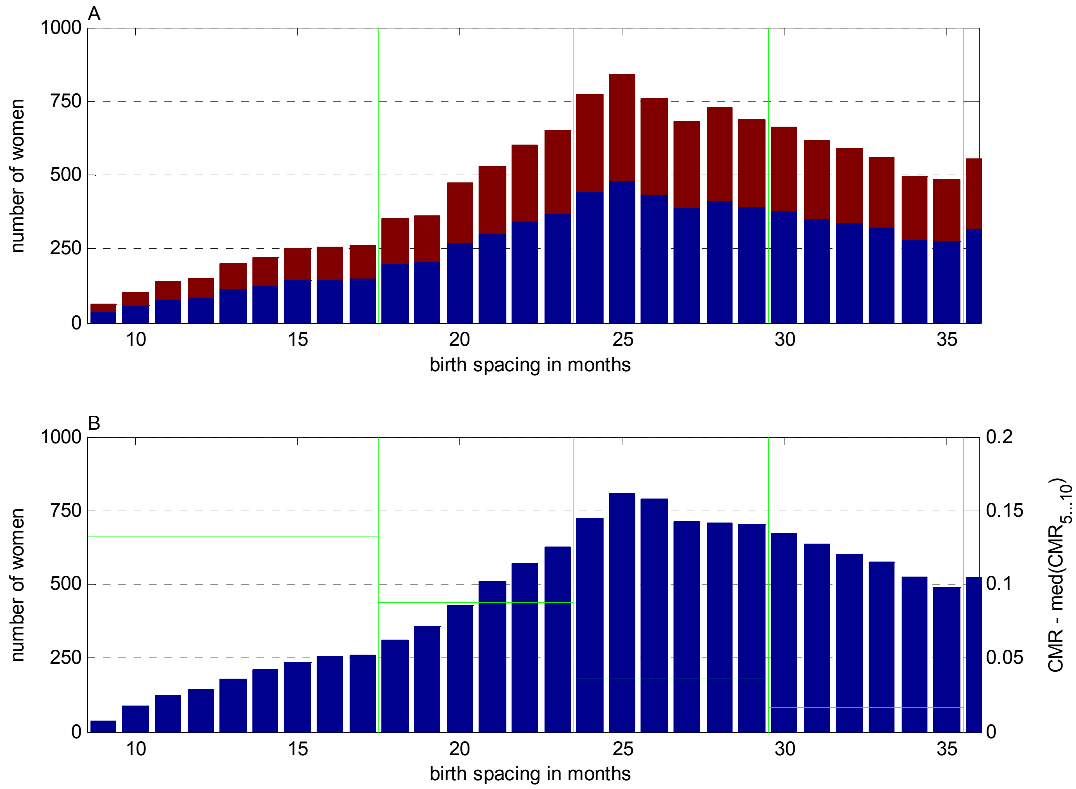
$$Attributable\,deaths\ proportion = \frac{\sum_{i=1}^{4}(CMR_i - median(CMR_5 \cdots CMR_{10})) * \left(number\ of\ births_i\right)}{\sum_{i=1}^{10}\left(number\ of\ births_i\right)}$$

$CMR_{1\text{ to }4}$ represents the child mortality rates for birth spacing of less than 18, 18 to 23, 23 to 29 and 30 to 35 months. $CMR_{5\text{ to }9}$ represents the child mortality rates for birth spacing of above 35 to 60+ months. CMR_{10} represents the child mortality rate for the first birth.

An intervention shifts the distribution of the number of births and the difference in proportions between baseline and intervention gives the reduction in child mortality. An intervention increases the birth spacing by 12*CYP/(total 15-44 maternal population) months.

For example for rural Tanzania, 500,000 CYP gives a mean population wide increase in birth interval of 0.47 months. This moves those subjects in the red region of Figure 2A , to the next birth spacing group to give the distribution shown in Figure 2B. The horizontal green lines show the value of CMR – median ($CMR_{5...10}$), for each birth spacing group using the right hand scale.

Figure 2: Absolute levels of PBI (Preceding Birth interval) from Tanzania DHS 2006, and the corresponding relative risk for child mortality by PBI.



The model assumes an even spread of the benefits from these CYP s throughout the population, which in turn is translated to an estimated increase in birth interval across the various subgroups within the population and hence to a reduction in population risk of child death. These deaths averted are then translated in turn into years of life lost to form a DALY (Disability Adjusted Life years) total for each level of output at each country program, which can be used to generate cost per DALY averted ratios.

Results

Population Services International (PSI) is one of a number of international NGOs that educate women on family planning and birth spacing and distribute and market family planning products in the world's poorest countries. More recently it has also been using its international distribution network to increase population access to malaria prevention and treatment products and child survival interventions such as oral rehydration therapy and micronutrient fortification supplements. As part of an exercise to become more evidence-based and to improve its allocative efficiency, PSI has been attempting to estimate the cost effectiveness of its various interventions across the various geographical locations it serves.

We used consumption data for family planning products delivered by PSI from a full year across the 36 countries it markets and distributes family planning products and services. We also undertook a detailed costing of each of these programs. The methodology of costing followed closely to the guidelines outlined by Walker et al (2005) and more specific details on the methodology can be found elsewhere (Stevens et al, 2005, Yukich et al 2008).

Using the PBI model described above a series of cost-effectiveness ratios were estimated using the model, in terms of cost per death averted and cost per DALY. The data sources used for the modeling exercise were taken from demographic surveillance and multiple indicator cluster surveys done in the past five years. Latin hypercube sampling was used to test the sensitivity of these models and generate 95% confidence intervals around the point estimates of cost per DALY. The results are summarized in table 1.

The WHO-CHOICE database was then used to generate ranges of cost-effectiveness for four of the main child survival interventions in the three WHO regions in which PSI does the bulk of its work; AFRO D and E (sub-Saharan Africa, high child mortality), SEAR D (South and East Asia, high child mortality) and AMRO D (Central and South America, high child mortality). The interventions were case management of diarrheal disease with oral rehydration therapy, case management of acute respiratory infections, vitamin A supplementation and micronutrient fortification.

The cost effectiveness data form table 1 is then compared to ranges of cost-effectiveness of the six child survival interventions taken from WHO CHOICE across these three WHO regions. In figure 3 we can compare estimates of the potential cost-effectiveness of Family Planning interventions alongside estimated ranges for the traditional child survival interventions in the three WHO regions with high child mortality.

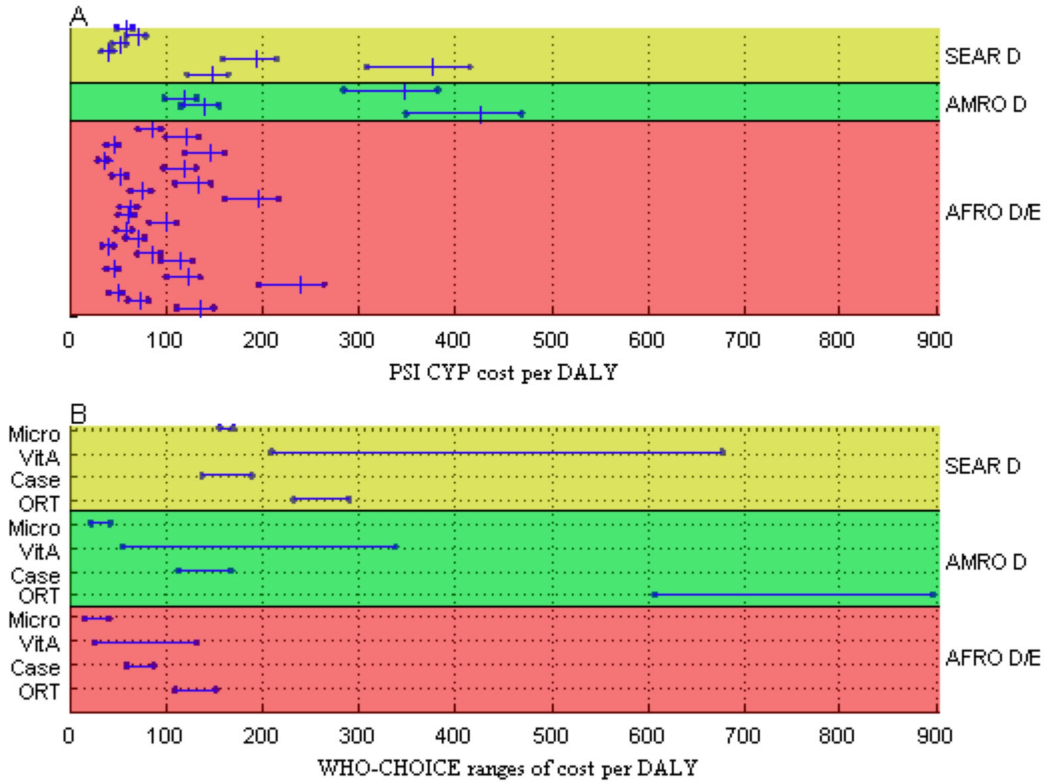
Table 1: Estimates of cost effectiveness of PSI Family Planning interventions in 36 countries in Africa, Asia and the Americas.

Country (WHO region)	Cost per DALY averted	95% Confidence Intervals
AFRO D		
Angola	135	111-149
Benin	74	60-81
Burkina Faso	50	41-55
Burundi	239	196-263
C.A.R.	122	100-135
Cameroon	46	38-51
Congo-Brazzaville	116	95-127
Congo-Kinshasa	86	70-94
Cote d Ivoire	41	34-45
Eritrea	71	58-78
Ethiopia	59	48-65
Guinea	101	83-111

Kenya	61	50-67
Madagascar	63	52-69
Malawi	196	160-216
Mali	77	63-84
Mozambique	133	109-146
Nigeria	54	44-59
Rwanda	119	97-131
Tanzania	36	30-40
Togo	145	119-160
Uganda	46	38-51
Zambia	121	99-133
Zimbabwe	86	71-95
SEAR D		
Cambodia	149	122-164
Laos	376	308-414
Myanmar	194	159-214
Afghanistan	40	33-44
India	53	43-58
Nepal	72	59-79
Pakistan	59	48-65
AMRO D		
Costa Rica	425	348-467
Dominican Republic	140	115-154
Mexico	120	98-132
Paraguay	346	283-381

From the tables and figures summarizing the impact of attributable child deaths averted from family planning interventions sits somewhere in between those highly efficacious targeted interventions such as micronutrient supplementation for infants and case management for ARI, and the slightly less cost effective ones, such as management of diarrheal disease with ORT and vitamin A supplementation. The comparison is more notable in countries in the regions SEAR D and AMRO D.

Figure3: Comparison of cost-effectiveness ranges of Child Survival interventions taken from WHO-CHOICE and estimates from Family Planning distribution interventions in three WHO regions



Discussion

The primary area of contention when addressing the relationship between birth interval and mortality is whether what we are seeing is causation or merely correlation. It is inevitable that households with lower average birth intervals may also be poorer and less educated which are in themselves confounders for poor health outcomes, but it is also true that larger family sizes are also strongly associated with malnutrition and lower levels of utilization of health care, even when weighted for wealth and education. Separate longitudinal studies have shown that as the birth intervals for countries rise over time so child morality rates fall, across all sub sets of the population, irrespective of wealth. In addition a number of papers have drawn attention to the potential confounder that high rates of neonatal death can be an a priori cause for measured short birth interval (Dissanayake 2000; Bhalotra & Van Soest, 2005; Maitra & Pal, 2008). Although most conclude that excluding this impact can lead to biased results, they conclude that the impact can be both under and overestimate the effect on child mortality and that it is impossible to predict the effect either way (Maitra & Pal; 2008).

It is noted that the model measures shifts in mean levels of birth interval across relatively large demographic sub groups within the population. The problem of birth spacing and the resulting impact, or association with higher child mortality is in reality limited to a subset of the population. In reality it is difficult to say whether an increase in population wide utilizations of family planning products means an equal and equitable increase across all sections of society. That said the same can certainly be said for most child survival interventions, even, or especially those provided by public health services. There is a great deal of evidence to support the inverse care law in that the poorest, and often the most in need are the last to access public health services or to seek treatment for illness (Gwatkin, 2005; Razzaque et al 2007; Peters et al 2008). This is another reason to pursue a multifaceted approach to the problem of the excessive number of preventable child deaths worldwide.

The role of cost-effectiveness data in priority setting is a contentious one, but rarely for reasons other than its sometimes inequitable and exclusionary nature. Health outcomes and their relationship to the systems that influence them are rarely linear. Population wide estimates of cost-effectiveness are an over simplification of a more complex truth, but they do act as a foundation for achieving a baseline for action. Methods of using this data will need to improve, complexity and heterogeneity will have to be factored in and context will need to be brought into play, and the value of this data will rise (Stevens & Normand, 2004).

We are already starting to address disease burden in a more holistic way with PAF and nutrition burden and co-morbidity, and as we move away from the more constricted one-disease; one-death basis of traditional disease burden estimation understanding the role of behavioral, cultural and sociological patterns such as birth spacing is the next logical step.

Conclusions

This paper argues that given the need for a movement towards a more holistic approach to reducing preventable child deaths worldwide, that in some places increasing access to family planning may be both a cost-effective and complementary addition to other more familiar child survival intervention strategies

Multiple studies have shown not just a correlation between population rates of birth interval and child mortality, but also that in populations where birth interval rises over time, so in all cases is this followed by a fall in child mortality. There are also a number of studies that give good evidence to the complex nature of the relationship between the preceding birth interval and the health of a child, be it biological in terms of nutrition and immunity, or social; through limited resources and energy on behalf of the mother. Our models show that intervening in communities where birth intervals are short and child mortality is high the potential cost-effectiveness of preventing child death is comparable to a number of other widely utilized direct intervention strategies.

At a time when progress has been shown to be worryingly slow in terms of reducing child mortality in the global context it may be worth considering greater access to family planning interventions as a complement to other interventions aimed at child survival.

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