Chapter 28

Postponing Adolescent Parity in Developing Countries through Education: An Extended Cost-Effectiveness Analysis

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INTRODUCTION

Despite substantial progress in the achievement of Millennium Development Goal 5 to reduce the maternal mortality ratio—the number of maternal deaths per 100,000 live births—by two-thirds between 2000 and 2015, substantial inequalities remain in maternal mortality across countries worldwide (Kassebaum and others 2014; UN 2013; UN MME 2015; Verguet and others 2014). Maternal mortality ratios remain unacceptably high in South Asia and Sub-Saharan Africa, particularly West Africa (Kassebaum and others 2014; UN MME 2015). Together, South Asia and Sub-Saharan Africa account for 86 percent of the world's maternal deaths (WHO and others 2014).

Building on the momentum gathered by the Millennium Development Goals, the post-2015 agenda and its Sustainable Development Goals set the ambitious target of further reducing the maternal mortality ratio, currently about 200 deaths per 100,000 live births globally (UNICEF 2016), to 70 per 100,000 by 2030 (UNW 2016).

Women ages 15–19 years face elevated risks of pregnancy-related mortality and morbidity. In low- and middle-income countries (LMICs), these risks are disproportionately higher (IHME 2013; WHO and others 2014), and the maternal mortality ratios are much larger, on average (Kassebaum and others 2014; UN MME 2015). Furthermore, among girls younger than age 16 years, the relative risk of pregnancy-related mortality is up to five times higher compared with women ages 20–24 years (Huang 2011; Mayor 2004). Although the education of girls has been expanded worldwide (Gakidou and others 2010), early marriages remain common; up to 65 percent and 76 percent of women are married by age 18 years in Bangladesh and Niger, respectively (UNICEF 2016). As a result, the rates of adolescent pregnancies remain very high in many LMICs (Bates, Maselko, and Schuler 2007; Beguy, Ndugwa, and Kabiru 2013; Chloe, Thapa, and Mishra 2004; Dixon-Mueller 2008).

Maternal and adolescent health need to be examined through a wider perspective beyond mortality—notably, morbidity outcomes, such as long-term sequelae for both mothers and their children, and the financial vulnerability of women and adolescents (Ashford 2002; Dale, Stoll, and Lucas 2003; Filippi and others 2006; Langer and others 2015). Pregnant young women present higher chances of school dropout (Lloyd and Mensch 2008; Marteleto, Lam, and Ranchhod 2008; Meekers and Ahmed 1999), and they could face high risks of pregnancy-related impoverishment and

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negative economic consequences (Arsenault and others 2013; Ilboudo, Russell, and D'Exelle 2013; Powell-Jackson and Hoque 2012) if they choose to carry their pregnancy to term. Out-of-pocket (OOP) medical payments in LMICs can lead to impoverishment and related coping strategies, such as borrowing money or selling assets, to pay for health care (Kruk, Goldmann, and Galea 2009; Xu and others 2003).

In the absence of other financing mechanisms, such as private health insurance or fee exemptions, household medical expenditures can be catastrophic (Wagstaff 2010), exceeding a specified percentage of total household expenditures. For example, with increased incidence of complicated deliveries owing to pregnancies at young ages, the OOP costs associated with maternal delivery in facilities are likely to be higher and may subsequently put pregnant adolescents at increased risk of medical impoverishment. In particular, this increased likelihood of financial risk would be expected to be greater among poorer socioeconomic groups; these groups have less disposable income and higher rates of adolescent pregnancies (IIPS 2010; INS and ICF International 2013). This hypothesis is one of several that this chapter examines.

Protection from health care financial risks has become a critical component of national strategies in many countries (Boerma and others 2014; WHO 2010, 2013). Reduction of these financial risks is one objective of public sector policies. For example, public investment in education to increase girls' educational levels could reduce adolescent pregnancies and subsequent risks of both mortality and impoverishment, especially among the poorest women.

Health economic evaluations (cost-effectiveness analyses) have traditionally focused on estimating an intervention's cost per health gain (Jamison and others 2006). Extended cost-effectiveness analysis (ECEA) (Verguet, Gauvreau, and others 2015; Verguet, Kim, and Jamison 2016; Verguet, Laxminarayan, and Jamison 2015; Verguet and others 2013; Verguet, Olson, and others 2015) supplements traditional economic evaluation by incorporating evaluation of financial risk protection (FRP)—prevention of medical impoverishment. ECEA quantifies how much FRP, equity, and health can be purchased for a given expenditure. ECEA can provide answers to help policy makers select the optimal policies for increasing FRP and equity and for improving the distribution of health benefits (WHO 2010, 2013).

Many determinants of adolescent pregnancy and fertility have long been reported in the scientific literature, notably by John Bongaarts (Bongaarts 1978; Bongaarts and Potter 1983). In this chapter, we restrict our analysis to one specific underlying factor of fertility—female educational attainment—and examine its impact on adolescent maternal mortality and medical impoverishment associated with complicated delivery in facility. For this purpose, this chapter uses ECEA to measure the potential mortality, FRP, and equity benefits that could be gained through public financing of increased education of adolescent girls in two illustrative country examples: Niger and India.

METHODS

This chapter examines the potential impact on maternal mortality and impoverishment of the increase in the level of female education by one school year for a cohort of adolescent women. Definitions of age groupings and age-specific terminology used in this volume can be found in chapter 1 (Bundy and others 2017).

We consider the population of adolescent women, ages 15–19 years, in Niger and India. Niger has the highest total fertility rate globally (7.6 children per woman of reproductive age) and a high maternal mortality ratio (553 deaths per 100,000 live births), leading to 5,400 maternal deaths annually. India has the largest population in South Asia (1.3 billion), the largest number of maternal deaths worldwide (45,000 deaths), and a high maternal mortality ratio (174 deaths per 100,000 live births) (Alkima and others 2016; UN DESA 2013; UN MME 2015).

General Approach

First, we examine the hypothetical impact of a one-year increase in the education level of adolescent girls. We study the linear relationship between the mean number of years of education among women ages 15–44 years (IHME 2010) and the adolescent pregnancy rate (percentage of women ages 15–19 years who have had children or are currently pregnant) in LMICs with populations greater than 1 million (World Bank 2015). Annex 28A, section 1 provides further details. This approach enables the estimation of the hypothetical impact of increasing education of girls on reducing adolescent pregnancy rates. In these two countries, we assume that the cohort of adolescent women who complete one more year of education would experience a reduction in pregnancy rates in the short term, that is, over the subsequent five years (ages 15, 16, 17, 18, and 19 years).

Second, using this estimated impact of increased education on adolescent pregnancy rates, we use the ECEA framework to estimate the potential reduction in adolescent maternal mortality and impoverishment.

We calculate the number of maternal deaths averted by a decrease in adolescent pregnancies, the amount of out-of-pocket (OOP) costs averted by the prevention of complicated deliveries, and the corresponding number of cases of catastrophic health expenditures averted. The counterfactual scenario corresponds to the case in which female education is maintained at the same level; hence, there would be no change in adolescent pregnancy rates.

ECEA provides a tool for gaining a more complete understanding of the health and financial benefits associated with different health policies and interventions. ECEA combines the traditional health system perspective from cost-effectiveness analysis with the patient perspective, notably by quantifying the benefits associated with avoiding medical impoverishment and assessing the distributional consequences, such as equity, of policies (Verguet, Kim, and Jamison 2016; Verguet, Laxminarayan, and Jamison 2015). This tool helps policy makers make decisions based on the joint benefits and tradeoffs associated with different policies and interventions, specifically in both health gains and FRP and equity benefits. In addition to health benefits, ECEA estimates the impact of policies along three dimensions:

- Household OOP private expenditures averted by the policy
- Financial protection benefits provided
- Distributional consequences, for example, as applied to socioeconomic status or geographical setting

Third, we tentatively assess the costs associated with raising the education level of adolescent girls by one year. To do so, we multiply the entering female adolescent cohort (estimated as the population of women ages 15–19 years divided by five, or about 204,000 per wealth quintile in Niger, for example) by the annual cost of primary education per pupil as estimated by the United Nations Educational, Scientific and Cultural Organization (UNESCO 2015). This approach enables us to quantify the financial resources that may be needed to achieve such an increase in female education. We do not discount the costs and benefits of increased education because the pregnancy events would occur only a few years into the future (annex 28A, section 2).

We rely on secondary data extracted from survey sources, published literature, and estimates from United Nations (UN) agencies. Specifically, we use the following:

- Country maternal mortality ratios and population estimates from the UN
- Percentage of women ages 15–19 years who are pregnant
- Incidence of complicated deliveries
- Skilled birth attendance coverage per income quintile, based on Niger's Demographic and Health Survey and India's District Level Household and Facility Survey, as a proxy for health care utilization

We rely on an estimated increased relative risk of maternal mortality among adolescent women (Huang 2011). In addition, we use data on OOP costs for complicated maternal deliveries and associated transportation costs extracted from the literature for West Africa (Arsenault and others 2013; Storeng and others 2008) and from India's National Sample Survey (NSSO 2004). Finally, we extract adolescent women's incomes from a country income distribution proxied by a gamma distribution supplemented by gross domestic product (GDP) per capita and Gini coefficient (Salem and Mount 1974; World Bank 2015). All of the parameters used in the analysis are shown in table 28.1.

ECEA Outcomes

First, we estimate the number of maternal deaths averted per income quintile owing to a decrease in the adolescent pregnancy rate through increased education. The magnitude of maternal mortality averted depends on the existing burden, the excess relative risk of maternal mortality among adolescent women, the distribution of adolescent pregnancies per income quintile, and the impact of education on reducing adolescent pregnancy rates.

Second, we estimate the amount of OOP expenditures averted related to complicated adolescent maternal deliveries and associated transportation costs. This amount depends on the incidence of complicated maternal deliveries, the relative risk of maternal mortality among adolescent women, the distribution of adolescent pregnancies per income quintile, health care utilization per income quintile, and the impact of education on reducing adolescent pregnancy rates.

Third, we measure FRP by the number of cases of catastrophic health expenditures averted, per income quintile, which depends on individual income, OOP expenditures, and the educational impact. A catastrophic health expenditure for an adolescent woman is defined as OOP expenses higher than 10 percent of income, a commonly used threshold (Pradhan and Rescott 2002; Ranson 2002; Wagstaff and van Doorslaer 2003). Specifically, among adolescent women no longer facing pregnancies, we estimate the number of individuals, per income quintile, for whom the size of OOP expenses

Table 28.1 Parameters Used for the Analysis of Adolescent Maternal Mortality and Impoverishment Averted by Increased Education in India and Niger

Parameter	India	Niger	Sources
Total population (millions)	1,311	20	UN DESA 2015
Population of women ages 15–19 years	58,400,000	1,021,000	UN DESA 2015
Maternal mortality ratio per 100,000 live births	174	553	Alkima and others 2016
Occurrence of complicated maternal delivery among all deliveries (%)	15	15	Authors' assumption based on Prual and others 2000
Relative risk of maternal mortality for women ages 15, 16, 17, 18, and 19 years	4.6, 1.0, 1.0, 1.0, 1.0	4.6, 1.0, 1.0, 1.0, 1.0	Based on Huang 2011
Percentage of women ages 15–19 years who are pregnant, from poorest to richest (income quintiles 1–5)	19; 17; 13; 8; 3	41; 43; 37; 32; 19	INS and ICF International 2013 IIPS 2010
Percentage of women ages 15, 16, 17, 18, and 19 years who are pregnant	1; 3; 5; 9; 12	3; 12; 16; 19; 18	INS and ICF International 2013 IIPS 2010
Health care utilization (percentage of skilled birth attendance coverage), from poorest to richest (income quintiles 1–5)	24; 34; 48; 64; 85	13; 19; 22; 30; 71	INS and ICF International 2013 IIPS 2007
Out-of-pocket direct medical cost (2014 U.S. dollars) of complicated delivery, from poorest to richest (income quintiles 1–5)	58; 62; 70; 81; 108	97; 127; 140; 124; 152	Based on Arsenault and others 2013; NSSO 2004; Storeng and others 2008
Out-of-pocket transportation cost (2014 U.S. dollars), from poorest to richest (income quintiles 1–5)	8; 8; 8; 8; 6	4 for all income quintiles	Based on NSSO 2004; Perkins and others 2009
Gross domestic product per capita (2014 U.S. dollars)	1,596	427	World Bank 2015
Gini index	0.34	0.32	World Bank 2015
Impact of female education on adolescent pregnancy rate	1 additional year of education leads to an 18 percent relative reduction (SE = 2 percent) in adolescent pregnancy rate	1 additional year of education leads to an 18 percent relative reduction (SE = 2 percent) in adolescent pregnancy rate	Annex 28A, section 1 and table S1
Cost of primary education, per pupil per year (2014 U.S. dollars)	258	72	Based on UNESCO 2015

Note: SE = standard error.

(sum of direct medical costs and transportation costs) would have exceeded 10 percent of their income.

The counterfactual scenario corresponds to the situation in which primary education of girls remains at the same level. All costs are expressed in 2014 U.S. dollars. Complete details of the mathematical derivations used for the analysis are given in annex 28A, section 3.

Sensitivity Analysis

Three univariate sensitivity analyses are performed:

- Different thresholds (20 percent and 40 percent of individual income) for the catastrophic health expenditures
- A poverty headcount, estimating the number of individuals falling below the country poverty line because of OOP costs, in lieu of cases of catastrophic health expenditures
- A smaller effect, 11 percent relative reduction (instead of 18 percent) (annex 28A, section 1, table S1), for the impact of a one-year increase in female education on the adolescent pregnancy rate

RESULTS

Costs

The total costs of increasing education of adolescent girls by one school year would be approximately US$15 million in Niger and US$3 billion in India. The number of adolescent women in the two countries, about 1 million in Niger and 58 million in India (table 28.1), is responsible for the large difference in the estimated cost. We observe different orders of magnitude for the size of the maternal deaths averted (160 for Niger and 1,250 for India), OOP payments averted (US$150,000 and US$3 million, respectively), and cases of catastrophic health expenditures averted (1,110 and 5,160, respectively) (tables 28.2 and 28.3).

Adolescent Maternal Deaths Averted

In each country, the extent of adolescent deaths averted, OOP payments averted, and cases of catastrophic health expenditures averted vary significantly across different income quintiles (tables 28.2 and 28.3). In both countries, more adolescent women's lives would be saved in the bottom two quintiles (49 percent in Niger and 61 percent in India), compared with the top two quintiles (30 percent and 20 percent, respectively).

Out-of-Pocket Expenditures Averted

The OOP expenditures averted display a different pattern. In Niger, more OOP expenditures would be averted in the richer income groups; about 54 percent of total OOP expenditures would be averted in the top two quintiles, in contrast to 27 percent in the bottom two quintiles (table 28.2). This finding occurs largely because richer individuals use more health care than do poorer individuals; it is also partly because richer individuals spend more out of pocket than do poorer individuals (table 28.1).

In India, the OOP expenditures averted are more evenly distributed among the different income groups. About 42 percent of total OOP expenditures averted accrue in the top two quintiles, in contrast to 34 percent in the bottom two quintiles (table 28.3).

Catastrophic Health Expenditures Averted

Catastrophic health expenditures results (FRP) reflect a combination of key drivers, including (1) the distributions of health care utilization and OOP costs among income quintiles and (2) individual income. For example, in Niger a larger number of cases of catastrophic health expenditures are averted among the richer (52 percent in the top two quintiles) than among the poorer (30 percent in the bottom two quintiles). Large inequalities exist in health care utilization (71 percent in the richest quintiles, compared with 13 percent in the poorest). Moreover, Nigerians' income is

Table 28.2 Impact of Increasing Mean Years of Female Education by One Year in Niger

Outcome	Total	Income quintile I	Income quintile II	Income quintile III	Income quintile IV	Income quintile V
Adolescent maternal deaths averted	164	40 (24%)	40 (25%)	34 (22%)	30 (19%)	20 (11%)
Adolescent OOP expenditures averted (2014 U.S. dollars)	152,000	13,000 (9%)	27,000 (18%)	29,000 (19%)	31,000 (20%)	52,000 (34%)
Adolescent cases of catastrophic health expenditures averted[a]	1,100	130 (12%)	200 (18%)	200 (18%)	240 (22%)	330 (30%)

Note: OOP = out-of-pocket.

a. Cases of catastrophic health expenditures are defined as OOP expenses greater than 10 percent of income.

Table 28.3 Impact of Increasing Mean Years of Female Education by One Year in India

Outcome	Total	Income quintile I	Income quintile II	Income quintile III	Income quintile IV	Income quintile V
Adolescent maternal deaths averted	1,260	400 (32%)	360 (29%)	260 (21%)	170 (14%)	70 (6%)
Adolescent OOP expenditures averted (2014 U.S. dollars)	3,050,000	430,000 (14%)	610,000 (20%)	730,000 (24%)	740,000 (24%)	540,000 (18%)
Adolescent cases of catastrophic health expenditures averted[a]	5,160	5,160 (100%)	0	0	0	0

Note: OOP = out-of-pocket.

a. Cases of catastrophic health expenditures are defined as OOP expenses greater than 10 percent of income.

very low, even in the richer socioeconomic groups; GDP per capita is US$427 (table 28.1).

In contrast, in India all the cases of catastrophic health expenditures that are averted are in the poorer quintiles (100 percent in the bottom income quintile); in spite of large inequalities in health care utilization (85 percent in the richest, compared with 24 percent in the poorest), substantial income inequalities remain. GDP per capita is approximately US$1,596, and richer individuals face little risk of catastrophic health expenditures (table 28.1). The difference between India and Niger occurs because the cost of a complicated delivery is higher relative to average income in Niger than in India.

Sensitivity Analyses

When the threshold for estimation of cases of catastrophic health expenditures is raised (to 20 percent or 40 percent), as expected the magnitude of the cases incurred decreases in India and Niger, with a slight alteration of the distribution across quintiles in Niger. Alternatively, when the poverty headcount metric is used, the distribution of induced poverty across quintiles is significantly altered (annex 28A, tables S3 and S4). Finally, when the impact of female education on the adolescent pregnancy rate is reduced (to 11 percent instead of 18 percent), maternal deaths, OOP costs, and induced cases of impoverishment averted were all reduced by 39 percent (annex 28A, tables S5 and S6).

DISCUSSION AND CONCLUSIONS

The use of the ECEA methodology enables the impact of public policies on distributional consequences and their benefits in protecting against impoverishment to be assessed, in addition to the traditional dimension of health benefits. This type of analysis provides critical additional metrics to policy makers inside and outside the health sector when allocating financial resources. We conclude that increased educational attainment for adolescent girls could bring large poverty reduction benefits in addition to significant health benefits by avoiding early pregnancies and maternal deaths. This finding underscores the great economic vulnerability of adolescent women in such settings (Filippi and others 2006; Langer and others 2015).

Our findings align well with a number of expectations. Beyond the large health and financial benefits, the extent of these gains varies significantly across socioeconomic groups. More lives would be saved in the poorer groups because they face higher rates of early pregnancy. However, more OOP expenditures would be averted in the richer groups because they use more health care than do poorer ones. Finally, individual income and broader country wealth—low income versus middle income—also affect the distribution of the FRP benefits.

Advantages of Analysis

Our approach permits FRP to be incorporated into the economic evaluation of public policies. This enables interventions to be selected on the basis of how much FRP and equity can be bought, in addition to how much health can be bought, per dollar expenditure. This methodology helps policy makers consider all of these dimensions when making financing decisions. It facilitates comparison across sectors, which is essential for ministries of finance and development. We show how the FRP and equity benefits of public policies can be substantial and should be taken into account, critically underscoring the multifaceted nature of maternal and adolescent health.

Limitation of Analysis

Our analysis presents several limitations.

First, we have limited data and rely on secondary data and published literature to estimate impact and costs (table 28.1). Accordingly, this analysis is illustrative. A more comprehensive accounting of incurred expenditures for adolescent women could be included, with detailed accounting of medical costs, transportation and housing costs, and time and wages lost. For simplicity, we use average OOP expenses linked to complicated deliveries, even though OOP expenses might significantly rise with the degree of complication and emergency. In particular, we do not include broader pregnancy-related OOP costs or other potential expenditures incurred by adolescent women. While we attempt to examine the impact of ill health on impoverishment, we do not study the impact of poverty on health, that is, the potential increased maternal mortality and morbidity consequences associated with lower socioeconomic status. Similarly, we do not include the potential lifetime economic consequences of adolescent pregnancy, such as its short-term impact on school attendance and its long-term impact on earnings losses, because of the lack of empirical data. We also do not consider the costs to induce girls to stay in school another year beyond the costs of an additional school year to the public sector.

Second, our analysis focuses on only the mortality consequences of adolescent pregnancy, and we do not account for the potential sequelae to the mothers and their children following complicated delivery; neither do we consider abortion. Delaying childbirth is modeled as a risk displacement to older women; the elevated risk might be a first pregnancy effect or due to an unstable relationship and abortion. Such elevated risk is particularly high at ages younger than 15 years; hence, the deaths averted could be even higher if that age group were considered in the analysis.

Third, we do not pursue a full uncertainty analysis because our purpose is to expose a framework for policy makers, rather than to provide definitive estimates. Similarly, we choose to represent FRP as measured by cases of catastrophic health expenditures averted. Alternatives include a money-metric value of insurance (McClellan and Skinner 2006; Verguet, Laxminarayan, and Jamison 2015), poverty cases averted (Verguet, Olson, and others 2015), and avoided cases of forced borrowing and asset sales. We choose the number of cases of catastrophic expenditures averted metric because of its simplicity. Yet, issues pertain to its use, notably, the choice of a specific threshold—for example, 5 percent, 20 percent, or 40 percent of the capacity to pay (Xu and others 2003)—and the fact that certain individuals may not always be counted in the analysis (Saksena, Hsu, and Evans 2014; Wagstaff 2010).

Fourth, our analysis is narrowly restricted to the impact of education on teenage pregnancy and does not account for the comparative impact of other determinants of fertility (Bongaarts 1978; Bongaarts and Potter 1983) or interventions to reduce unintended pregnancies (DiCenso and others 2002; Hindin and Fatusi 2009). Similarly, we choose a simple modeling approach to examine the impact of one additional school year on teenage pregnancy and do not detail any specific features of education in the two countries studied, including, for example, the quality and impact of educational expenditures or the determinants of educational attainment (Glewwe and Kremer 2006; Heyneman and Loxley 1983).

In summary, our study's primary intent is to demonstrate how increasing levels of female education could potentially decrease rates of adolescent pregnancies and subsequently yield maternal mortality gains, as well as important equity and FRP benefits, to adolescent women.

ANNEX

The annex to this chapter is as follows. It is available at http://www.dcp-3.org/CAHD.

- Annex 28A. Estimation Methods Used in the Extended Cost-Effectiveness Analysis of Postponing Adolescent Parity

NOTES

Portions of this chapter were previously published:

- Verguet, S., A. Nandi, V. Filippi, and D. A. P. Bundy. 2016. "Maternal-Related Deaths and Impoverishment among Adolescent Girls in India and Niger: Findings from a Modelling Study." *BMJ Open* 6: e011586. doi:10.1136/bmjopen-2016-011586. © COPYRIGHT OWNER Verguet and others. Licensed under Creative Commons Attribution (CC BY 4.0) available at: https://creativecommons.org/licenses/by/4.0/.

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US$1,045 or less
- Middle-income countries (MICs) are subdivided:
  a) lower-middle-income = US$1,046 to US$4,125
  b) upper-middle-income (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more.

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