

# UC San Diego

## UC San Diego Electronic Theses and Dissertations

### Title

Linkages to Survival : : An Examination of the Reproductive and Maternal Health Continuum of Care

### Permalink

<https://escholarship.org/uc/item/2ch990rd>

### Author

McDougal, Lotus Padma

### Publication Date

2014

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA, SAN DIEGO

SAN DIEGO STATE UNIVERSITY

Linkages to Survival:  
An Examination of the Reproductive and Maternal Health Continuum of Care

A dissertation submitted in partial satisfaction of the  
requirements for the degree Doctor of Philosophy

in

Public Health (Global Health)

by

Lotus Padma McDougal

Committee in charge:

University of California, San Diego

Anita Raj, Chair  
Craig McIntosh  
Melanie L.A. Rusch  
Jay G. Silverman

San Diego State University

Thomas E. Novotny  
María Luisa Zúñiga

2014

Copyright

Lotus Padma McDougal, 2014

All rights reserved.

The Dissertation of Lotus Padma McDougal is approved, and is acceptable in quality and form for publication on microfilm and electronically.

---

---

---

---

---

---

---

---

Chair

University of California, San Diego

San Diego State University

2014

## TABLE OF CONTENTS

SIGNATURE PAGE.....	iii
TABLE OF CONTENTS .....	iv
LIST OF TABLES .....	vii
LIST OF FIGURES.....	viii
ACKNOWLEDGEMENTS .....	ix
VITA .....	xi
ABSTRACT OF THE DISSERTATION.....	xiii
CHAPTER 1:.....	1
Background .....	1
Reproductive and Maternal Health Continuum of Care .....	2
Overview .....	3
Figures.....	5
References .....	6
CHAPTER 2:.....	9
Abstract .....	9
Background .....	9
Methods.....	10
Results .....	10
Conclusion.....	10
Background .....	11
Methods.....	12
Sample.....	12
Measures .....	13

Analyses .....	14
Results .....	15
Discussion .....	18
Acknowledgements .....	22
Figures .....	23
Tables .....	26
Appendix .....	28
References .....	32
CHAPTER 3:.....	35
Abstract .....	35
Background .....	35
Methods.....	35
Results .....	36
Conclusions.....	36
Background .....	37
Methods.....	38
Sample.....	38
Measures .....	39
Analyses .....	41
Results .....	42
Discussion .....	44
Acknowledgements .....	48
Figures.....	49
Tables .....	51

Appendix .....	64
References .....	70
CHAPTER 4:.....	75
Abstract .....	75
Background .....	75
Methods.....	75
Results .....	76
Conclusion.....	76
Introduction .....	77
Methods.....	78
Sample.....	78
Measures .....	79
Analysis.....	80
Results .....	81
Discussion .....	83
Conclusion.....	87
Acknowledgements .....	89
Tables .....	90
Appendix .....	94
References .....	98
CHAPTER 5:.....	103
References .....	107

## LIST OF TABLES

Table 2.1: Bivariate and multivariate associations of equity factors and covariates with full utilization of the reproductive and maternal health continuum of care for the most recent birth in the past five years among Bangladeshi women. ....	26
Appendix Table 2.1: Bivariate and multivariate associations of equity factors and covariates with utilization antenatal care, skilled birth attendance and postpartum contraception for the most recent birth in the past five years among Bangladeshi women.....	30
Table 3.1: Sociodemographic, equity and reproductive health characteristics associated with maternal health service utilization in Bangladesh, 2011. ....	51
Table 3.2: Multivariate associations with maternal health services at most recent pregnancy in Bangladesh 2011 (n=7,170). ....	58
Table 3.3: Pre-pregnancy contraceptive use/antenatal care interaction in skilled birth attendance model. ....	63
Appendix Table 3.1: Bivariate associations with maternal health services at most recent pregnancy in Bangladesh 2011 (n=7,170).....	64
Table 4.1: Select background characteristics of countries included in analysis.....	90
Table 4.2: Frequency of neonatal deaths and reproductive and maternal health service utilization for most recent pregnancy in the past five years. ....	91
Table 4.3: Adjusted relationship between reproductive and maternal health continuum of care utilization and neonatal mortality, overall and stratified by neonatal mortality level. ....	92
Table 4.4: Adjusted relationship between reproductive and maternal health continuum of care utilization and neonatal mortality, overall and stratified by neonatal mortality level. ....	93
Appendix Table 4.1: Individual reproductive and maternal health service utilization frequencies for most recent pregnancy in the past five years. ....	94
Appendix Table 4.2: Unadjusted relationship between reproductive and maternal health continuum of care utilization and neonatal mortality, overall and stratified by neonatal mortality level.....	96
Appendix Table 4.3: Unadjusted relationship between reproductive and maternal health continuum of care utilization and neonatal mortality, overall and stratified by neonatal mortality level.....	97



## LIST OF FIGURES

Figure 1.1: Health services assessed along the reproductive and maternal health continuum of care .....	5
Figure 2.1: Flow of women in Bangladesh along the reproductive and maternal health continuum of care for their most recent pregnancy in the past 5 years. ....	23
Figure 2.2: Drop-offs along the reproductive and maternal health continuum of care among Bangladeshi women with a pregnancy in the past five years. ....	24
Figure 2.3: Drop-offs along the reproductive and maternal health continuum of care among Bangladeshi women with a pregnancy in the past five years, stratified by wealth quintile. ....	25
Appendix Figure 2.1: Drop-offs along the reproductive and maternal health continuum of care, with antenatal care as the entry point, among Bangladeshi women with a pregnancy in the past five years. ....	28
Appendix Figure 2.2: Drop-offs along the reproductive and maternal health continuum of care, with antenatal care as the entry point, among Bangladeshi women with a pregnancy in the past five years, stratified by wealth quintile. ....	29
Figure 3.1: Relationships assessed along the reproductive and maternal health continuum of care. ....	49
Figure 3.2: Locations/sources of health service utilization among women with a birth in the previous 5 years in Bangladesh. ....	50

## ACKNOWLEDGEMENTS

This dissertation would not have been possible without the support and mentorship of my chair, Dr. Anita Raj. Dr. Raj has worked closely with me for nearly three years, providing not only consistent and robust research training, but also encouraging my development as an independent scholar, and ensuring that I had regular professional development opportunities. She leads by example, and I consider myself fortunate to have had the opportunity to work with and learn from her. My dissertation committee has been a source of expertise and encouragement, for which I am very grateful. Dr. Melanie Rusch was an invaluable source of epidemiologic and methodological training and resources, and made a remarkable commitment to continue her mentorship of me even after leaving San Diego. Dr. Jay Silverman contributed not only expertise in maternal and child health and gender inequity, but sound professional advice. Dr. Thomas Novotny was a mentor throughout my time in the Joint Doctoral Program in Public Health (Global Health), and regularly went out of his way to ensure that I had meaningful academic and professional opportunities. Dr. Craig McIntosh provided excellent methodological insights that expand the traditional bounds within which public health research operates, as well as an emphasis on the importance of the policy implications of my work. Lastly, Dr. María Luisa Zúñiga has provided critical expertise on health services research, particularly quality of care. I would also like to thank Dr. Nancy Binkin for her invaluable expertise in maternal and child health, and for her mentorship which allowed me to be housed in academia but remain engaged in multilateral work. Finally, I thank my family, for the love, support and humor that kept me grounded throughout this process.

I have been fortunate to receive several sources of funding supporting my dissertation research. The American Association of University Women awarded me an American

Fellowship which allowed me to focus on my scholarship, research and writing over the past year. There is a paucity of pre-doctoral funding for global maternal and child health research, and the AAUW filled that critical gap for me. In addition, much of my research has been supported by generous grants from the David and Lucile Packard Foundation awarded to Dr. Anita Raj (Grants #2011-37366 and #2013-39405).

Chapter 2, in full, is currently being prepared for submission for publication of the material. McDougal, L; Binkin, N; Rusch, ML; Silverman, JG; Raj, A.: *Retention across the reproductive and maternal health continuum of care in Bangladesh: A cross-sectional analysis of survey data*. Lotus McDougal was the primary investigator and author of this material.

Chapter 3, in full, is currently being prepared for submission for publication of the material. McDougal, L; Rusch, ML; Silverman, JG; Raj, A.: *Linkages within the reproductive and maternal health continuum of care in Bangladesh 2011: A cross-sectional analysis*. Lotus McDougal was the primary investigator and author of this material.

Chapter 4, in full, is currently being prepared for submission for publication of the material. McDougal, L; Rusch, ML; Silverman, JG; Zúñiga, ML; Raj, A.: *Examining the relationship between the reproductive and maternal health continuum of care and neonatal mortality: A cross-sectional, multi-country analysis*. Lotus McDougal was the primary investigator and author of this material.

## VITA

- 2014            Doctor of Philosophy in Public Health (Global Health)  
University of California, San Diego and San Diego State University
- 2007            Masters in Public Health in International Health  
Boston University School of Public Health
- 2006            Certificate, Managing Complex Humanitarian Emergencies  
Boston University School of Public Health
- 2000            Bachelor of Arts in Biological Anthropology  
Swarthmore College

## PUBLICATIONS

1. Raj A, McDougal L, Rusch ML: Effects of young maternal age and short interpregnancy interval on infant mortality in South Asia. *Int JGynaecol Obstet* 2014, 124:86-87.
2. McDougal L, Strathdee SA, Rangel G, Martinez G, Vera A, Sirotin N, Stockman JK, Ulibarri MD, Raj A: Adverse pregnancy outcomes and sexual violence among female sex workers who inject drugs on the United States-Mexico border. *Violence Vict* 2013, 28:496-512.
3. Raj A, Vilms RJ, McDougal L, Silverman JG: Association between having no sons and using no contraception among a nationally representative sample of young wives in Nepal. *Int JGynaecol Obstet* 2013, 121:162-165.
4. McDougal L, Moteetee MM, Mohai F, Mphale M, Mahanty B, Motaung B, Ankrah V, Reynolds M, Legins K, Tiam A, Luo C, McClure C, Binkin N: Lesotho's Minimum PMTCT Package: lessons learned for combating vertical HIV transmission using co-packaged medicines. *J Int AIDS Soc* 2012, 15:17326.
5. Raj A, McDougal L, Rusch ML: Changes in prevalence of girl child marriage in South Asia. *JAMA* 2012, 307:2027-2029.
6. McDougal L, Beard J: Revisiting sphere: new standards of service delivery for new trends in protracted displacement. *Disasters* 2011, 35:87-101.

## FIELDS OF STUDY

Major Fields: Global Public Health and Epidemiology

Studies in global maternal and child health  
Professors Anita Raj, Jay Silverman and Nancy Binkin

Studies in epidemiologic theory and methods  
Professors Anita Raj, Melanie Rusch

## **ABSTRACT OF THE DISSERTATION**

Linkages to Survival:  
An Examination of the Reproductive and Maternal Health Continuum of Care

by

Lotus Padma McDougal

Doctor of Philosophy in Public Health (Global Health)

University of California, San Diego, 2014  
San Diego State University, 2014

Professor Anita Raj, Chair

**Background :** Each year, an estimated 287,000 women and 3 million newborns in low and middle income countries die of largely preventable causes. Global organizations have adopted a continuum of care model to mitigate these deaths, in which health interventions are conceptualized as a continuous stream of services. This approach remains untested in practice,

however. This research aims to explore utilization and linkages within the reproductive and maternal health continuum of care (RMH CoC), and to assess the association between this utilization and newborn deaths.

**Methods:** This analysis used Demographic and Health Survey data to assess (1) retention and inequities within the RMH CoC in Bangladesh (Chapter 2) (2) linkages between services along the RMH CoC in Bangladesh (Chapter 3) and (3) associations between RMH CoC service utilization and neonatal mortality globally (Chapter 4). Specific services analyzed included pre-pregnancy contraceptive use, antenatal care (ANC), skilled birth attendance (SBA) and postpartum contraceptive use.

**Results:** Only 6% of women reported using all four RMH CoC services assessed in Bangladesh. Inequities were clear, with women in the wealthiest quintile having a 10 times higher odds of full utilization than women in the poorest wealth quintile (aOR=10.11, 95% CI 3.82-26.77). Pre-pregnancy contraceptive use was associated with postpartum contraceptive use (aOR=1.71, 95% CI 1.47-1.98), and ANC was associated with SBA among both pre-pregnancy contraceptive users (aOR=2.76, 95% CI 2.20-3.47 for 1-3 ANC; aOR 6.84, 95% CI 5.26-8.88 for 4+ ANC) and non-users (aOR 1.99, 95% CI 1.56-2.53 for 1-3 ANC; aOR 4.30, 95% CI 3.29-5.64 for 4+ ANC). Globally, serial receipt of pre-pregnancy contraception, ANC and SBA was protective against neonatal mortality (AOR=0.61, 95% CI 0.52-0.73).

**Conclusion:** There are clear utilization gaps and pervasive inequities in the RMH CoC in Bangladesh. Linkages within reproductive and within maternal life stages are strong, but require additional support to connect with one another. The measurable neonatal survival benefit seen with the serial use of services along the RMH CoC demonstrates a need for increased attention to early adoption and retention along the continuum to leverage the greatest gains in the face of increasingly limited resources.

## **CHAPTER 1:**

### **Introduction**

#### **BACKGROUND**

Each year, an estimated 287,000 women worldwide die from pregnancy and delivery complications [1], and 7.6 million children die before their fifth birthday [2]. Over 40% of those children (3 million) die before reaching one month of age [3]. The distribution of this mortality is rank with disparities, with 98% of the burden falling in low and middle income countries. These deaths are largely preventable using interventions delivered through health services across reproductive, maternal, newborn and child life stages [4-6]. Together, these services and interventions are termed the reproductive, maternal, newborn and child health (RMNCH) continuum of care, a model supported by the World Health Organization and others, in which health interventions that have been proven effective and feasible in resource-constrained settings are conceptualized as an integrated stream of services across life stages and places of delivery [4-10]. This approach is based on a commitment to improve health systems and health services by avoiding parallel service delivery, and is particularly relevant for RMNCH because of the direct linkages between maternal and child health [5, 11-15]. In practice, however, women's utilization of this approach in the countries most affected by maternal and child mortality is not well understood.

Over the last decade, the continuum of care model has become the foundation of global RMNCH programming, supported by the World Health Organization and others [7-9, 16]. Despite this focus, there is an inadequate understanding of how women use services along the RMNCH continuum of care, and how those differences in service utilization affect health outcomes. Analyses of the RMNCH continuum of care have largely been population-



based, and have focused on predictors of utilization of specific services such as wealth or education, basic service utilization counts for children under five, or national-level coverage snapshots [10, 17-21]. No studies have directly measured the relationship between the continuum of care and neonatal mortality at the individual level.

### **REPRODUCTIVE AND MATERNAL HEALTH CONTINUUM OF CARE**

This body of work focuses on the reproductive and maternal health components of the continuum of care, as they have low coverage globally, are the least equitably distributed, and have measurable benefits for the health of women and their children [5, 17, 22-25]. The reproductive and maternal health continuum of care (RMH CoC) being assessed is outlined in Figure 1.1, and was selected to highlight health service contacts in different phases of the continuum, as well as based on data quality and availability.

If all women who wanted to delay or avoid pregnancy used modern contraceptives, it is estimated that there would be a more than 30% reduction in maternal mortality, a 10% reduction in child deaths, a 2/3 reduction in unintended pregnancies (from 75 million to 22 million) and a more than 70% decline in unsafe abortions [5, 26]. Additionally, contraceptive prevalence is a sentinel indicator for Millennium Development Goal (MDG) 5B, achieving universal access to reproductive health [27]. Proper antenatal care during pregnancy, also a sentinel indicator for Millennium Development Goal 5B, has the capacity to reduce maternal and neonatal mortality, to reduce neonatal tetanus, and prevent mother to child transmission of HIV [5, 27-29]. Skilled birth attendance, a sentinel indicator for Millennium Development Goal 5A (reducing maternal mortality by  $\frac{3}{4}$  from 1990 levels), can improve maternal survival, and can reduce stillbirths by 23-45%, as well as up to an estimated 17% of neonatal mortality [15, 23, 30]. Postnatal care, an important health service with benefits for mothers and

newborns, was not included as part of this continuum due to concerns about the validity of the indicator as currently measured [31].

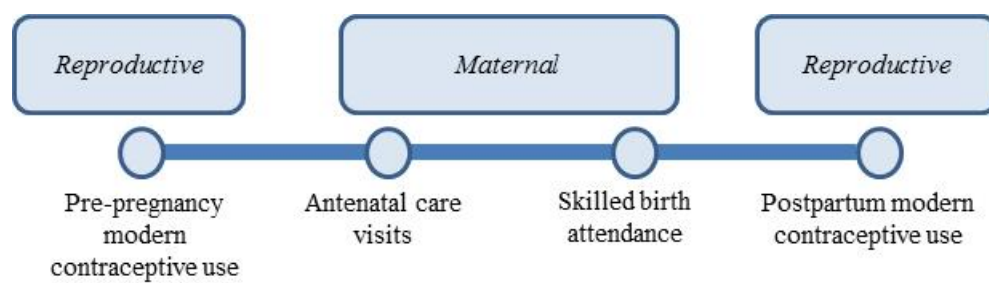
The RMH CoC may be key to reducing neonatal mortality globally, but we lack understanding of how the current continuum of care is used in nations most affected, and on the direct impact of continuum of care on neonatal mortality.

## **OVERVIEW**

This dissertation is comprised of this introductory chapter (Chapter 1), three research papers (Chapters 2-4) and a concluding chapter (Chapter 5). Paper 1 (Chapter 2), entitled “Retention across the reproductive and maternal health continuum of care in Bangladesh: A cross-sectional analysis of survey data”, is a descriptive and quantitative assessment that explores how women are utilizing the RMH CoC, as well as factors associated with full utilization along the RMH CoC. There is a particular focus on the role of equity in retention across health services. This analysis is focused on Bangladesh, a country with a history of commitment to maternal and child health, and the largest neonatal mortality reductions of any low-income country [32]. Paper 2, (Chapter 3), “Linkages within the reproductive and maternal health continuum of care in Bangladesh 2011: A cross-sectional analysis”, builds on the utilization and retention findings from Paper 1, and examines the relationship between services within the RMH CoC, specifically how early service utilization is related to subsequent service utilization. As with Chapter 2, this analysis uses Bangladesh as the country of focus. Finally, Paper 3 (Chapter 4), “Examining the relationship between the reproductive and maternal health continuum of care and neonatal mortality: A multi-country analysis”, then explores how the RMH CoC is associated with health outcomes, by measuring the association between service utilization along the RMH CoC and neonatal mortality. This

analysis assesses this relationship globally, using all Demographic and Health Surveys conducted between 2008 and 2013 with reproductive calendar data collected, comprising more than 188,000 women across 29 countries.

This body of work is designed to improve understanding of the importance of the reproductive and maternal health continuum of care, and to inform whether it is a reasonable approach with which to create public health impact. In the face of substantial underachievement on global goals for maternal and child mortality reduction [10, 33] and diminishing resources [34], a deeper and more nuanced understanding of the reproductive and maternal health continuum of care is a valuable tool with which to support policy-makers and program managers in their efforts to more strategically leverage existing knowledge, services and resources, and save the lives of women and children globally.

**FIGURES**

**Figure 1.1:** Health services assessed along the reproductive and maternal health continuum of care

## REFERENCES

1. World Health Organization, UNICEF, UNFPA and The World Bank: Trends in maternal mortality: 1990 to 2010. WHO, UNICEF, UNFPA and The World Bank estimates. Geneva: WHO; 2012.
2. Liu L, Johnson HL, Cousens S, Perin J, Scott S, Lawn JE, Rudan I, Campbell H, Cibulskis R, Li M, Mathers C, Black RE, Child Health Epidemiology Reference Group of WHO, UNICEF: Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *Lancet* 2012, 379:2151-2161.
3. UNICEF, World Health Organization, The World Bank, United Nations: Levels & Trends in Child Mortality: Report 2012. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. New York: UNICEF; 2012.
4. Bhutta ZA, Ali S, Cousens S, Ali TM, Haider BA, Rizvi A, Okong P, Bhutta SZ, Black RE: Alma-Ata: Rebirth and Revision 6 Interventions to address maternal, newborn, and child survival: what difference can integrated primary health care strategies make? *Lancet* 2008, 372:972-989.
5. World Health Organization: Packages of Interventions for Family Planning, Safe Abortion Care, Maternal, Newborn and Child Health. Geneva: WHO; 2010.
6. The Partnership for Maternal, Newborn and Child Health: Essential interventions, commodities and guidelines for reproductive, maternal, newborn and child health: A global review of the key interventions related to reproductive, maternal, newborn and child health (RMNCH). Geneva: WHO; 2011.
7. World Health Organization: World Health Report 2005: Making every mother and child count. Geneva: WHO; 2005.
8. PMNCH Fact Sheet: Enable the Continuum of care  
[[http://www.who.int/pmnch/about/continuum\\_of\\_care/en/index.html](http://www.who.int/pmnch/about/continuum_of_care/en/index.html)]
9. Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE: Continuum of care for maternal, newborn, and child health: from slogan to service delivery. *Lancet* 2007, 370:1358-1369.
10. World Health Organization and UNICEF: Countdown to 2015: Maternal, Newborn and Child Survival. Building a Future for Women and Children - The 2012 Report. Geneva: WHO; 2012.
11. Lawn JE, Tinker A, Munjanja SP, Cousens S: Where is maternal and child health now? *Lancet* 2006, 368:1474-1477.
12. Organisation for Economic Co-operation and Development: Paris Declaration on Aid Effectiveness. Paris: OECD; 2005.

13. Ronsmans C, Chowdhury ME, Dasgupta SK, Ahmed A, Koblinsky M: Effect of parent's death on child survival in rural Bangladesh: a cohort study. *Lancet* 2010, 375:2024-2031.
14. Bhutta ZA, Cabral S, Chan CW, Keenan WJ: Reducing maternal, newborn, and infant mortality globally: An integrated action agenda. *Int J Gynaecol Obstet* 2012, 119 Suppl 1:S13-17.
15. Darmstadt GL, Walker N, Lawn JE, Bhutta ZA, Haws RA, Cousens S: Saving newborn lives in Asia and Africa: cost and impact of phased scale-up of interventions within the continuum of care. *Health Policy Plan* 2008, 23:101-117.
16. The Partnership for Maternal, Newborn and Child Health: Strategic Framework 2012 to 2015. Geneva, Switzerland: PMNCH; 2011.
17. Barros AJ, Ronsmans C, Axelson H, Loaiza E, Bertoldi AD, Franca GV, Bryce J, Boerma JT, Victora CG: Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries. *Lancet* 2012, 379:1225-1233.
18. Countdown Equity Analysis G, Boerma JT, Bryce J, Kinfu Y, Axelson H, Victora CG: Mind the gap: equity and trends in coverage of maternal, newborn, and child health services in 54 Countdown countries. *Lancet* 2008, 371:1259-1267.
19. Victora CG, Barros AJ, Axelson H, Bhutta ZA, Chopra M, Franca GV, Kerber K, Kirkwood BR, Newby H, Ronsmans C, Boerma JT: How changes in coverage affect equity in maternal and child health interventions in 35 Countdown to 2015 countries: an analysis of national surveys. *Lancet* 2012.
20. Victora CG, Fenn B, Bryce J, Kirkwood BR: Co-coverage of preventive interventions and implications for child-survival strategies: evidence from national surveys. *Lancet* 2005, 366:1460-1466.
21. Ahmed S, Creanga AA, Gillespie DG, Tsui AO: Economic status, education and empowerment: implications for maternal health service utilization in developing countries. *PLoS One* 2010, 5:e11190.
22. Countdown to 2015: Accountability for maternal, newborn and child survival: The 2013 Update. Geneva: WHO and UNICEF; 2013.
23. Lassi ZS, Majeed A, Rashid S, Yakoob MY, Bhutta ZA: The interconnections between maternal and newborn health - evidence and implications for policy. *J Matern Fetal Neonatal Med* 2013, 26 Suppl 1:3-53.
24. World Health Organization: Programming strategies for Postpartum Family Planning. Geneva; 2013.
25. World Health Organization: WHO Antenatal Care Randomized Trial: Manual for the Implementation of the New Model. Geneva: DRHR/FCH/WHO; 2002.

26. Singh S, Darroch JE, Ashford LS, Vlassof M: Adding it up: The costs and benefits of investing in family planning and maternal and newborn health. Guttmacher Institute; 2009.
27. Official list of MDG indicators  
[<http://mdgs.un.org/unsd/mdg/Host.aspx?Content=Indicators/OfficialList.htm>]
28. Pervin J, Moran A, Rahman M, Razzaque A, Sibley L, Streatfield PK, Reichenbach LJ, Koblinsky M, Hruschka D, Rahman A: Association of antenatal care with facility delivery and perinatal survival - a population-based study in Bangladesh. *BMC Pregnancy Childbirth* 2012, 12:111.
29. McCurdy RJ, Kjerulff KH, Zhu J: Prenatal care associated with reduction of neonatal mortality in Sub-Saharan Africa: evidence from Demographic and Health Surveys. *Acta Obstet Gynecol Scand* 2011, 90:779-790.
30. Yakoob MY, Ali MA, Ali MU, Imdad A, Lawn JE, Van Den Broek N, Bhutta ZA: The effect of providing skilled birth attendance and emergency obstetric care in preventing stillbirths. *BMC Public Health* 2011, 11 Suppl 3:S7.
31. Moran AC, Kerber K, Sitrin D, Guenther T, Morrissey CS, Newby H, Fishel J, Yoder PS, Hill Z, Lawn JE: Measuring coverage in MNCH: indicators for global tracking of newborn care. *PLoS Med* 2013, 10:e1001415.
32. Save the Children: Surviving the First Day: State of the World's Mothers 2013. London; 2013.
33. Lozano R, Wang H, Foreman KJ, Rajaratnam JK, Naghavi M, Marcus JR, Dwyer-Lindgren L, Lofgren KT, Phillips D, Atkinson C, Lopez AD, Murray CJ: Progress towards Millennium Development Goals 4 and 5 on maternal and child mortality: an updated systematic analysis. *Lancet* 2011, 378:1139-1165.
34. Hsu J, Pitt C, Greco G, Berman P, Mills A: Countdown to 2015: changes in official development assistance to maternal, newborn, and child health in 2009-10, and assessment of progress since 2003. *Lancet* 2012.

## CHAPTER 2:

### Retention across the reproductive and maternal health continuum of care in

#### Bangladesh: A cross-sectional analysis of survey data

McDougal, L<sup>1,2</sup>; Binkin, N<sup>3</sup>; Rusch, ML<sup>4</sup>; Silverman, JG<sup>2,5</sup>; Raj, A<sup>2,5</sup>

<sup>1</sup> San Diego State University/University of California, San Diego Joint Doctoral Program in Public Health (Global Health), San Diego, CA USA

<sup>2</sup> Center on Gender Equity and Health, University of California, San Diego, San Diego, CA USA

<sup>3</sup> Graduate School of Public Health, San Diego State University, San Diego, CA USA

<sup>4</sup> Island Health, Vancouver, BC Canada

<sup>5</sup> Division of Global Public Health, University of California San Diego School of Medicine, San Diego, CA USA

#### ABSTRACT

**Background:** The continuum of care is a core principle of reproductive, maternal, newborn and child health (RMNCH) policy and programs. Although coverage of individual interventions across the continuum has been well-described, little is known about completion of the full package of recommended services. In this paper, we describe progression along the reproductive and maternal health continuum of care (RMH CoC) in Bangladesh, from pre-pregnancy contraceptive use to  $\geq 4$  antenatal care visits, skilled birth attendance and postpartum contraceptive use, and the role of equity in retention across all four services.



**Methods:** We used 2011 Bangladesh Demographic and Health Survey data to describe utilization patterns and drop-offs overall and by wealth quintile along the RMH CoC. Logistic regression was used to further examine the role of wealth status in the utilization of all four services, controlling for other key sociodemographic and reproductive health variables.

**Results:** Only 6% of women used all four services along the RMH CoC, with values ranging from 0% in the poorest quintile to 18% in the richest. The largest relative drop-off (78%) was between pre-pregnancy contraceptive use and antenatal care, with substantial differences between the poorest quintile (95%) and the richest (49%). Middle, richer and richest quintile women had significantly higher odds of full RMH CoC use compared with those in the poorest quintile (adjusted odds ratio (aOR)=3.57, 95% CI 1.38-9.26; aOR=6.03, 95% CI 2.34-15.54; aOR=10.11, 95% CI=3.82-26.77, respectively).

**Conclusion:** Full RMH CoC utilization is rare in Bangladesh, despite the country's sustained commitment to improving RMNCH. Only one fifth of pre-pregnancy contraceptive users received antenatal care. Furthermore, substantial inequities occurred in retention, with none of the poorest women receiving all four services. Efforts to improve retention and reduce barriers in transitions between reproductive and maternal health services are needed, and should include equity considerations in their implementation.

## **BACKGROUND**

The continuum of care (CoC) approach to reproductive, maternal, newborn and child health (RMNCH) is increasingly recognized as fundamental to improving the health of women and children globally [1]. The CoC views the interventions and services designed to reduce maternal and child morbidity and mortality as a continuum that spans life stages and places of service delivery (community, home, health facility) and recognizes the interrelationship between maternal and child health [1-3].

Most studies to date have focused on service-specific or composite measures of coverage of interventions along the continuum [4-6], or on the transitions between specific reproductive and maternal health services [2, 7]. These analyses have demonstrated that the coverage of individual RMNCH services is particularly poor for reproductive and maternal health (RMH) interventions, which are also the least equitably distributed [4]. A recent analysis of each of the interventions along the RMNCH CoC showed that the absolute and relative inequities in skilled birth attendance were greater than for any other intervention, followed closely by antenatal care and met need for family planning [4]. Nearly all child health interventions, by contrast, had higher coverage and were more equitably distributed than reproductive and maternal interventions [4].

Despite the considerable body of knowledge about individual interventions along the RMNCH CoC, little is known about continuity of services and the influence that wealth has on transitions from pre-conception to delivery and beyond. Although individual services by themselves produce substantial benefit in terms of RMNCH outcomes [8, 9], the maximum benefit is likely to result from receiving all the recommended interventions [2]. As has been shown in multiple studies on the prevention of mother to child transmission of HIV, individual coverage levels often disguise how few women received the full cascade of services that were

needed to prevent infection [10, 11]; such individual coverage levels also may fail to reveal the extent to which the full range of services is concentrated in those who have greater access by virtue of wealth or other factors such as education and place of residence [12].

We therefore undertook a study to examine the extent to which women complete the entire reproductive and maternal health continuum of care, from pre-pregnancy contraception to antenatal care to use of a skilled birth attendant at delivery and postpartum contraception; to identify the main points where women drop off along that continuum; and to assess the role of wealth and other key socioeconomic factors in receiving the full complement of services. Understanding such patterns and risk factors is critical to understanding the barriers to RMH CoC utilization, and consequently, to developing evidence-based solutions to mitigate low utilization.

For purposes of this analysis, we used recent data from Bangladesh, a country that has experienced the greatest reduction in newborn mortality of any low-income country (over 49% since 1990) and is on track to meet Millennium Development Goals 4 and 5 [13, 14]. While it has achieved high coverage and considerable equity in its reproductive and child health services, the same has not been true for most of the maternal health indicators, which exhibit low coverage and far less equitable distribution [4, 6, 15].

## **METHODS**

### **Sample**

The Demographic and Health Surveys (DHS) provide nationally representative samples of the population assessing demographic, health and nutrition indicators, and are available for public use [16]. For this study, we used data from the 2011 Bangladesh Demographic and Health Survey, in which households were selected using a stratified, two-

stage cluster design. A detailed questionnaire was administered to ever-married women of reproductive age who agreed to participate in individual interviews (n=17,842 women 12-49 years of age) [15]; the response rate was 98% [15].

Our study was restricted to ever-married women aged 15-49 with a live birth in the five years preceding the interview who answered questions regarding antenatal care and birth attendance for that most recent birth (n=7,306 unweighted; 7,344 weighted).

Ethical approval for this analysis was given by the Institutional Review Board at the University of California, San Diego.

### **Measures**

The four components assessed along the reproductive and maternal health continuum of care were pre-pregnancy contraceptive use,  $\geq 4$  ANC visits, skilled birth attendance and postpartum contraceptive use, all of which focused around the most recent birth in the last five years. Pre-pregnancy contraceptive use was categorized as any vs. no use of modern contraceptives prior to the most recent pregnancy. This was derived from the reproductive calendar within DHS; the time frame was between the first month of the recent pregnancy and either the beginning of the reproductive calendar (five years prior to interview) or the end of the penultimate pregnancy, whichever interval was shorter. Modern contraception included the pill, IUDs, injectables, implants, male condoms, female sterilization and male sterilization. ANC was categorized as reporting  $\geq 4$  visits (WHO-recommended minimum number [17]; at least one of which must have been with a skilled provider) vs. did not report  $\geq 4$  ANC visits (no ANC, ANC from unskilled providers only, or  $< 4$  ANC visits). Skilled antenatal care providers were defined as a qualified doctor, nurse, midwife, paramedic, family welfare visitor, community skilled birth attendant, medical assistant or sub-assistant community medical officer. Skilled birth attendance was categorized as any vs. no attendance provided by

a doctor, nurse, midwife, paramedic, family welfare visitor/assistant, or community skilled birth attendant [15, 18]. Postpartum contraceptive use was defined as any vs. no use of modern contraceptives subsequent to the most recent birth. Child health services were not assessed because of their highly equitable distribution in Bangladesh [6, 15].

The primary dependent variable was full RMH CoC utilization, defined as having reported pre-pregnancy contraceptive use,  $\geq 4$  ANC visits, skilled birth attendance and postpartum contraceptive use versus fewer than all four components.

The primary independent variable was household wealth quintile, provided by DHS, and based on a principal components analysis of household assets and housing characteristics [19]. Regression models included measures of social and gender equity (urban/rural residence, respondent and spouse's education level [none/primary/secondary or higher], decision-maker responsible for the respondent's health care [respondent/spouse/respondent and spouse jointly/other]), reproductive history (months since index birth [ $\leq 15/16-36/\geq 37$ ], respondent's age at birth of most recent child [ $\leq 17/18-24/25-34/35-49$ ], parity [ $1/2/\geq 3$ ], interpregnancy interval for most recent pregnancy [ $< 24$  months/ $\geq 24$  months or firstborn], wantedness of most recent pregnancy [yes/no], having ever terminated a pregnancy [yes/no], having ever had a child who died [yes/no]) and covariates (administrative division [Dhaka/Barisal/Chittagong/Khulna/Rajshani/Rangpur/Sylhet], religion [Muslim/non-Muslim]).

### **Analyses**

To assess utilization of services along the RMH CoC, frequencies were calculated for each of the individual reproductive and maternal health components. To more closely examine the pattern of services, a branching tree was developed that shows the number of women who had received each possible combination of the four sequential services. For each component,

percentages were calculated as a percentage of the preceding component, and as a percentage of the total.

To examine the drop-off between the sequential components along the continuum, we calculated 1) the percentage of women who had a pregnancy within the past five years but did not receive pre-pregnancy contraception; 2) those who had received pre-pregnancy contraception but not  $\geq 4$  ANC visits, 3) those who received pre-pregnancy contraception and  $\geq 4$  ANC visits but did not have skilled birth attendance; and 4) those who had pre-pregnancy contraception,  $\geq 4$  ANC visits and skilled birth attendance, but did not receive postpartum contraception. Percentages and 95% confidence intervals were calculated for all drop-offs for the whole population and stratified by wealth quintile.

Bivariate logistic regression was used to assess the relationship between the covariates, including wealth quintile, and full RMH CoC utilization. Variables that were significant at the  $p < 0.05$  level were then included in a multivariable logistic regression. No collinearity was found using a tolerance cutoff of 0.10. All analyses adjusted for survey design. Statistical calculations were performed using SAS v. 9.3.

## **RESULTS**

Of the 7,344 women in the sample, 3,495 (48%) used pre-pregnancy contraception, 1,490 (20%) received  $\geq 4$  ANC visits, 2,148 (29%) received skilled birth attendance and 5,184 (71%) used postpartum contraception. Overall, 926 women (13%) used none of the RMH CoC components, 2,352 (32%) used only one component, 2,638 (36%) used only two components, 1,019 (14%) used three components and only 408 (6%) reported utilizing all four components. The most frequently observed pattern consisted of only pre-pregnancy and postpartum

contraceptive use (23%), while the second most frequent pattern was postpartum contraceptive use alone (21%; Figure 2.1).

With respect to the full RMH CoC, the largest relative drop-off occurred between pre-pregnancy contraceptive use and ANC; of the 48% of women who received pre-pregnancy contraception, fewer than a quarter (22%) went on to receive  $\geq 4$  ANC visits (Figure 2.2). Of those who received pre-pregnancy contraception and  $\geq 4$  ANC visits, 66% went on to receive skilled birth attendance. The smallest relative drop-off was from skilled birth attendance to postpartum contraceptive use – 81% of women who reported using the first three services also reported postpartum contraceptive use (Figure 2.2).

In terms of equity, the patterns differed considerably by wealth quintile (Figure 2.3). Although the percentage of women who entered the RMH CoC was relatively similar, with 42% of the poorest quintile and 53% of the richest quintile using pre-pregnancy contraception, the percentages of women who completed the full RMH CoC ranged from 0% in the poorest to 18% in the richest quintiles. The largest relative drop-off across all quintiles was the transition from pre-pregnancy contraceptive use to  $\geq 4$  ANC visits (Figure 2.3).

While the richest quintile experienced a more gradual drop-off along the continuum, the pattern was different in the other four quintiles (Figure 2.3). In these poorer quintiles, a sharp drop occurred between pre-pregnancy contraceptive use and  $\geq 4$  ANC visits, with the percentage of women who used pre-pregnancy contraceptive and also received the recommended number of ANC visits ranging from 2% among the poorest to 13% among the second richest. These low levels of utilization dropped further between ANC and skilled birth attendance. Across all quintiles, the smallest relative drop-off was the final step in the continuum, from skilled birth attendance to postpartum contraceptive use.

Wealth quintile showed a strong dose-response relationship with full RMH CoC utilization in both bivariate and multivariate analyses (Table 2.1). After adjusting for other variables, women in the middle, richer and richest quintiles had a three to ten times higher odds of full RMH CoC utilization as compared to their counterparts in the poorest quintiles (middle aOR=3.57, 95% CI 1.38-9.26; richer aOR=6.03, 95% CI 2.34-15.54 and richest aOR=10.11, 95% CI=3.82-26.77). Other equity-related factors that were significantly and positively associated with full RMH CoC utilization in multivariate analyses included urban residence (aOR=2.30, 95% CI 1.71-3.10), education (aOR=2.17, 95% CI 1.02-4.58 for secondary or higher) and spousal education (aOR=3.22, 95% CI 1.70-6.10 for secondary or higher education). Having the respondent's husband involved in health care decision-making for the respondent also increased the odds of full CoC use, as compared with the respondent alone (spouse as decision-maker aOR=1.72, 95% CI 1.13-2.62; respondent and spouse jointly aOR=1.95, 95% CI 1.31-2.92).

A post-hoc exploratory analysis was conducted to test antenatal care as a more appropriate entry point to the continuum, since some women may have chosen not to use pre-pregnancy family planning in an effort to conceive. This analysis defined an alternate RMH CoC as  $\geq 4$  antenatal care visits, skilled birth attendance and postpartum contraception, and used the same methodology and independent variables as presented earlier for the full RMH CoC. Drop-offs along the continuum followed the same patterns both overall and stratified by wealth quintile as analyses using pre-pregnancy contraception as an entry point (Appendix Figures 2.1 and 2.2). The multivariate analysis results were also similar to those presented in Table 2.1, with women in the middle, richer and richest quintiles again being significantly more likely to report utilization of all three services than women in the poorest quintiles (aOR=2.48, 95% CI=1.30-4.74 ; aOR=4.13, 95% CI=2.18-7.82; aOR=8.32, 95% CI 4.37-



15.81, respectively; Appendix Table 2.1). All other equity factors assessed (urban/rural residence, education level, spousal education and health care decision-maker) remained positively associated with the outcome (Appendix Table 2.1).

## **DISCUSSION**

Despite high coverage of some of the interventions along the RMH CoC, fewer than one in 15 women in Bangladesh reported having received the full complement of pre-pregnancy contraception,  $\geq 4$  antenatal care visits, skilled birth attendance and postpartum contraception. Twice as many women (13%) reported using none of the four services. Contraceptive use, both pre-pregnancy and postpartum, was more commonly reported than antenatal care or birth attendance. However, less than half of the women who had given birth within the past five years reported pre-pregnancy contraception, and subsequent retention along the continuum was poor. The largest relative drop-off, both overall and across wealth quintiles, was between pre-pregnancy contraception and  $\geq 4$  ANC visits, where over three-quarters of all pre-pregnancy contraceptive users did not receive the recommended four visits. The transition from ANC to skilled birth attendance saw an additional substantial drop-off. These retention patterns were especially dramatic for the poorer quintiles.

Our study showed that the same equity factors that are predictive of coverage of individual reproductive and maternal health services in Bangladesh and elsewhere [4, 20-25] also predicted retention across the RMH CoC. Overall, women in the wealthier quintiles had a 3.6 to 10.1 times higher odds of full RMH CoC utilization than women in the poorest quintile. Living in urban areas, having secondary or higher education for women or their spouses, and having spouses involved in health care decision making were all positively associated with full retention along the RMH continuum.

While the main focus of our analysis was on the full RMH continuum of care, our findings indicated that basic retention patterns across wealth quintiles and the characteristics associated with retention along the continuum of care are consistent regardless of whether pre-pregnancy family planning or antenatal care are viewed as the entry points.

The loss of women from the cascade moving from pre-pregnancy contraceptive use to antenatal care, and the finding that over 50% of women received only pre-pregnancy and/or postpartum contraception suggests that the transition from reproductive to maternal health services is problematic in Bangladesh. Modern contraceptives are procured primarily from private pharmacies, public outreach activities and public facilities [15], while analysis of DHS data demonstrates that skilled ANC and skilled birth attendance were predominantly provided in public and private facilities. Greater efforts are needed to improve the linkages between reproductive and maternal services and inform the public of the importance of maternal health services in improving the health of women and their infants. Proximity to health facilities, an important factor in accessing health services, does not appear to be a major barrier in Bangladesh, as over 98% of women in our sample reported having a health facility within two kilometers of their village.

Women in the poorest two quintiles who used pre-pregnancy contraception experienced the greatest drop-offs between pre-pregnancy contraception and ANC and subsequently between ANC and skilled birth attendance, which suggests that cost barriers around utilization of facility-based services may play a role in retention along the RMH CoC. While maternal health services offered in government facilities in Bangladesh are ostensibly free, there are additional fees appended that may present substantial financial barriers [26, 27]. Identification and mitigation of these extra costs may be one opportunity to reduce the equity gap documented in this analysis. A pilot voucher program to address these concerns was

launched in 2007, which subsidizes fees and transportation costs for services; initial results are positive [28, 29]. A separate initiative, first piloted in 2006, is also working to improve access and reduce inequities within Bangladesh by making antenatal care and other RMNCH services more outreach-based for rural women [24]. Further examination of these and other options designed to increase early engagement and maximize retention across the continuum of care is required.

Examination of service utilization along the RMNCH continuum of care has largely focused on intervention-specific and composite measures of coverage, highlighted through the work of Countdown to 2015 [4, 6]. While this methodology is a valuable means of estimating national-level aggregated measures of service utilization, we believe that our approach of looking at retention along the cascade at the individual level affords a useful, and complementary, means of assessing continuity along the continuum. Such an approach has proven highly useful in the HIV arena, particularly in prevention of mother to child transmission of HIV, where the “PMTCT cascade” is a focal point of intervention and evaluation [10, 11, 30]. The quantification of drop-offs along the PMTCT cascade and measurement of impact on health outcomes created broad agreement on the need to monitor each step along the cascade and improve health system performance, including through innovative outreach mechanisms [10, 12, 30]. This same approach would greatly benefit efforts to further lower maternal and neonatal mortality.

There are several important limitations to this analysis. DHS data are gathered through self-report, and there is potential susceptibility to social desirability bias and recall bias, which might differ by socio-demographic status, although the use of data surrounding only the most recent pregnancy is designed to reduce the latter. In addition, data were not uniformly available on quality of services, an important component of health service utilization. Finally,

the structure of DHS questionnaires make it difficult to distinguish between access to versus demand for the measures of utilization assessed in this analysis, a constraint which limits interpretation. However, the high availability of local health facilities, and large percentage of outreach-based contraceptive distribution in Bangladesh suggest that that pre-pregnancy and postpartum contraceptive use may more reflective of demand than access.

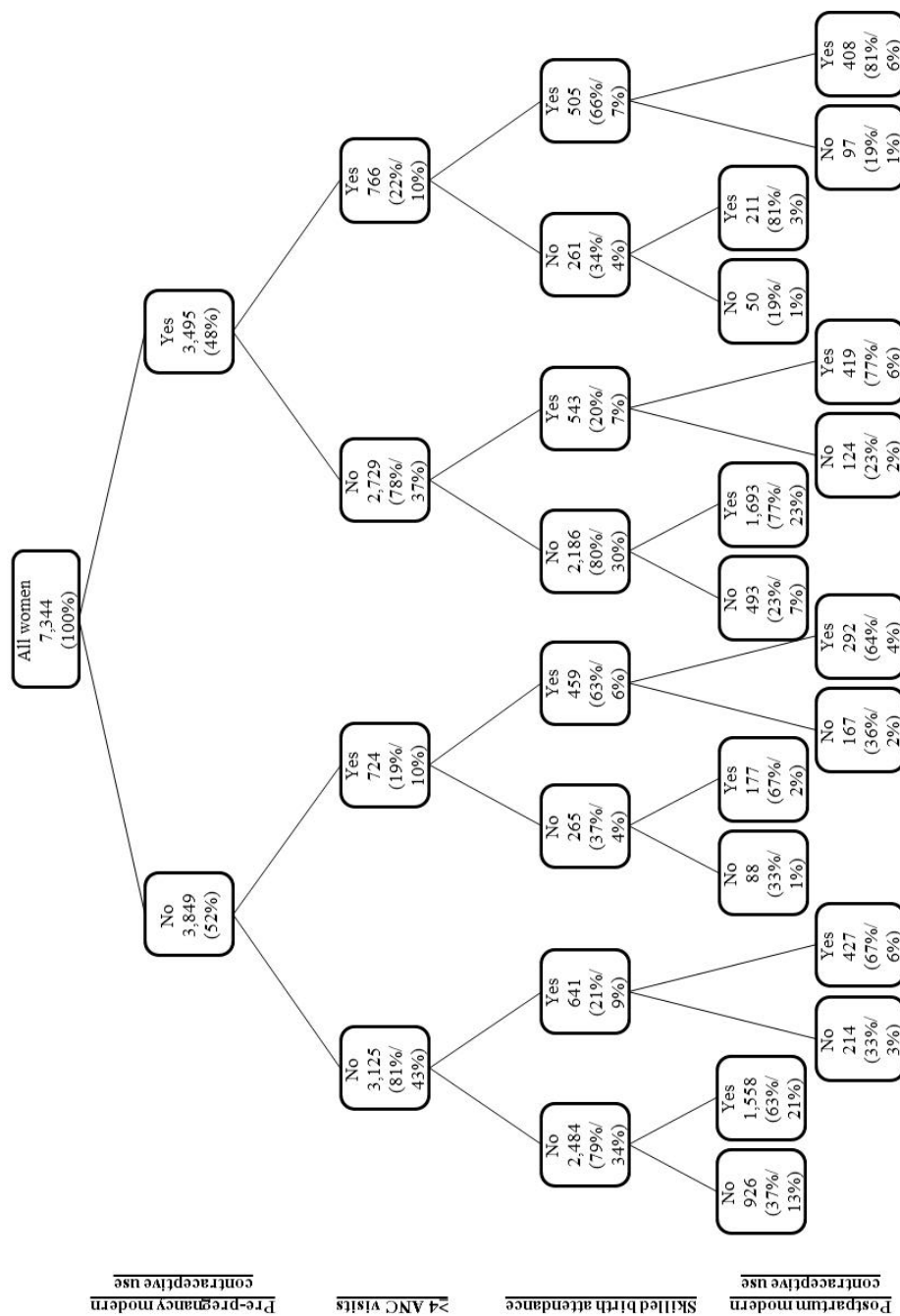
Our study documents very low utilization of the full reproductive and maternal health continuum of care in Bangladesh, and great inequities within that utilization. These results highlight the major gaps in utilization of the reproductive and maternal health care continuum of care in Bangladesh, which are likely to be even greater in countries experiencing higher rates of maternal and neonatal mortality, and suggest that greater emphasis is needed to improve retention across the continuum, to mitigate existing inequities, and to improve linkages between reproductive and maternal health services. There is a need for further studies of retention along the continuum of care, as well as the identification of methods of improving uptake and sustained engagement along the entire reproductive and maternal continuum of care.

**ACKNOWLEDGEMENTS**

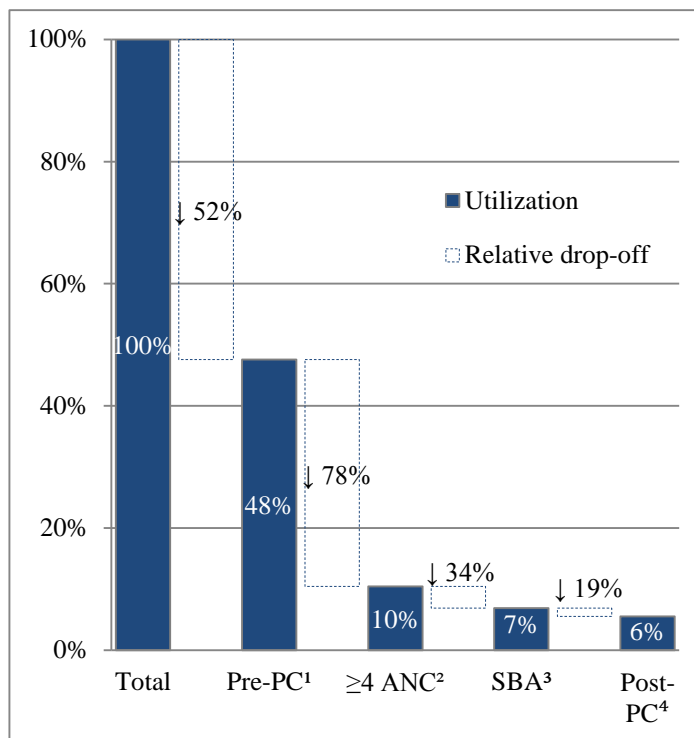
This analysis was supported by a grant from the David and Lucile Packard Foundation (Grant #2011-37366) and an American Fellowship from AAUW.

Chapter 2, in full, is currently being prepared for submission for publication of the material. McDougal, L; Binkin, N; Rusch, ML; Silverman, JG; Raj, A.: *Retention across the reproductive and maternal health continuum of care in Bangladesh: A cross-sectional analysis of survey data*. Lotus McDougal was the primary investigator and author of this material.

FIGURES



**Figure 2.1:** Flow of women in Bangladesh along the reproductive and maternal health continuum of care for their most recent pregnancy in the past 5 years.  
*Note:* Boxes show weighted numbers and row percentages/percentages of the total. Pre-pregnancy modern contraceptive use indicates use within the last five years and prior to the most recent pregnancy. ≥4 ANC visits indicates ≥4 antenatal care visits for most recent pregnancy, at least one of which was skilled. Skilled birth attendance is for most recent pregnancy. Postpartum modern contraceptive use indicates use subsequent to most recent pregnancy.



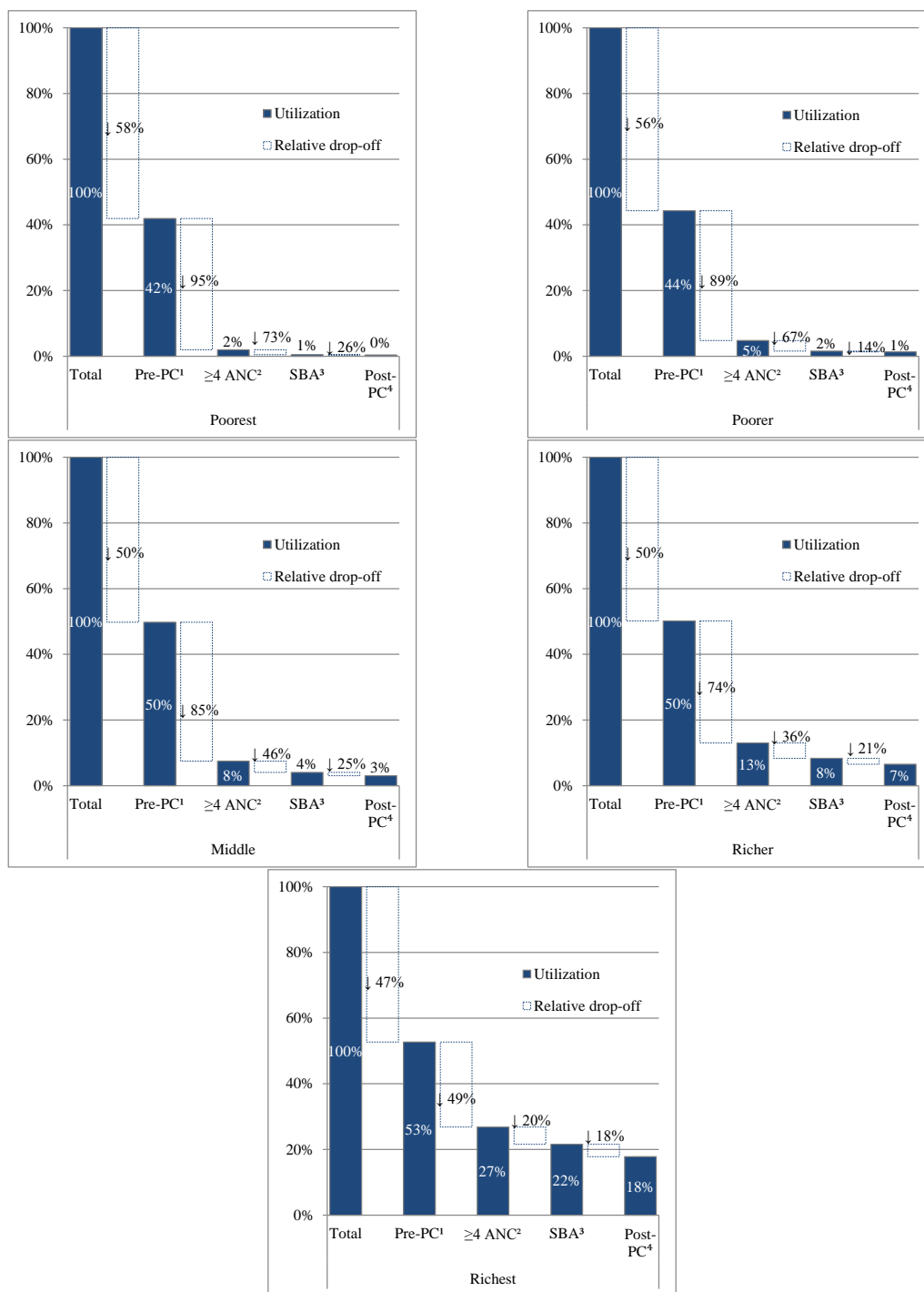
**Figure 2.2:** Drop-offs along the reproductive and maternal health continuum of care among Bangladeshi women with a pregnancy in the past five years.

<sup>1</sup> Pre-pregnancy contraceptive use.

<sup>2</sup> ≥4 ANC visits at least one of which was skilled, among pre-pregnancy contraceptive users

<sup>3</sup> Skilled birth attendance, among pre-pregnancy contraceptive and ANC users.

<sup>4</sup> Postpartum contraceptive use, among pre-pregnancy contraceptive, ANC and skilled birth attendance users.



**Figure 2.3:** Drop-offs along the reproductive and maternal health continuum of care among Bangladeshi women with a pregnancy in the past five years, stratified by wealth quintile.

<sup>1</sup> Pre-pregnancy contraceptive use.

<sup>2</sup> ≥4 ANC visits at least one of which was skilled, among pre-pregnancy contraceptive users.

<sup>3</sup> Skilled birth attendance, among pre-pregnancy contraceptive and ANC users.

<sup>4</sup> Postpartum contraceptive use, among pre-pregnancy contraceptive, ANC and skilled birth attendance users.



## TABLES

**Table 2.1:** Bivariate and multivariate associations of equity factors and covariates with full utilization of the reproductive and maternal health continuum of care for the most recent birth in the past five years among Bangladeshi women.

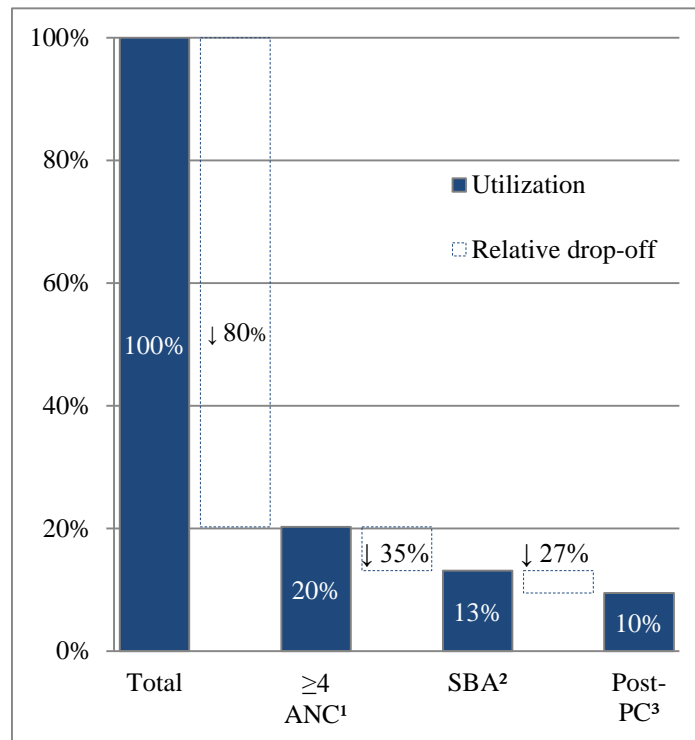
	OR (95% CI)	p value	Adjusted OR (95% CI)*	p value
<b>Equity</b>				
Household wealth quintile				
Poorest	1.00	-	1.00	-
Poorer	3.47 (1.28, 9.46)	0.015	2.27 (0.81, 6.36)	0.121
Middle	7.96 (3.23, 19.60)	<0.0001	3.57 (1.38, 9.26)	0.009
Richer	17.80 (7.29, 43.43)	<0.0001	6.03 (2.34, 15.54)	0.0002
Richest	54.91 (22.71, 132.76)	<0.0001	10.11 (3.82, 26.77)	<0.0001
Type of residence				
Rural	1.00	-	1.00	-
Urban	5.32 (4.04, 7.00)	<0.0001	2.30 (1.71, 3.10)	<0.0001
Education level				
None	1.00	-	1.00	-
Primary	1.24 (0.61, 2.51)	0.557	0.82 (0.38, 1.78)	0.615
Secondary or higher	9.07 (4.78, 17.21)	<0.0001	2.17 (1.02, 4.58)	0.043
Spousal education level				
None	1.00	-	1.00	-
Primary	2.39 (1.33, 4.30)	0.004	1.30 (0.68, 2.48)	0.435
Secondary or higher	13.98 (8.25, 23.72)	<0.0001	3.22 (1.70, 6.10)	0.0003
Decision-maker for respondent's health care				
Respondent	1.00	-	1.00	-
Spouse	1.13 (0.76, 1.69)	0.545	1.72 (1.13, 2.62)	0.012
Respondent/ spouse jointly	1.79 (1.24, 2.60)	0.002	1.95 (1.31, 2.92)	0.001
Other	0.79 (0.44, 1.40)	0.416	0.90 (0.47, 1.70)	0.735
<b>Reproductive health</b>				
Months since most recent pregnancy				
≤15	1.31 (0.96, 1.77)	0.746	1.42 (1.03, 1.97)	0.035
16-36	1.57 (1.18, 2.10)	0.007	1.75 (1.30, 2.36)	0.0003
≥37	1.00	-	1.00	-
Age at child's birth (years)				
≤17	0.67 (0.33, 1.38)	0.280	0.43 (0.17, 1.07)	0.068
18-24	1.07 (0.57, 2.01)	0.838	0.64 (0.28, 1.45)	0.283
25-34	1.59 (0.87, 2.93)	0.134	1.00 (0.48, 2.04)	0.989
35-49	1.00	-	1.00	-
Parity				
1	2.01 (1.44, 2.80)	<0.0001	1.29 (0.79, 2.09)	0.308
2	1.98 (1.43, 2.75)	<0.0001	1.22 (0.80, 1.85)	0.352
3+	1.00	-	1.00	-

**Table 2.1:** continued

	OR (95% CI)	p value	Adjusted OR (95% CI)*	p value
<b>Interpregnancy interval</b>				
<24 months	1.00	-	1.00	-
≥24 months or firstborn	2.61 (1.42, 4.79)	0.002	1.56 (0.80, 3.01)	0.189
<b>Most recent pregnancy wanted</b>				
No	1.00	-	-	-
Yes	1.03 (0.80, 1.33)	0.803	-	-
<b>Ever had a terminated pregnancy</b>				
No	1.00	-	1.00	-
Yes	1.42 (1.10, 1.82)	0.007	1.29 (0.95, 1.76)	0.102
<b>Ever had a child who died</b>				
No	1.94 (1.28, 2.93)	0.002	0.85 (0.50, 1.44)	0.539
Yes	1.00	-	1.00	-
<b>Covariates</b>				
<b>Administrative division</b>				
Dhaka	1.00	-	1.00	-
Barisal	0.68 (0.43, 1.06)	0.085	1.23 (0.79, 1.92)	0.352
Chittagong	0.63 (0.43, 0.94)	0.022	0.84 (0.57, 1.24)	0.373
Khulna	1.17 (0.81, 1.70)	0.411	1.45 (0.98, 2.16)	0.065
Rajshani	0.58 (0.36, 0.93)	0.025	0.99 (0.61, 1.61)	0.972
Rangpur	0.65 (0.42, 0.999)	0.049	1.46 (0.92, 2.30)	0.109
Sylhet	0.34 (0.21, 0.55)	<0.0001	0.51 (0.32, 0.83)	0.007
<b>Religion</b>				
Muslim	1.00	-	-	-
Non-Muslim	1.33 (0.93, 1.91)	0.118	-	-

\*Adjusted for all variables reaching  $p < 0.05$  significance in bivariate associations.

## APPENDIX

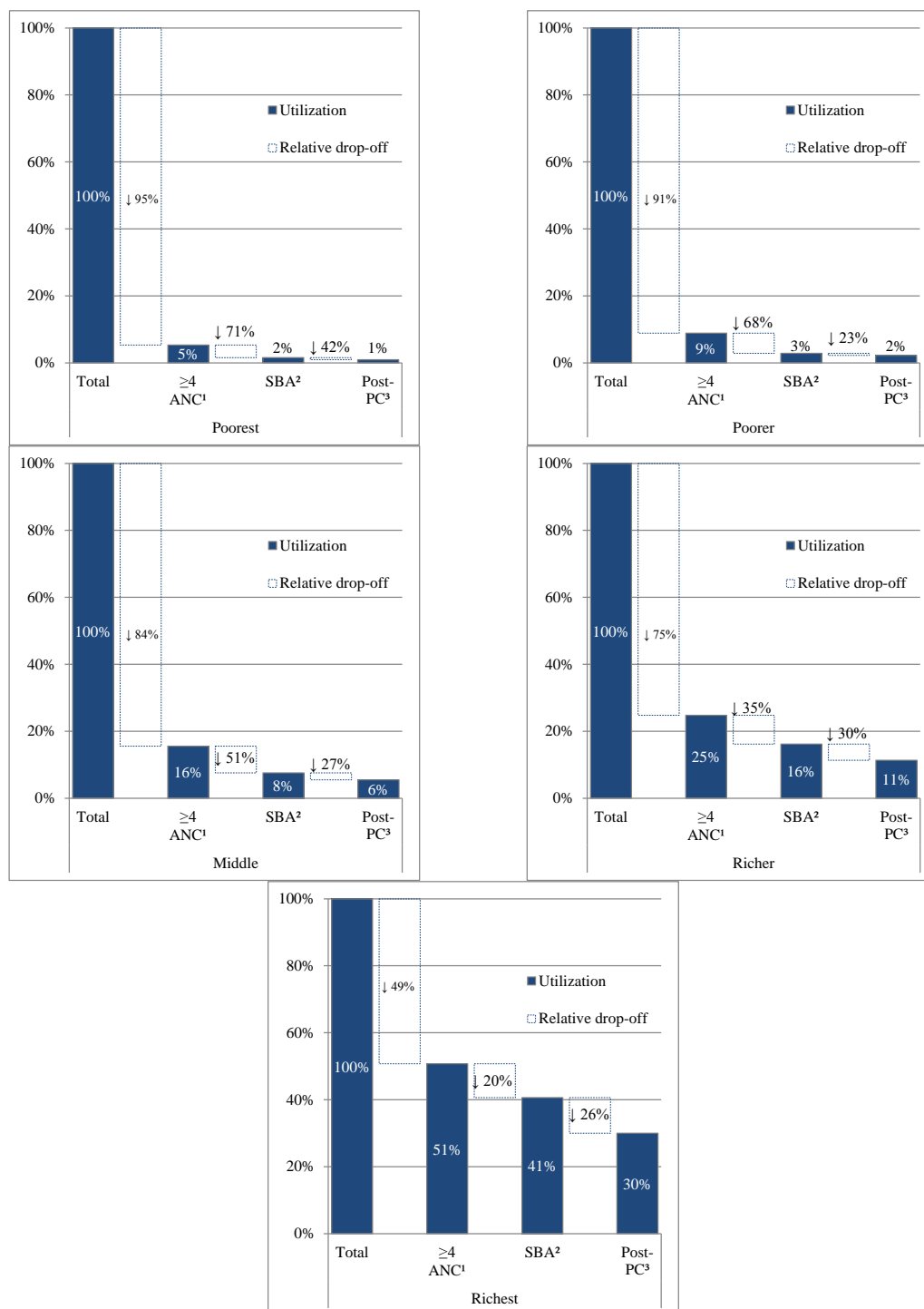


**Appendix Figure 2.1:** Drop-offs along the reproductive and maternal health continuum of care, with antenatal care as the entry point, among Bangladeshi women with a pregnancy in the past five years.

<sup>1</sup> ≥4 ANC visits at least one of which was skilled

<sup>2</sup> Skilled birth attendance, among ANC users.

<sup>3</sup> Postpartum contraceptive use, among ANC and skilled birth attendance users.



**Appendix Figure 2.2:** Drop-offs along the reproductive and maternal health continuum of care, with antenatal care as the entry point, among Bangladeshi women with a pregnancy in the past five years, stratified by wealth quintile.

<sup>1</sup> ≥4 ANC visits at least one of which was skilled

<sup>2</sup> Skilled birth attendance, among ANC users.

<sup>3</sup> Postpartum contraceptive use, among ANC and skilled birth attendance users.

**Appendix Table 2.1:** Bivariate and multivariate associations of equity factors and covariates with utilization antenatal care, skilled birth attendance and postpartum contraception for the most recent birth in the past five years among Bangladeshi women.

	OR (95% CI)	p value	Adjusted OR (95% CI)*	p value
<b>Equity</b>				
Household wealth quintile				
Poorest	1.00	-	1.00	-
Poorer	2.47 (1.26, 4.81)	0.008	1.42 (0.71, 2.84)	0.322
Middle	6.32 (3.45, 11.59)	<0.0001	2.48 (1.30, 4.74)	0.006
Richer	13.85 (7.77, 24.68)	<0.0001	4.13 (2.18, 7.82)	<0.0001
Richest	46.58 (26.49, 81.90)	<0.0001	8.32 (4.37, 15.81)	<0.0001
Type of residence				
Rural	1.00	-	1.00	-
Urban	5.21 (4.14, 6.56)	<0.0001	2.31 (1.80, 2.96)	<0.0001
Education level				
None	1.00	-	1.00	-
Primary	1.95 (1.06, 3.60)	0.033	1.37 (0.71, 2.67)	0.349
Secondary or higher	14.43 (8.08, 25.78)	<0.0001	3.66 (1.90, 7.05)	0.0001
Spousal education level				
None	1.00	-	1.00	-
Primary	2.68 (1.72, 4.18)	<0.0001	1.22 (0.76, 1.95)	0.405
Secondary or higher	14.31 (9.64, 21.23)	<0.0001	2.62 (1.66, 4.14)	<0.0001
Decision-maker for respondent's health care				
Respondent	1.00	-	1.00	-
Spouse	0.98 (0.71, 1.37)	0.921	1.47 (1.02, 2.13)	0.040
Respondent/ spouse jointly	1.47 (1.10, 1.98)	0.011	1.67 (1.19, 2.34)	0.003
Other	1.15 (0.74, 1.77)	0.541	1.16 (0.69, 1.94)	0.584
<b>Reproductive health</b>				
Months since most recent pregnancy				
≤15	0.85 (0.67, 1.08)	0.076	-	-
16-36	1.04 (0.83, 1.30)	0.215	-	-
≥37	1.00	-	-	-
Age at child's birth (years)				
≤17	1.43 (0.83, 2.46)	0.200	0.50 (0.24, 1.04)	0.062
18-24	1.43 (0.84, 2.42)	0.190	0.56 (0.28, 1.11)	0.096
25-34	1.79 (1.07, 2.99)	0.027	0.94 (0.50, 1.77)	0.851
35-49	1.00	-	1.00	-
Parity				
1	3.44 (2.67, 4.42)	<0.0001	2.66 (1.81, 3.89)	<0.0001
2	2.16 (1.64, 2.86)	<0.0001	1.45 (1.02, 2.07)	0.039
3+	1.00	-	1.00	-
Interpregnancy interval				
<24 months	1.00	-	1.00	-
≥24 months or firstborn	2.18 (1.42, 3.35)	0.0004	1.03 (0.62, 1.69)	0.921

Appendix Table 2.1: continued

	OR (95% CI)	p value	Adjusted OR (95% CI)*	p value
Most recent pregnancy wanted				
No	1.00	-	1.00	-
Yes	2.18 (1.42, 3.35)	<0.0001	0.94 (0.75, 1.18)	0.586
Ever had a terminated pregnancy				
No	1.00	-	1.00	-
Yes	1.33 (1.08, 1.63)	0.008	1.44 (1.12, 1.85)	0.005
Ever had a child who died				
No	2.29 (1.64, 3.20)	<0.0001	0.73 (0.47, 1.12)	0.143
Yes	1.00	-	1.00	-
<b>Covariates</b>				
Administrative division				
Dhaka	1.00	-	1.00	-
Barisal	0.70 (0.46, 1.04)	0.079	1.29 (0.85, 1.95)	0.242
Chittagong	0.70 (0.49, 0.998)	0.049	0.93 (0.65, 1.33)	0.698
Khulna	1.06 (0.77, 1.46)	0.731	1.23 (0.88, 1.71)	0.232
Rajshani	0.73 (0.52, 1.01)	0.060	1.37 (0.97, 1.93)	0.077
Rangpur	0.65 (0.46, 0.92)	0.014	1.42 (0.97, 2.07)	0.070
Sylhet	0.47 (0.32, 0.69)	0.0001	0.75 (0.52, 1.07)	0.110
Religion				
Muslim	1.00	-	1.00	-
Non-Muslim	1.78 (1.34, 2.36)	<0.0001	1.61 (1.21, 2.13)	0.001

\*Adjusted for all variables reaching  $p < 0.05$  significance in bivariate associations.

## REFERENCES

1. Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE: Continuum of care for maternal, newborn, and child health: from slogan to service delivery. *Lancet* 2007, 370:1358-1369.
2. Lassi ZS, Majeed A, Rashid S, Yakoob MY, Bhutta ZA: The interconnections between maternal and newborn health - evidence and implications for policy. *J Matern Fetal Neonatal Med* 2013, 26 Suppl 1:3-53.
3. Bhutta ZA, Lassi ZS, Blanc A, Donnay F: Linkages among reproductive health, maternal health, and perinatal outcomes. *Semin Perinatol* 2010, 34:434-445.
4. Barros AJ, Ronsmans C, Axelson H, Loaiza E, Bertoldi AD, Franca GV, Bryce J, Boerma JT, Victora CG: Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries. *Lancet* 2012, 379:1225-1233.
5. Victora CG, Barros AJ, Axelson H, Bhutta ZA, Chopra M, Franca GV, Kerber K, Kirkwood BR, Newby H, Ronsmans C, Boerma JT: How changes in coverage affect equity in maternal and child health interventions in 35 Countdown to 2015 countries: an analysis of national surveys. *Lancet* 2012.
6. Countdown to 2015: Accountability for maternal, newborn and child survival: The 2013 Update. Geneva: WHO and UNICEF; 2013.
7. Do M, Hotchkiss D: Relationships between antenatal and postnatal care and post-partum modern contraceptive use: evidence from population surveys in Kenya and Zambia. *BMC Health Serv Res* 2013, 13:6.
8. World Health Organization: Packages of Interventions for Family Planning, Safe Abortion Care, Maternal, Newborn and Child Health. Geneva: WHO; 2010.
9. Bhutta ZA, Cabral S, Chan CW, Keenan WJ: Reducing maternal, newborn, and infant mortality globally: An integrated action agenda. *Int JGynaecol Obstet* 2012, 119 Suppl 1:S13-17.
10. Barker PM, Mphatswe W, Rollins N: Antiretroviral drugs in the cupboard are not enough: the impact of health systems' performance on mother-to-child transmission of HIV. *J Acquir Immune Defic Syndr* 2011, 56:e45-48.
11. Stringer EM, Chi BH, Chintu N, Creek TL, Ekouevi DK, Coetzee D, Tih P, Boulle A, Dabis F, Shaffer N, Wilfert CM, Stringer JS: Monitoring effectiveness of programmes to prevent mother-to-child HIV transmission in lower-income countries. *Bull World Health Organ* 2008, 86:57-62.
12. Tudor Car L, Brusamento S, Elmoniry H, van Velthoven MH, Pape UJ, Welch V, Tugwell P, Majeed A, Rudan I, Car J, Atun R: The uptake of integrated perinatal

prevention of mother-to-child HIV transmission programs in low- and middle-income countries: a systematic review. *PLoS One* 2013, 8:e56550.

13. Save the Children: *Surviving the First Day: State of the World's Mothers 2013*. London; 2013.
14. World Health Organization and UNICEF: *Countdown to 2015: Maternal, Newborn and Child Survival. Building a Future for Women and Children - The 2012 Report*. Geneva: WHO; 2012.
15. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International: *Bangladesh Demographic and Health Survey 2011*. Dhaka, Bangladesh and Calverton, Maryland, USA: National Institute of Population Research and Training, Mitra and Associates, and ICF International; 2013.
16. DHS Overview [<http://www.measuredhs.com/What-We-Do/Survey-Types/DHS.cfm>]
17. World Health Organization: *WHO Antenatal Care Randomized Trial: Manual for the Implementation of the New Model*. Geneva: DRHR/FCH/WHO; 2002.
18. World Health Organization, International Confederation of Midwives, International Federation of Gynecology and Obstetrics: *Making pregnancy safer: the critical role of the skilled attendant. A joint statement by WHO, ICM and FIGO*. Geneva; 2004.
19. Rutstein S, Johnson K: *The DHS Wealth Index*. Calverton, Maryland: ORC Macro; 2004.
20. Titaley CR, Dibley MJ, Roberts CL: Factors associated with underutilization of antenatal care services in Indonesia: results of Indonesia Demographic and Health Survey 2002/2003 and 2007. *BMC Public Health* 2010, 10:485.
21. Ahmed S, Creanga AA, Gillespie DG, Tsui AO: Economic status, education and empowerment: implications for maternal health service utilization in developing countries. *PLoS One* 2010, 5:e11190.
22. Khan MM, Kramer A, Khandoker A, Pruffer-Kramer L, Islam A: Trends in sociodemographic and health-related indicators in Bangladesh, 1993-2007: will inequities persist? *Bull World Health Organ* 2011, 89:583-593.
23. Countdown Equity Analysis G, Boerma JT, Bryce J, Kinfa Y, Axelson H, Victora CG: Mind the gap: equity and trends in coverage of maternal, newborn, and child health services in 54 Countdown countries. *Lancet* 2008, 371:1259-1267.
24. Quayyum Z, Khan MN, Quayyum T, Nasreen HE, Chowdhury M, Ensor T: "Can community level interventions have an impact on equity and utilization of maternal health care" - evidence from rural Bangladesh. *International journal for equity in health* 2013, 12:22.



25. Simkhada B, Teijlingen ER, Porter M, Simkhada P: Factors affecting the utilization of antenatal care in developing countries: systematic review of the literature. *J Adv Nurs* 2008, 61:244-260.
26. Nahar S, Costello A: The hidden cost of 'free' maternity care in Dhaka, Bangladesh. *Health Policy Plan* 1998, 13:417-422.
27. National Institute of Population Research and Training (NIPORT), Mitra and Associates, Macro International: Bangladesh Demographic and Health Survey 2007. Dhaka, Bangladesh and Calverton, Maryland, USA: National Institute of Population Research and Training, Mitra and Associates, and Macro International; 2009.
28. Nguyen HT, Hatt L, Islam M, Sloan NL, Chowdhury J, Schmidt JO, Hossain A, Wang H: Encouraging maternal health service utilization: an evaluation of the Bangladesh voucher program. *Soc Sci Med* 2012, 74:989-996.
29. Ahmed S, Khan MM: Is demand-side financing equity enhancing? Lessons from a maternal health voucher scheme in Bangladesh. *Soc Sci Med* 2011, 72:1704-1710.
30. Chi BH, Adler MR, Bolu O, Mbori-Ngacha D, Ekouevi DK, Gieselman A, Chipato T, Luo C, Phelps BR, McClure C, Mofenson LM, Stringer JS: Progress, challenges, and new opportunities for the prevention of mother-to-child transmission of HIV under the US President's Emergency Plan for AIDS Relief. *J Acquir Immune Defic Syndr* 2012, 60 Suppl 3:S78-87.

## CHAPTER 3:

### Linkages within the reproductive and maternal health continuum of care in Bangladesh 2011: A cross-sectional analysis

McDougal, L<sup>1,2</sup>; Rusch, ML<sup>3</sup>; Silverman, JG<sup>2,4</sup>; Raj, A<sup>2,4</sup>

<sup>1</sup> San Diego State University/University of California, San Diego Joint Doctoral Program in Public Health (Global Health), San Diego, CA USA

<sup>2</sup> Center on Gender Equity and Health, University of California, San Diego, San Diego, CA USA

<sup>3</sup> Island Health, Vancouver, BC Canada

<sup>4</sup> Division of Global Public Health, University of California San Diego School of Medicine, San Diego, CA USA

#### ABSTRACT

**Background:** The continuum of care is a fundamental approach to reproductive, maternal, newborn and child health policy and programs. However, linkages across services along the continuum of care are inadequately understood, which hinders targeted efforts to increase coverage. This paper aims to assess linkages in reproductive and maternal health services in Bangladesh, a country with demonstrated commitment to women's health, but low coverage of key services.

**Methods:** This study uses data from 15-49 year old women with a birth in the 5 years prior to interview from the 2011 Bangladesh Demographic and Health Survey (n=7,170). Three

logistic regression models were used to examine relationships within the reproductive and maternal health continuum of care. The first model assessed the association of pre-pregnancy contraceptive use with skilled antenatal care (ANC), the second model assessed the associations of pre-pregnancy contraceptive use and ANC with skilled birth attendance (SBA), and the third model assessed the associations of pre-pregnancy contraceptive use, ANC and SBA with postpartum modern contraceptive use.

**Results:** Pre-pregnancy contraceptive use increased the odds of ANC (1-3 visits aOR=1.27, 95% CI=1.10-1.47; 4+ visits aOR=1.28, 95% CI=1.06-1.55). ANC was positively associated with SBA among both pre-pregnancy contraceptive users (aOR 2.76, 95% CI 2.20-3.47 for 1-3 ANC; aOR 6.84, 95% CI 5.26-8.88 for 4+ ANC) and non-users (aOR 1.99, 95% CI 1.56-2.53 for 1-3 ANC; aOR 4.30, 95% CI 3.29-5.64 for 4+ ANC). Among women who used pre-pregnancy contraceptives but did not receive skilled ANC, there was a 26% decreased odds of SBA (95% CI 0.57-0.96). Pre-pregnancy contraceptive use increased the odds of postpartum contraceptive use (aOR=1.71, 95% CI=1.47-1.98), but neither ANC nor SBA was associated with postpartum contraceptive use.

**Conclusions:** There are clear linkages within maternal health services and within reproductive health services, but linkages across life stages were variable. Removing barriers to women accessing health services early in their reproductive life cycles, and addressing barriers in the transitions between reproductive and maternal health care will facilitate sustained and repeated engagement along the CoC, which has measurable health benefits for women and their children.

## **BACKGROUND**

In 2011, more than 273,000 women and 2.9 million children under the age of one month died, due to largely preventable causes [1-3]. The continuum of care, an approach in which health services and interventions are viewed as an integrated stream across life stages and service delivery modalities, is increasingly endorsed as a means of reducing these deaths, and improving the health of women and their children [4-7]. Consequently, there have been multiple calls for increased coverage of services along the continuum of care, as well as estimates of the health benefits available through improved utilization [8-12].

Globally, reproductive and maternal health services have low coverage, and are more inequitably distributed than child health services, despite their demonstrated health benefits [5, 13-15]. One important aspect of improving coverage of the services necessary to improve reproductive and maternal health is understanding the linkages between the health services contained within that portion of the continuum of care. Unfortunately, the linkages between reproductive and maternal health services within the context of the reproductive and maternal health continuum of care (RMH CoC) are inadequately understood, particularly, how utilization of services earlier in the continuum is associated with subsequent service utilization [5, 16].

This paper examines the issues of linkages in Bangladesh, a country which is on track towards achieving Millennium Development Goals 4 and 5 ( $\frac{2}{3}$  reduction in child mortality and  $\frac{3}{4}$  reduction in maternal mortality from 1990 levels by 2015, respectively), and has a history of government commitment towards improving reproductive and maternal health through policy change and innovative programs [17-20]. Despite these achievements, coverage of many key maternal health services is low: only 26% of pregnant women in Bangladesh receive the WHO-recommended 4 or more antenatal care (ANC) visits, 29% of

women deliver in a health facility, and 32% of deliveries are supervised by a skilled birth attendant [21]. Contraceptive use is higher, with 52% of currently married women using a modern method, and 14% unmet need (a measure of women who do not want to become pregnant but are not using contraception) [21]. It is unclear, however, how much overlap there is across these coverage statistics, in other words, how many women are accessing these services in serial, and whether utilization of one or more services affects subsequent service utilization.

Identifying linkages between health services along the RMH CoC will not only improve understanding of the underlying mechanisms of utilization within the RMH CoC, but will identify potentially important entry points that facilitate subsequent utilization, thus informing an evidence-based approach to increasing health service utilization in reproductive and maternal health policy and implementation. The goal of this paper, therefore, is to assess how four key services (pre-pregnancy contraceptive use, antenatal care, skilled birth attendance and post-pregnancy contraceptive use) along the reproductive and maternal health continuum of care are related to each other among women living in Bangladesh.

## **METHODS**

### **Sample**

This sample is drawn from the 2011 Bangladesh Demographic and Health Survey, a nationally representative survey assessing population health, nutrition and service utilization. Ever-married women aged 12-49 living in selected households were eligible to participate; the response rate was 98% [21]. This analysis was limited to ever-married women aged 15-49 who had a birth between six months and five years prior to interview. The World Health Organization has identified six months as the window beyond which all women who wish to

use postpartum family planning should be using a method other than lactational amenorrhea [14]. The sample was further restricted to subjects with data available for all dependent and independent variables (n=7,170). The data used in this analysis were de-identified and publicly available.

## **Measures**

Four measures along the RMH CoC were assessed: pre-pregnancy contraceptive use (none/any), ANC visits, skilled birth attendance (no/yes) and postpartum contraceptive use (none/any), all as measured for the most recent birth in the last 5 years. To assess differences by level of ANC receipt, ANC was categorized as no ANC /no skilled ANC (zero visits or visits with only unskilled providers), 1-3 visits (at least one of which must have been with a skilled provider), and 4+ visits (WHO-recommended minimum number [15]; at least one of which must have been with a skilled provider). Skilled antenatal care providers included doctors, nurses, midwives, paramedics, family welfare visitors, community skilled birth attendants, medical assistants or sub-assistant community medical officers. Skilled birth attendants included doctors, nurses, midwives, paramedics, family welfare visitors/assistants, or community skilled birth attendants [21, 22]. Modern contraception included the pill, IUDs, injectables, implants, male condoms, female sterilization and male sterilization. Pre-pregnancy contraceptive use was defined as any use of modern contraception prior to the most recent pregnancy resulting in a birth but within the past 5 years, or prior to the most recent birth and subsequent to the second most recent birth, whichever window was shorter. Postpartum contraceptive use was defined as any use of modern contraceptives between the most recent birth and interview. Timing of contraceptive use was derived from the reproductive calendar collected by Measure DHS.

To assess linkages within the RMH CoC, three models were constructed, with ANC, SBA and postpartum contraceptive use as dependent variables. The primary independent variables for each model are summarized in Figure 3.1. In the ANC model, the independent variable of interest was pre-pregnancy contraceptive use. For skilled birth attendance, the primary independent variables were pre-pregnancy contraceptive use and antenatal care. For postpartum contraceptive use, the primary independent variables were pre-pregnancy contraceptive use, antenatal care and skilled birth attendance.

Models assessing linkages were adjusted for equity, reproductive health and demographic factors. Equity variables included household wealth quintile, urban/rural residence, maternal and spousal education (none/primary/secondary or higher), current work status, relationship to household head (head/wife of head/daughter of head/daughter-in-law of head/other relative or not related), age at marriage ( $<15/15-17/\geq 18$ ), and person responsible for making health care decisions for respondent (self/ husband/ self and husband jointly/ other). Household wealth quintile was calculated by Measure DHS based on a principal components analysis of household assets (including ownership of goods such as televisions, radios and bicycles) and housing characteristics (including type of flooring, source of drinking water, type of toilet, etc.) [13, 23]. Current work status measured whether the respondent did any work in the 7 days prior to being interviewed, or was regularly employed but missed work in the past week; it was dichotomized into currently working/not currently working. Reproductive health variables included respondent's age at most recent birth ( $\leq 17/18-24/25-34/35-49$ ), parity ( $1/2/\geq 3$ ), interpregnancy interval ( $<24$  months between most recent two births/ $\geq 24$  months or firstborn), wantedness of most recent pregnancy (no/yes), having ever had a pregnancy termination (no/yes) and having ever had a child who died (no/yes). Pregnancy termination referred to the respondent reporting ever having had a termination,

which included miscarriage, abortion and stillbirth. Wantedness of most recent pregnancy measured whether the most recent child born was wanted at that time (wanted) vs. later or never (not wanted). Demographic covariates included religion (Muslim/non-Muslim) and geographic administrative division.

Reports of locations of antenatal care and birth attendance, and the source of modern contraceptives for current users, were obtained as reported to DHS, and categorized into public, private, NGO, home and other locations. Source information for pre-pregnancy contraceptive use and postpartum contraceptive use were not collected in the current dataset. Distance to the nearest health facility was obtained from the community questionnaire administered as part of the DHS.

### **Analyses**

Descriptive frequencies were calculated for RMH CoC variables, as well as for all reproductive health, equity and demographic covariates. Bivariate logistic regression was used to assess the relationship between independent variables and antenatal care (using multinomial logistic models), between independent variables and skilled birth attendance, and between independent variables and postpartum contraceptive use (using binary logistic models) (Figure 3.1; bivariate results shown in Appendix Table 3.1). Covariates that were significant at the  $p < 0.05$  level were included in multivariate models, while the RMH CoC independent variables shown in Figure 3.1 were included in multivariate models regardless of bivariate significance. Interactions between independent RMH CoC variables were tested in the skilled birth attendance model and postpartum contraceptive use model. The interaction between pre-pregnancy contraceptive use and antenatal care in the skilled birth attendance



level was significant ( $p=0.03$ ) and included in the multivariate model. No collinearity existed using a tolerance cutoff of 0.30.

Descriptive frequencies were also calculated for the location of services, to assess source by health service received, and to measure the distance to the nearest health facility.

Analyses were adjusted for survey design, and performed using SAS v.9.3. Ethical approval for this analysis was provided by the University of California, San Diego.

## **RESULTS**

Approximately half of women (48%) reported pre-pregnancy contraceptive use, compared with nearly three-quarters (71%) reporting modern contraceptive use subsequent to their most recent birth (Table 3.1). Most (85%) postpartum contraceptive users remained current users of modern contraception at the time of interview. Among the 53% of women reporting skilled antenatal care for their most recent birth, nearly two-thirds (62%) reported 1-3 visits, while the remaining third (32%) reported 4 or more. Just under half of all women reported either no ANC (35%) or no skilled ANC (11%) for their most recent birth. Less than one-third of women (29%) reported skilled birth attendance; 89% of those deliveries were assisted by a skilled attendant at a health facility.

Both the public and private sectors play a major role in the provision of skilled reproductive and maternal health care in Bangladesh (Figure 3.2). Among women reporting skilled antenatal care, 44% received services through the private sector, and 42% received services through the public sector. While 37% of women reporting skilled birth attendance received their care through the public sector, significantly more (47%;  $p<0.05$ ) received care through the private sector, most commonly in a private hospital. Among current modern contraceptive users, the distribution between public/private sources was nearly equal (48%

and 47%, respectively). Within the public sector, outreach activities are important delivery modalities for contraception in Bangladesh. Nearly 40% of women procured their modern contraceptives through government home or community delivery, 56% of which was obtained from government field workers. Within the private sector, the majority (79%) of women obtained contraceptives through private pharmacies. 98% of the sample lived within two kilometers of a health facility (including satellite clinics).

Regarding linkages within the continuum of care, women who reported pre-pregnancy contraceptive use had a 1.3 times higher odds of receiving skilled ANC (Table 3.2). There was a strong dose-response relationship between antenatal care and skilled birth attendance, both among women who reported pre-pregnancy contraceptive use (aOR 2.76, 95% CI 2.20-3.47 for 1-3 ANC; aOR 6.84, 95% CI 5.26-8.88 for 4+ ANC) and those who did not report pre-pregnancy contraceptive use (aOR 1.99, 95% CI 1.56-2.53 for 1-3 ANC; aOR 4.30, 95% CI 3.29-5.64 for 4+ ANC) (Table 3.3).

Among women reporting no ANC/no skilled ANC, those using modern contraception prior to their most recent pregnancy had a 26% lower odds of skilled birth attendance compared to women who did not use pre-pregnancy modern contraception (aOR=0.74, 95% CI 0.57-0.96) (Table 3.3). Pre-pregnancy contraceptive use was positively associated with postpartum contraceptive use (aOR 1.71, 95% CI 1.47-1.98) (Table 3.2). There was no relationship between antenatal care or skilled birth attendance and postpartum contraceptive use.

A number of key equity and reproductive health variables showed strong associations with RMH CoC outcomes. Wealthier, more educated and urban-residing women had a higher odds of skilled antenatal care, skilled birth attendance and postpartum contraception relative to their poorer, less educated and rural-residing counterparts (Table 3.2). Women with more

educated spouses, who were at least 18 when they married, and had fewer children, had higher odds of maternal health service utilization, but not postpartum contraception. Relative to daughters-in-law of the head of household, wives of the head of household had a higher odds of skilled birth attendance and postpartum contraception. Younger women, and women whose spouses were involved in health care decision-making had a higher odds of postpartum contraception than older women and women who made their own decisions about their health care. Women who experienced the death of a child had a higher odds of 4 or more ANC visits and skilled birth attendance, but a 22% lower odds of postpartum contraceptive use.

## **DISCUSSION**

These analyses document inconsistent linkages across the reproductive and maternal health continuum of care in Bangladesh. Linkages within reproductive health services (pre-pregnancy contraceptive use and postpartum contraceptive use) and within maternal health services (skilled antenatal care and skilled birth attendance) were strong. Pre-pregnancy contraceptive users had a 71% increased odds of also being postpartum contraceptive users. Skilled antenatal care users had a 2 – 6.8 times higher odds of using skilled birth attendance, even after adjusting for factors known to affect birth attendance, which is consistent with findings in this and other settings [24-26]. This may be related to the fact that both of these services are facility-based, compared with contraceptives, which are frequently procured through outreach activities in Bangladesh [20, 21]. Only 3% of women receiving skilled ANC obtained their ANC care through satellite or community clinics or outreach workers, and no women reported skilled birth attendance in these clinic or outreach settings. Conversely, 40% of current modern contraceptive users received their contraceptives from home or

community delivery; more than half of this clinic/outreach procurement came directly from government field workers.

In contrast to the within-life stage linkages, linkages between reproductive and maternal health services were variable. Pre-pregnancy contraceptive use was associated with an increased odds of skilled antenatal care. Pre-pregnancy contraceptive users who also used skilled antenatal care had increased odds of skilled birth attendance, but pre-pregnancy contraceptive users who did not use any ANC/skilled ANC had decreased odds of skilled birth attendance. This was the only negative association among continuum of care variables, and may be indicative of women who are able and willing to utilize outreach-based services, but have a barrier of some sort to facility-based services. There was no association between either ANC or skilled birth attendance with postpartum contraceptive use. This is not consistent with findings elsewhere [16, 27, 28], though this may again be due to differences in family planning delivery modalities between settings (i.e., facility based vs. outreach).

This evidence suggests that increasing the number of women using modern contraception in Bangladesh may increase not only the odds that women would return to contraceptive use following pregnancy, but may also increase utilization of maternal health services such as skilled antenatal care and skilled birth attendance. Similarly, and in-line with previous findings [24], a heightened focus on increasing antenatal care may have a beneficial impact on skilled birth attendance. Consistent with other research, earlier engagement in service utilization along the continuum of care appears to generally have a sustained benefit in terms of subsequent services [16, 29-31].

There were several other factors which retained their protective association in multivariate analyses. Women with more educated husbands were more likely to use skilled ANC and birth attendance, indicating that health knowledge and health education may have a

protective effect at the couple level, beyond that seen at the individual level. In couples where the husband was involved in health care decision-making, there was an increased odds of postpartum contraception use, supporting increased engagement of men in women's health programs and health education. The utility of a male involvement approach to CoC utilization has been noted in this setting and elsewhere [32-35], and merits further research.

Several associations between gendered inequities and non-utilization of services came to light in these analyses. Very young age at marriage was associated with decreased utilization of antenatal care and skilled birth attendance, an issue that may compound the already heightened vulnerabilities of this population [36]. Daughters-in-law of the head of household had decreased odds of postpartum contraceptive use relative to wives of the head; daughters of the household head had even lower odds of postpartum contraceptive use than daughters-in-law. A minority of women (11%) had sole responsibility for making decisions about their own health care. These findings indicate that accessing services along the RMH CoC may be compromised at multiple levels, and that gender equity and empowerment are necessary considerations in efforts to increase RMH CoC coverage.

Consistent with previously published research in Bangladesh and other settings, wealthier, more educated, and urban-residing women were more likely to use all reproductive and maternal health services examined [13, 37-42]. Mitigating key barriers to utilization such as cost of services [43, 44] may be an opportunity to reduce these inequities [13, 39, 45, 46]. Programs such as voucher and microcredit initiatives designed to address these disparities have shown positive results [45, 47, 48].

This study has important limitations. The data are drawn from a cross-sectional, observational survey, and cannot make attributions of causality. As all data analyzed were gathered through self-report, they are susceptible to social desirability bias and recall bias,

though analysis of events surrounding the most recent birth was designed to reduce the latter concern. Comprehensive quality of service information was not available for all outcomes analyzed, therefore this important aspect of health service utilization could not be assessed. Finally, postnatal care, an important aspect of maternal health services, was not included due to validity concerns in the variable as it is currently collected [49]. Despite these limitations, this analysis offers insights into the relationship between services along the RMH CoC.

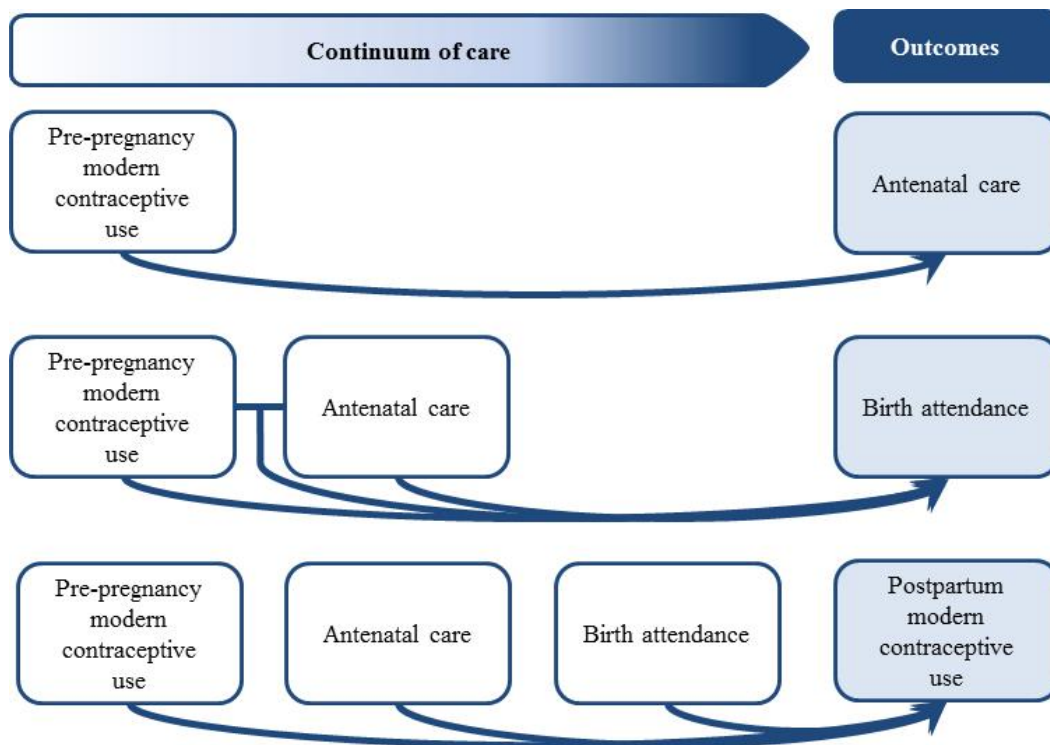
This study represents an important contribution to assessing if and how utilization of services along the reproductive and maternal health continuum of care are linked to one another. Associations within maternal health services and within reproductive health services were strong, but linkages between maternal and reproductive health services were variable. Identification of these positive linkages within life stages emphasizes the importance of removing barriers to access early, both in a woman's reproductive life and in each pregnancy cycle. At the same time, the gaps across life stages indicate a need for increased focus on the continuum approach in Bangladesh. Male involvement, female empowerment and social equity also merit greater consideration in their application to the reproductive and maternal health continuum of care. Programs designed to improve coverage are important steps towards improving service utilization, but should be implemented with a view towards building on existing synergies, connecting gaps along the reproductive and maternal health continuum of care, and addressing social and gender inequities.

**ACKNOWLEDGEMENTS**

This analysis was supported by a grant from the David and Lucile Packard Foundation (Grant #2011-37366) and an American Fellowship from AAUW. Drs. Nancy Binkin and Victoria Ojeda provided valuable comments on earlier drafts of this paper.

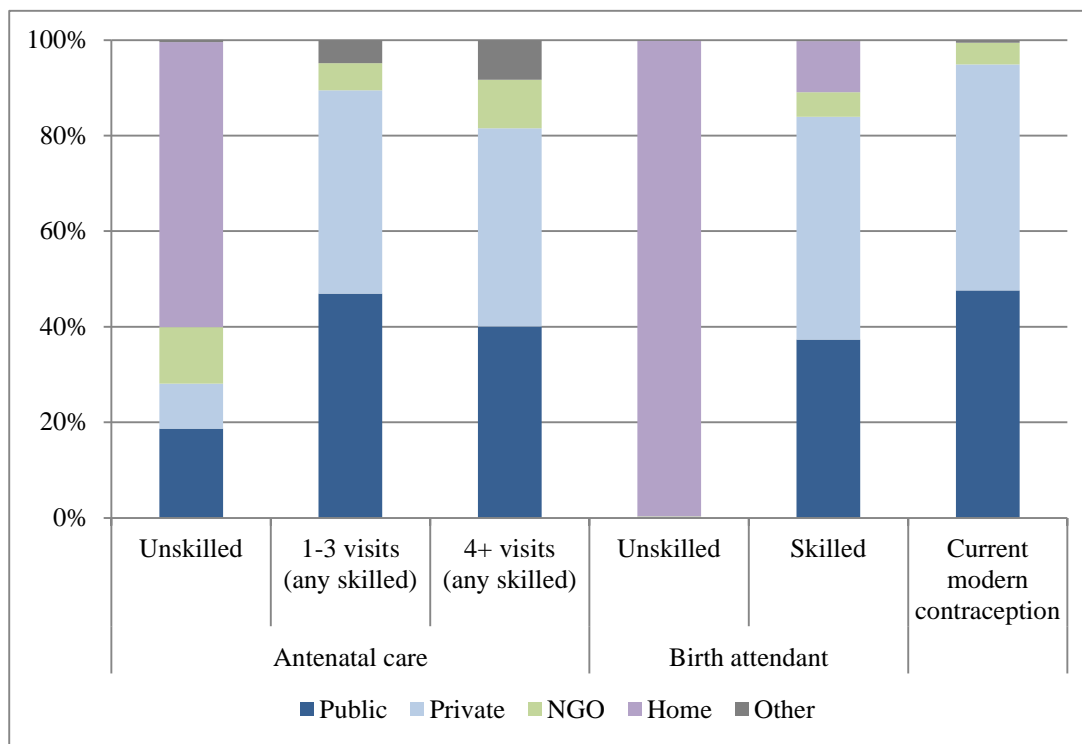
Chapter 3, in full, is currently being prepared for submission for publication of the material. McDougal, L; Rusch, ML; Silverman, JG; Raj, A.: *Linkages within the reproductive and maternal health continuum of care in Bangladesh 2011: A cross-sectional analysis*. Lotus McDougal was the primary investigator and author of this material.

## FIGURES



**Figure 3.1:** Relationships assessed along the reproductive and maternal health continuum of care.





**Figure 3.2:** Locations/sources of health service utilization among women with a birth in the previous 5 years in Bangladesh.

## TABLES

**Table 3.1:** Sociodemographic, equity and reproductive health characteristics associated with maternal health service utilization in Bangladesh, 2011.

	Total sample	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
		No ANC/no skilled ANC	1-3 ANC visits	4+ ANC visits	No skilled birth attendance	Skilled birth attendance	None	Any
Sample size (unwtd.)	7,170	3,156	2,371	1,643	4,849	2,321	2,044	5,126
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Total	-	46.5% (44.4, 48.7)	33.0% (31.4, 34.6)	20.4% (18.9, 22.0)	70.6% (68.9, 72.4)	29.4% (27.6, 31.1)	28.8% (27.4, 30.2)	71.2% (69.8, 72.6)
<b>Continuum of care</b>								
Pre-pregnancy contraceptive use								
None	52.2% (50.7, 53.7)	55.5% (53.3, 57.7)	49.8% (47.4, 52.3)	48.4% (45.5, 51.3)	52.6% (50.7, 54.4)	51.2% (48.7, 53.7)	64.4% (61.7, 67.1)	47.2% (45.5, 48.9)
Any	47.8% (46.3, 49.3)	44.5% (42.3, 46.7)	50.2% (47.7, 52.6)	51.6% (48.7, 54.5)	47.4% (45.6, 49.3)	48.8% (46.3, 51.3)	35.6% (32.9, 38.3)	52.8% (51.1, 54.5)
<b>Antenatal care</b>								
No ANC / no skilled ANC	46.5% (44.4, 48.7)	-	-	-	58.5% (56.2, 60.8)	17.8% (15.8, 19.8)	48.9% (45.5, 52.2)	45.6% (43.3, 47.9)
1-3 ANC visits	33.0% (31.4, 34.6)	-	-	-	31.3% (29.4, 33.2)	37.2% (34.9, 39.6)	32.1% (29.4, 34.7)	33.4% (31.6, 35.2)
4+ ANC visits	20.4% (18.9, 22.0)	-	-	-	10.2% (9.0, 11.4)	45.0% (42.3, 47.7)	19.1% (16.7, 21.5)	21.0% (19.4, 22.6)
<b>Skilled birth attendance</b>								
No	70.6% (68.9, 72.4)	-	-	-	-	-	71.7% (68.9, 74.5)	70.2% (68.3, 72.0)
Yes	29.4% (27.6, 31.1)	-	-	-	-	-	28.3% (25.5, 31.1)	29.8% (28.0, 31.7)

Table 3.1: continued

	Total sample	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
		No ANC/no skilled ANC	1-3 ANC visits	4+ ANC visits	No skilled birth attendance	Skilled birth attendance	None	Any
		% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
<b>Equity</b>								
Household wealth quintile								
Poorest	21.9% (20.0, 23.9)	33.2% (30.5, 36.0)	16.0% (13.9, 18.1)	5.8% (4.4, 7.2)	27.9% (25.5, 30.2)	7.7% (6.3, 9.1)	25.3% (22.0, 28.6)	20.6% (18.7, 22.4)
Poorer	20.1% (18.9, 21.3)	27.2% (25.4, 29.0)	17.2% (15.4, 19.1)	8.7% (7.0, 10.4)	23.9% (22.5, 25.4)	10.9% (9.3, 12.4)	19.0% (17.0, 21.0)	20.6% (19.1, 22.0)
Middle	19.8% (18.4, 21.1)	20.2% (18.2, 22.2)	21.9% (19.9, 24.0)	15.2% (13.0, 17.5)	21.1% (19.4, 22.7)	16.6% (14.7, 18.5)	19.9% (17.6, 22.2)	19.7% (18.3, 21.1)
Richer	19.7% (18.2, 21.2)	14.1% (12.3, 15.9)	24.8% (22.6, 27.0)	24.0% (21.4, 26.7)	17.0% (15.4, 18.7)	26.0% (23.8, 28.2)	20.3% (17.7, 22.8)	19.4% (17.9, 21.0)
Richest	18.5% (17.0, 20.1)	5.3% (4.2, 6.4)	20.1% (17.8, 22.3)	46.2% (42.7, 49.8)	10.1% (8.7, 11.5)	38.9% (36.0, 41.8)	15.6% (13.5, 17.6)	19.8% (18.0, 21.5)
Type of residence								
Rural	76.8% (75.8, 77.9)	86.9% (85.0, 88.7)	76.7% (74.7, 78.8)	54.0% (50.4, 57.7)	84.0% (82.4, 85.5)	59.6% (56.8, 62.3)	82.4% (80.3, 84.4)	74.6% (73.2, 75.9)
Urban	23.2% (22.1, 24.3)	13.1% (11.3, 15.0)	23.3% (21.2, 25.3)	46.0% (42.3, 49.6)	16.0% (14.5, 17.6)	40.4% (37.7, 43.2)	17.6% (15.6, 19.7)	25.4% (24.1, 26.8)
Education level								
None	19.3% (17.6, 20.9)	30.2% (27.7, 32.7)	12.7% (10.9, 14.6)	4.8% (3.6, 6.1)	24.2% (22.1, 26.3)	7.4% (6.2, 8.7)	24.3% (21.2, 27.3)	17.2% (15.7, 18.8)
Primary	30.0% (28.5, 31.5)	38.4% (36.2, 40.7)	27.3% (25.0, 29.6)	15.2% (13.0, 17.3)	34.9% (33.0, 36.7)	18.4% (16.4, 20.3)	29.7% (27.2, 32.2)	30.1% (28.5, 31.8)
Secondary or higher	50.7% (48.4, 53.1)	31.4% (28.7, 34.1)	59.9% (57.1, 62.8)	80.0% (77.6, 82.5)	41.0% (38.4, 43.6)	74.2% (72.0, 76.5)	46.1% (42.3, 49.8)	52.6% (50.4, 54.9)

Table 3.1: continued

	Total sample	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
		No ANC/no skilled ANC	1-3 ANC visits	4+ ANC visits	No skilled birth attendance	Skilled birth attendance	None	Any
		% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Spousal education level								
None	28.3% (26.5, 30.2)	41.1% (38.6, 43.6)	22.0% (19.8, 24.1)	9.6% (7.8, 11.4)	34.9% (32.7, 37.1)	12.5% (10.8, 14.1)	31.3% (28.1, 34.6)	27.1% (25.3, 28.9)
Primary	29.1% (27.7, 30.5)	33.1% (31.1, 35.2)	29.7% (27.3, 32.1)	18.7% (16.3, 21.2)	32.2% (30.6, 33.9)	21.5% (19.1, 23.9)	28.5% (26.2, 30.9)	29.3% (27.6, 31.0)
Secondary or higher	42.6% (40.6, 44.6)	25.8% (23.7, 27.8)	48.3% (45.5, 51.2)	71.7% (68.9, 74.5)	32.9% (30.9, 34.8)	66.0% (63.2, 68.8)	40.1% (37.0, 43.3)	43.6% (41.5, 45.7)
Currently working								
No	90.3% (89.3, 91.3)	91.4% (90.1, 92.7)	89.4% (87.7, 91.1)	89.2% (87.3, 91.1)	90.5% (89.3, 91.7)	89.7% (88.2, 91.3)	92.9% (91.7, 94.2)	89.2% (88.0, 90.5)
Yes	9.7% (8.7, 10.7)	8.6% (7.3, 9.9)	10.6% (8.9, 12.3)	10.8% (8.9, 12.7)	9.5% (8.3, 10.7)	10.3% (8.7, 11.8)	7.1% (5.8, 8.3)	10.8% (9.5, 12.0)
Relationship to household head								
Daughter-in-law	16.0% (14.7, 17.2)	13.0% (11.5, 14.5)	17.6% (15.7, 19.4)	20.2% (17.7, 22.7)	15.0% (13.5, 16.4)	18.4% (16.4, 20.5)	17.1% (14.9, 19.3)	15.5% (14.2, 16.9)
Head	4.3% (3.7, 4.9)	3.3% (2.5, 4.0)	5.5% (4.5, 6.6)	4.6% (3.5, 5.8)	3.9% (3.2, 4.6)	5.3% (4.2, 6.3)	7.1% (5.8, 8.4)	3.2% (2.6, 3.7)
Wife of head	63.8% (62.1, 65.5)	71.7% (69.6, 73.7)	58.2% (55.7, 60.8)	55.0% (51.7, 58.3)	67.2% (65.3, 69.1)	55.7% (53.1, 58.3)	53.7% (50.5, 56.9)	67.9% (66.2, 69.6)
Daughter of head	10.0% (9.1, 10.9)	7.9% (6.7, 9.0)	11.7% (10.1, 13.2)	12.2% (10.2, 14.2)	9.1% (8.1, 10.2)	12.1% (10.6, 13.6)	13.8% (12.0, 15.7)	8.5% (7.6, 9.4)
Other relative/not related	5.9% (5.2, 6.6)	4.2% (3.3, 5.1)	7.0% (5.8, 8.2)	8.0% (6.6, 9.5)	4.8% (4.1, 5.6)	8.5% (7.1, 9.8)	8.3% (6.8, 9.8)	4.9% (4.3, 5.6)

Table 3.1: continued

	Total sample	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
		No ANC/no skilled ANC	1-3 ANC visits	4+ ANC visits	No skilled birth attendance	Skilled birth attendance	None	Any
		% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Age at marriage								
<15	35.3% (33.7, 36.9)	42.5% (40.2, 44.7)	32.4% (30.0, 34.8)	23.7% (21.1, 26.4)	40.6% (38.6, 42.5)	22.7% (20.6, 24.8)	33.8% (31.3, 36.3)	35.9% (34.1, 37.8)
15-17	42.2% (40.8, 43.7)	43.2% (41.1, 45.2)	42.8% (40.6, 45.0)	39.2% (36.2, 42.2)	42.6% (40.9, 44.2)	41.5% (38.9, 44.1)	42.7% (40.3, 45.2)	42.1% (40.5, 43.6)
≥18	22.4% (21.1, 23.8)	14.4% (12.8, 15.9)	24.8% (22.6, 26.9)	37.1% (34.0, 40.2)	16.9% (15.4, 18.3)	35.8% (33.1, 38.5)	23.4% (21.1, 25.8)	22.0% (20.5, 23.5)
Decision-maker for respondent's health care								
Respondent	11.2% (10.2, 12.1)	9.9% (8.6, 11.1)	13.4% (11.8, 15.1)	10.4% (8.9, 12.0)	10.8% (9.6, 11.9)	12.1% (10.6, 13.6)	14.9% (13.0, 16.8)	9.6% (8.6, 10.6)
Spouse	32.0% (30.2, 33.8)	36.1% (33.6, 38.5)	30.2% (27.8, 32.7)	25.7% (23.1, 28.4)	33.5% (31.4, 35.7)	28.5% (26.2, 30.7)	30.6% (27.7, 33.6)	32.6% (30.7, 34.5)
Respondent / spouse jointly	49.8% (48.0, 51.6)	48.2% (45.8, 50.5)	48.6% (46.0, 51.2)	55.4% (52.2, 58.6)	49.1% (47.1, 51.2)	51.3% (48.8, 53.8)	43.0% (40.3, 45.7)	52.5% (50.5, 54.6)
Other	7.0% (6.3, 7.8)	5.9% (4.9, 6.9)	7.7% (6.4, 9.0)	8.4% (6.8, 10.1)	6.6% (5.7, 7.5)	8.1% (6.8, 9.4)	11.5% (9.7, 13.2)	5.2% (4.5, 5.9)

Table 3.1: continued

	Total sample	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
		No ANC/no skilled ANC	1-3 ANC visits	4+ ANC visits	No skilled birth attendance	Skilled birth attendance	None	Any
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
<b>Reproductive health</b>								
Age at most recent birth								
35-49	4.9% (4.4, 5.5)	6.6% (5.7, 7.6)	4.0% (3.0, 4.9)	2.7% (1.7, 3.6)	5.7% (4.9, 6.5)	3.1% (2.3, 4.0)	7.1% (5.9, 8.4)	4.1% (3.4, 4.7)
25-34	30.5% (29.2, 31.8)	30.2% (28.4, 31.9)	29.4% (27.4, 31.5)	33.2% (30.2, 36.1)	29.8% (28.3, 31.3)	32.2% (29.8, 34.7)	33.2% (30.7, 35.6)	29.5% (27.9, 31.0)
18-24	49.9% (48.4, 51.3)	49.0% (47.0, 51.0)	50.7% (48.3, 53.1)	50.6% (47.5, 53.7)	49.9% (48.3, 51.6)	49.8% (47.2, 52.4)	47.9% (45.2, 50.5)	50.7% (49.1, 52.3)
≤17	14.6% (13.7, 15.6)	14.2% (12.8, 15.6)	15.9% (14.3, 17.5)	13.6% (11.6, 15.5)	14.6% (13.5, 15.7)	14.8% (13.0, 16.5)	11.8% (10.2, 13.5)	15.8% (14.6, 16.9)
Parity								
3+	36.9% (35.3, 38.4)	47.5% (45.4, 49.6)	32.2% (29.9, 34.4)	20.3% (18.0, 22.6)	43.0% (41.2, 44.8)	22.2% (20.2, 24.3)	40.5% (37.7, 43.2)	35.4% (33.7, 37.2)
2	29.8% (28.6, 31.0)	28.4% (26.5, 30.3)	30.4% (28.4, 32.4)	32.1% (29.6, 34.7)	29.6% (28.2, 31.1)	30.2% (28.2, 32.3)	27.0% (24.7, 29.3)	31.0% (29.5, 32.4)
1	33.3% (31.9, 34.7)	24.1% (22.2, 26.0)	37.5% (35.1, 39.8)	47.6% (44.9, 50.3)	27.4% (25.8, 29.0)	47.5% (45.1, 50.0)	32.6% (30.1, 35.1)	33.6% (32.0, 35.3)
Interpregnancy interval								
<24 months	7.4% (6.7, 8.0)	9.5% (8.4, 10.5)	6.3% (5.2, 7.4)	4.4% (3.2, 5.6)	8.5% (7.7, 9.4)	4.7% (3.7, 5.7)	8.2% (7.0, 9.4)	7.1% (6.3, 7.8)
≥24 months or firstborn	92.6% (92.0, 93.3)	90.5% (89.5, 91.6)	93.7% (92.6, 94.8)	95.6% (94.4, 96.8)	91.5% (90.6, 92.3)	95.3% (94.3, 96.3)	91.8% (90.6, 93.0)	92.9% (92.2, 93.7)

**Table 3.1:** continued

	Total sample	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
		No ANC/no skilled ANC	1-3 ANC visits	4+ ANC visits	Total sample	No ANC/no skilled ANC	1-3 ANC visits	4+ ANC visits
		% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
<b>Most recent pregnancy wanted</b>								
No	29.3% (28.0, 30.6)	34.4% (32.4, 36.4)	26.5% (24.5, 28.6)	22.4% (20.2, 24.5)	32.0% (30.4, 33.6)	22.9% (20.9, 24.9)	27.1% (24.8, 29.4)	30.2% (28.7, 31.8)
Yes	70.7% (69.4, 72.0)	65.6% (63.6, 67.6)	73.5% (71.4, 75.5)	77.6% (75.5, 79.8)	68.0% (66.4, 69.6)	77.1% (75.1, 79.1)	72.9% (70.6, 75.2)	69.8% (68.2, 71.3)
<b>Ever had a terminated pregnancy</b>								
No	81.8% (80.8, 82.8)	82.9% (81.5, 84.2)	81.7% (79.9, 83.5)	79.6% (77.5, 81.8)	82.3% (81.1, 83.5)	80.6% (78.8, 82.5)	82.4% (80.4, 84.3)	81.6% (80.4, 82.8)
Yes	18.2% (17.2, 19.2)	17.1% (15.8, 18.5)	18.3% (16.5, 20.1)	20.4% (18.2, 22.5)	17.7% (16.5, 18.9)	19.4% (17.5, 21.2)	17.6% (15.7, 19.6)	18.4% (17.2, 19.6)
<b>Ever had a child who died</b>								
No	86.0% (85.0, 87.0)	81.5% (79.9, 83.1)	88.6% (87.1, 90.1)	92.0% (90.5, 93.4)	84.0% (82.8, 85.3)	90.6% (89.3, 92.0)	82.1% (79.9, 84.3)	87.6% (86.5, 88.6)
Yes	14.0% (13.0, 15.0)	18.5% (16.9, 20.1)	11.4% (9.9, 12.9)	8.0% (6.6, 9.5)	16.0% (14.7, 17.2)	9.4% (8.0, 10.7)	17.9% (15.7, 20.1)	12.4% (11.4, 13.5)
<b>Demographic</b>								
<b>Religion</b>								
Muslim	91.4% (89.9, 93.0)	93.2% (91.4, 95.0)	91.0% (89.1, 92.9)	88.1% (85.4, 90.8)	93.2% (91.8, 94.6)	87.2% (84.6, 89.9)	92.7% (90.9, 94.5)	90.9% (89.3, 92.5)
Non-Muslim	8.6% (7.0, 10.1)	6.8% (5.0, 8.6)	9.0% (7.1, 10.9)	11.9% (9.2, 14.6)	6.8% (5.4, 8.2)	12.8% (10.1, 15.4)	7.3% (5.5, 9.1)	9.1% (7.5, 10.7)

**Table 3.1:** continued

	Total sample	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
		No ANC/no skilled ANC	1-3 ANC visits	4+ ANC visits	Total sample	No ANC/no skilled ANC	1-3 ANC visits	4+ ANC visits
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Administrative division								
Dhaka	31.5% (30.2, 32.9)	32.4% (29.4, 35.4)	28.7% (26.2, 31.3)	34.0% (30.4, 37.7)	31.4% (29.3, 33.5)	31.8% (28.9, 34.6)	30.8% (27.7, 33.8)	31.8% (30.3, 33.4)
Barisal	5.8% (5.4, 6.3)	6.2% (5.3, 7.0)	5.4% (4.8, 6.1)	5.7% (4.5, 6.9)	6.3% (5.6, 7.0)	4.7% (3.8, 5.7)	4.8% (4.1, 5.6)	6.2% (5.7, 6.8)
Chittagong	21.5% (20.4, 22.7)	21.2% (18.5, 24.0)	23.8% (21.5, 26.1)	18.5% (15.1, 21.9)	21.9% (20.0, 23.8)	20.7% (18.1, 23.2)	25.9% (23.4, 28.5)	19.7% (18.4, 21.0)
Khulna	9.7% (9.0, 10.3)	7.6% (6.7, 8.6)	10.8% (9.5, 12.2)	12.5% (10.4, 14.6)	7.7% (6.9, 8.6)	14.3% (12.5, 16.1)	8.1% (6.8, 9.3)	10.3% (9.5, 11.1)
Rajshani	13.7% (12.5, 14.8)	13.1% (10.7, 15.6)	15.5% (13.7, 17.2)	11.9% (9.7, 14.1)	13.9% (12.1, 15.6)	13.2% (11.5, 14.9)	11.3% (9.2, 13.3)	14.6% (13.5, 15.8)
Rangpur	10.9% (10.2, 11.6)	11.5% (10.0, 13.0)	9.2% (8.0, 10.4)	12.5% (10.1, 14.9)	11.5% (10.4, 12.5)	9.7% (8.2, 11.2)	8.2% (7.0, 9.4)	12.1% (11.1, 13.0)
Sylhet	6.9% (6.4, 7.3)	7.9% (6.8, 9.1)	6.6% (5.7, 7.4)	4.9% (3.5, 6.3)	7.4% (6.6, 8.1)	5.7% (4.6, 6.8)	11.0% (9.5, 12.5)	5.2% (4.7, 5.7)



**Table 3.2:** Multivariate associations with maternal health services at most recent pregnancy in Bangladesh 2011 (n=7,170).

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits					
	aOR (95% CI) <sup>1</sup>	aOR (95% CI) <sup>1</sup>	p-value	aOR (95% CI) <sup>2</sup>	p-value	aOR (95% CI) <sup>1</sup>	p-value
<b>Continuum of care</b>							
Pre-pregnancy contraceptive use			<0.01		0.02		<0.0001
None	[REF]	[REF]		[REF]		[REF]	
Any	1.27 (1.10, 1.47)	1.28 (1.06, 1.55)		0.74 (0.57, 0.96) <sup>3</sup>		1.71 (1.47, 1.98)	
Antenatal care					<0.0001		0.41
No ANC / no skilled ANC	-	-		[REF]		[REF]	
1-3 ANC visits (any skilled)	-	-		1.99 (1.56, 2.53) <sup>3</sup>		1.02 (0.87, 1.19)	
4+ ANC visits (any skilled)	-	-		4.30 (3.29, 5.64) <sup>3</sup>		0.90 (0.74, 1.10)	
Skilled birth attendance							0.37
No	-	-		-		[REF]	
Yes	-	-		-		0.93 (0.79, 1.09)	
<b>Equity</b>							
Household wealth quintile			<0.0001		<0.0001		<0.01
Poorest	[REF]	[REF]		[REF]		[REF]	
Poorer	0.99 (0.80, 1.22)	1.08 (0.77, 1.52)		1.20 (0.92, 1.57)		1.30 (1.07, 1.59)	
Middle	1.35 (1.10, 1.68)	1.82 (1.32, 2.49)		1.46 (1.12, 1.91)		1.21 (0.99, 1.49)	
Richer	1.95 (1.54, 2.47)	3.22 (2.31, 4.49)		2.14 (1.63, 2.82)		1.22 (0.98, 1.52)	
Richest	3.49 (2.57, 4.75)	10.01 (6.68, 15.01)		2.99 (2.18, 4.09)		1.62 (1.23, 2.13)	

**Table 3.2:** continued

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits					
	aOR (95% CI) <sup>1</sup>	aOR (95% CI) <sup>1</sup>	p-value	aOR (95% CI) <sup>2</sup>	p-value	aOR (95% CI) <sup>1</sup>	p-value
Type of residence			<0.0001		<0.0001		<0.01
Rural	[REF]	[REF]		[REF]		[REF]	
Urban	1.26 (1.004, 1.58)	2.43 (1.83, 3.24)		1.71 (1.43, 2.05)		1.29 (1.07, 1.55)	
Education level			<0.0001		<0.01		0.01
None	[REF]	[REF]		[REF]		[REF]	
Primary	1.38 (1.11, 1.73)	1.79 (1.25, 2.55)		1.16 (0.89, 1.52)		1.22 (1.01, 1.48)	
Secondary or higher	2.30 (1.78, 2.97)	4.29 (2.99, 6.15)		1.48 (1.13, 1.95)		1.39 (1.12, 1.73)	
Spousal education level			<0.0001		<0.001		0.94
None	[REF]	[REF]		[REF]		[REF]	
Primary	1.12 (0.94, 1.34)	1.14 (0.85, 1.51)		1.12 (0.88, 1.42)		1.02 (0.86, 1.19)	
Secondary or higher	1.36 (1.11, 1.68)	2.08 (1.58, 2.74)		1.53 (1.22, 1.92)		1.04 (0.86, 1.25)	
Currently working							<0.01
No	-	-		-		[REF]	
Yes	-	-		-		1.40 (1.12, 1.75)	

**Table 3.2:** continued

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits					
	aOR (95% CI) <sup>1</sup>	aOR (95% CI) <sup>1</sup>	p-value	aOR (95% CI) <sup>2</sup>	p-value	aOR (95% CI) <sup>1</sup>	p-value
Relationship to household head			0.03		0.01		<0.0001
Daughter-in-law	[REF]	[REF]		[REF]		[REF]	
Head	1.59 (1.12, 2.27)	1.86 (1.19, 2.90)		1.77 (1.21, 2.57)		0.70 (0.52, 0.94)	
Wife of head	1.01 (0.82, 1.26)	1.00 (0.75, 1.34)		1.26 (1.03, 1.54)		1.43 (1.17, 1.74)	
Daughter of head	1.23 (0.92, 1.66)	1.15 (0.80, 1.66)		1.16 (0.90, 1.49)		0.64 (0.51, 0.81)	
Other relative/ not related	1.37 (1.001, 1.86)	1.35 (0.93, 1.96)		1.53 (1.13, 2.06)		0.73 (0.54, 0.98)	
Age at marriage			0.02		<0.001		
<15	[REF]	[REF]		[REF]		-	
15-17	1.00 (0.86, 1.16)	0.97 (0.77, 1.21)		1.33 (1.12, 1.58)		-	
≥18	1.27 (1.03, 1.58)	1.39 (1.05, 1.83)		1.63 (1.28, 2.06)		-	
Decision-maker for respondent's health care			0.03		0.76		<0.0001
Respondent	[REF]	[REF]		[REF]		[REF]	
Spouse	0.78 (0.62, 0.995)	1.02 (0.75, 1.37)		1.00 (0.79, 1.27)		1.41 (1.13, 1.76)	
Respondent / spouse jointly	0.86 (0.69, 1.08)	1.29 (0.97, 1.72)		0.93 (0.75, 1.15)		1.48 (1.20, 1.84)	
Other	0.87 (0.62, 1.20)	1.35 (0.90, 2.04)		0.97 (0.70, 1.36)		0.69 (0.52, 0.91)	

Table 3.2: continued

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits					
	aOR (95% CI) <sup>1</sup>	aOR (95% CI) <sup>1</sup>	p-value	aOR (95% CI) <sup>2</sup>	p-value	aOR (95% CI) <sup>1</sup>	p-value
<b>Reproductive health</b>							
Age at most recent birth			<0.0001		<0.01		<0.0001
35-49	[REF]	[REF]		[REF]		[REF]	
25-34	1.07 (0.78, 1.46)	1.30 (0.82, 2.06)		1.12 (0.79, 1.59)		1.35 (1.01, 1.81)	
18-24	0.80 (0.56, 1.15)	0.67 (0.40, 1.15)		0.78 (0.52, 1.16)		1.87 (1.39, 2.52)	
≤17	0.77 (0.50, 1.18)	0.49 (0.26, 0.92)		0.73 (0.45, 1.19)		2.72 (1.91, 3.88)	
Parity			<0.0001		<0.0001		0.45
3+	[REF]	[REF]		[REF]		[REF]	
2	1.22 (1.003, 1.50)	1.87 (1.43, 2.44)		1.48 (1.19, 1.83)		0.90 (0.74, 1.09)	
1	1.84 (1.40, 2.42)	3.99 (2.77, 5.73)		2.55 (1.93, 3.38)		0.88 (0.71, 1.09)	
Interpregnancy interval			0.96		0.64		
<24 months	[REF]	[REF]		[REF]		-	
≥24 months or firstborn	0.96 (0.74, 1.26)	0.97 (0.65, 1.46)		1.08 (0.79, 1.48)		-	
Most recent pregnancy wanted			0.08		0.98		0.04
No	[REF]	[REF]		[REF]		[REF]	
Yes	1.18 (1.02, 1.36)	1.15 (0.95, 1.38)		1.00 (0.84, 1.18)		0.86 (0.74, 0.99)	
Ever had a terminated pregnancy							
No	[REF]	[REF]	<0.001	-		-	
Yes	1.21 (1.02, 1.44)	1.47 (1.20, 1.80)		-		-	

**Table 3.2:** continued

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits					
	aOR (95% CI) <sup>1</sup>	aOR (95% CI) <sup>1</sup>	p-value	aOR (95% CI) <sup>2</sup>	p-value	aOR (95% CI) <sup>1</sup>	p-value
Ever had a child who died			0.07		<0.001		0.01
No	[REF]	[REF]		[REF]		[REF]	
Yes	1.04 (0.85, 1.28)	1.41 (1.05, 1.89)		1.49 (1.18, 1.87)		0.78 (0.64, 0.95)	
<b>Demographic</b>							
Religion			0.09		<0.001		0.01
Muslim	[REF]	[REF]		[REF]		[REF]	
Non-Muslim	1.19 (0.89, 1.58)	1.44 (1.03, 2.00)		1.65 (1.27, 2.15)		1.30 (1.05, 1.60)	
Administrative division			<0.0001		<0.0001		<0.0001
Dhaka	[REF]	[REF]		[REF]		[REF]	
Barisal	1.09 (0.84, 1.41)	1.52 (1.02, 2.27)		1.00 (0.74, 1.35)		1.35 (1.06, 1.71)	
Chittagong	1.19 (0.92, 1.53)	0.95 (0.65, 1.39)		1.02 (0.80, 1.31)		0.87 (0.72, 1.07)	
Khulna	1.43 (1.07, 1.91)	1.73 (1.19, 2.52)		2.06 (1.57, 2.71)		1.17 (0.93, 1.48)	
Rajshahi	1.67 (1.26, 2.22)	1.70 (1.14, 2.55)		1.43 (1.11, 1.84)		1.30 (1.04, 1.64)	
Rangpur	1.22 (0.91, 1.63)	2.59 (1.70, 3.93)		1.31 (0.97, 1.77)		1.36 (1.07, 1.73)	
Sylhet	1.11 (0.83, 1.48)	0.93 (0.60, 1.45)		1.00 (0.76, 1.31)		0.60 (0.47, 0.76)	

<sup>1</sup> Adjusted for all variables shown in column.

<sup>2</sup> Adjusted for all variables shown in column and pre-pregnancy contraception/antenatal care interaction (p=0.03).

<sup>3</sup> See Table 3.3 for interaction term breakdown.

**Table 3.3:** Pre-pregnancy contraceptive use/antenatal care interaction in skilled birth attendance model.

		Skilled birth attendance
Pre-pregnancy contraceptive use	Antenatal care	aOR (95% CI) <sup>1</sup>
None	No ANC / no skilled ANC	[REF]
None	1-3 ANC visits (any skilled)	1.99 (1.56, 2.53)
None	4+ ANC visits (any skilled)	4.30 (3.29, 5.64)
Any	No ANC / no skilled ANC	0.74 (0.57, 0.96)
Any	1-3 ANC visits (any skilled)	2.76 (2.20, 3.47)
Any	4+ ANC visits (any skilled)	6.84 (5.26, 8.88)

<sup>1</sup> Adjusted for all variables shown in skilled birth attendance model in Table 3.2.

## APPENDIX

**Appendix Table 3.1:** Bivariate associations with maternal health services at most recent pregnancy in Bangladesh 2011 (n=7,170).

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
	OR (95% CI)	OR (95% CI)					
<b>Continuum of care</b>							
Pre-pregnancy contraceptive use			<0.0001		0.39		<0.0001
None	[REF]	[REF]		[REF]		[REF]	
Any	1.25 (1.11, 1.42)	1.33 (1.15, 1.54)		1.06 (0.93, 1.19)		2.02 (1.76, 2.31)	
Antenatal care							
No ANC / no skilled ANC	-	-		[REF]	<0.0001	[REF]	0.11
1-3 ANC visits (any skilled)	-	-		3.92 (3.34, 4.59)		1.12 (0.97, 1.29)	
4+ ANC visits (any skilled)	-	-		14.49 (11.96, 17.56)		1.18 (0.999, 1.39)	
Skilled birth attendance							
No	-	-		-		[REF]	0.29
Yes	-	-		-		1.08 (0.94, 1.24)	

Appendix Table 3.1: continued

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits					
	OR (95% CI)	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
<b>Equity</b>							
Household wealth quintile			<0.0001		<0.0001		<0.001
Poorest	[REF]	[REF]		[REF]		[REF]	
Poorer	1.32 (1.09, 1.61)	1.83 (1.33, 2.53)		1.64 (1.29, 2.10)		1.33 (1.10, 1.61)	
Middle	2.26 (1.88, 2.72)	4.31 (3.14, 5.92)		2.86 (2.26, 3.61)		1.22 (1.01, 1.48)	
Richer	3.66 (3.00, 4.46)	9.75 (7.16, 13.26)		5.52 (4.43, 6.89)		1.18 (0.96, 1.45)	
Richest	7.90 (6.14, 10.15)	49.99 (34.88, 71.63)		14.00 (10.79, 18.16)		1.56 (1.26, 1.94)	
Type of residence			<0.0001		<0.0001		<0.0001
Rural	[REF]	[REF]		[REF]		[REF]	
Urban	2.00 (1.63, 2.46)	5.63 (4.38, 7.23)		3.56 (2.93, 4.32)		1.59 (1.35, 1.88)	
Education level			<0.0001		<0.0001		<0.0001
None	[REF]	[REF]		[REF]		[REF]	
Primary	1.69 (1.39, 2.06)	2.47 (1.79, 3.39)		1.71 (1.36, 2.16)		1.43 (1.20, 1.71)	
Secondary or higher	4.54 (3.72, 5.54)	15.94 (11.82, 21.51)		5.88 (4.71, 7.34)		1.61 (1.36, 1.91)	
Spousal education level			<0.0001		<0.0001		0.02
None	[REF]	[REF]		[REF]		[REF]	
Primary	1.68 (1.43, 1.97)	2.41 (1.85, 3.13)		1.86 (1.53, 2.27)		1.19 (1.004, 1.40)	
Secondary or higher	3.51 (2.98, 4.13)	11.86 (9.30, 15.13)		5.62 (4.69, 6.73)		1.26 (1.07, 1.47)	



Appendix Table 3.1: continued

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits					
	OR (95% CI)	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Currently working			0.06		0.39		<0.0001
No	[REF]	[REF]		[REF]		[REF]	
Yes	1.27 (1.02, 1.57)	1.29 (1.002, 1.66)		1.10 (0.89, 1.34)		1.59 (1.28, 1.97)	
Relationship to household head			<0.0001		<0.0001		<0.0001
Daughter-in-law	[REF]	[REF]		[REF]		[REF]	
Head	1.26 (0.93, 1.71)	0.92 (0.65, 1.31)		1.10 (0.80, 1.51)		0.49 (0.37, 0.64)	
Wife of head	0.60 (0.51, 0.71)	0.50 (0.40, 0.61)		0.67 (0.57, 0.79)		1.39 (1.16, 1.66)	
Daughter of head	1.10 (0.85, 1.42)	1.00 (0.74, 1.36)		1.08 (0.86, 1.35)		0.67 (0.54, 0.84)	
Other relative/ not related	1.24 (0.91, 1.68)	1.23 (0.88, 1.72)		1.43 (1.09, 1.87)		0.66 (0.50, 0.86)	
Age at marriage			<0.0001		<0.0001		0.29
<15	[REF]	[REF]		[REF]		[REF]	
15-17	1.30 (1.14, 1.49)	1.62 (1.35, 1.95)		1.74 (1.50, 2.02)		0.93 (0.81, 1.05)	
≥18	2.26 (1.87, 2.74)	4.62 (3.72, 5.74)		3.79 (3.16, 4.56)		0.88 (0.75, 1.04)	

Appendix Table 3.1: continued

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits					
	OR (95% CI)	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Decision-maker for respondent's health care			<0.0001		<0.01		<0.0001
Respondent	[REF]	[REF]		[REF]		[REF]	
Spouse	0.62 (0.50, 0.76)	0.67 (0.53, 0.85)		0.75 (0.62, 0.92)		1.65 (1.34, 2.04)	
Respondent / spouse jointly	0.74 (0.61, 0.90)	1.09 (0.87, 1.35)		0.93 (0.77, 1.11)		1.89 (1.56, 2.30)	
Other	0.97 (0.74, 1.27)	1.36 (0.99, 1.86)		1.09 (0.83, 1.44)		0.71 (0.55, 0.91)	
<b>Reproductive health</b>							
Age at most recent birth			<0.0001		<0.001		<0.0001
35-49	[REF]	[REF]		[REF]		[REF]	
25-34	1.64 (1.21, 2.21)	2.72 (1.81, 4.09)		1.96 (1.42, 2.70)		1.57 (1.21, 2.03)	
18-24	1.74 (1.29, 2.34)	2.56 (1.68, 3.90)		1.81 (1.29, 2.52)		1.87 (1.46, 2.39)	
≤17	1.88 (1.38, 2.57)	2.36 (1.56, 3.59)		1.83 (1.31, 2.58)		2.35 (1.75, 3.15)	
Parity			<0.0001		<0.0001		<0.01
3+	[REF]	[REF]		[REF]		[REF]	
2	1.58 (1.36, 1.84)	2.65 (2.20, 3.19)		1.97 (1.70, 2.29)		1.31 (1.12, 1.53)	
1	2.30 (1.96, 2.69)	4.62 (3.89, 5.50)		3.35 (2.88, 3.90)		1.18 (1.02, 1.36)	
Interpregnancy interval			<0.0001		<0.0001		0.11
<24 months	[REF]	[REF]		[REF]		[REF]	
≥24 months or firstborn	1.55 (1.24, 1.95)	2.27 (1.66, 3.09)		1.89 (1.46, 2.46)		1.18 (0.96, 1.43)	

Appendix Table 3.1: continued

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits					
	OR (95% CI)	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Most recent pregnancy wanted			<0.0001		<0.0001		0.02
No	[REF]	[REF]		[REF]		[REF]	
Yes	1.45 (1.27, 1.66)	1.82 (1.56, 2.12)		1.58 (1.39, 1.81)		0.86 (0.75, 0.98)	
Ever had a terminated pregnancy			0.03		0.14		0.54
No	[REF]	[REF]		[REF]		[REF]	
Yes	1.08 (0.92, 1.27)	1.24 (1.06, 1.45)		1.12 (0.97, 1.29)		1.05 (0.89, 1.24)	
Ever had a child who died			<0.0001		<0.0001		<0.0001
No	[REF]	[REF]		[REF]		[REF]	
Yes	0.57 (0.47, 0.68)	0.39 (0.31, 0.48)		0.54 (0.45, 0.65)		0.65 (0.56, 0.77)	
<b>Demographic</b>							
Religion			<0.001		<0.0001		0.02
Muslim	[REF]	[REF]		[REF]		[REF]	
Non-Muslim	1.36 (1.01, 1.83)	1.86 (1.36, 2.55)		2.00 (1.57, 2.54)		1.27 (1.04, 1.55)	

**Appendix Table 3.1:** continued

	Antenatal care			Skilled birth attendance		Postpartum contraceptive use	
	1-3 ANC visits	4+ ANC visits					
	OR (95% CI)	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Administrative division			<0.0001		<0.0001		<0.0001
Dhaka	[REF]	[REF]		[REF]		[REF]	
Barisal	0.99 (0.77, 1.27)	0.87 (0.62, 1.23)		0.74 (0.54, 1.02)		1.25 (0.995, 1.57)	
Chittagong	1.26 (0.95, 1.68)	0.83 (0.58, 1.19)		0.93 (0.71, 1.23)		0.74 (0.60, 0.90)	
Khulna	1.60 (1.23, 2.10)	1.56 (1.14, 2.14)		1.82 (1.40, 2.37)		1.23 (0.98, 1.56)	
Rajshani	1.33 (0.98, 1.79)	0.86 (0.59, 1.27)		0.94 (0.72, 1.24)		1.26 (0.99, 1.60)	
Rangpur	0.90 (0.68, 1.19)	1.03 (0.73, 1.46)		0.84 (0.64, 1.10)		1.43 (1.13, 1.80)	
Sylhet	0.93 (0.69, 1.26)	0.59 (0.39, 0.90)		0.77 (0.57, 1.03)		0.46 (0.36, 0.59)	

**REFERENCES**

1. Liu L, Johnson HL, Cousens S, Perin J, Scott S, Lawn JE, Rudan I, Campbell H, Cibulskis R, Li M, Mathers C, Black RE, Child Health Epidemiology Reference Group of WHO, UNICEF: Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *Lancet* 2012, 379:2151-2161.
2. Lozano R, Wang H, Foreman KJ, Rajaratnam JK, Naghavi M, Marcus JR, Dwyer-Lindgren L, Lofgren KT, Phillips D, Atkinson C, Lopez AD, Murray CJ: Progress towards Millennium Development Goals 4 and 5 on maternal and child mortality: an updated systematic analysis. *Lancet* 2011, 378:1139-1165.
3. Bhutta ZA, Cabral S, Chan CW, Keenan WJ: Reducing maternal, newborn, and infant mortality globally: An integrated action agenda. *Int J Gynaecol Obstet* 2012, 119 Suppl 1:S13-17.
4. Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE: Continuum of care for maternal, newborn, and child health: from slogan to service delivery. *Lancet* 2007, 370:1358-1369.
5. Lassi ZS, Majeed A, Rashid S, Yakoob MY, Bhutta ZA: The interconnections between maternal and newborn health - evidence and implications for policy. *J Matern Fetal Neonatal Med* 2013, 26 Suppl 1:3-53.
6. Bhutta ZA, Chopra M, Axelson H, Berman P, Boerma T, Bryce J, Bustreo F, Cavagnero E, Cometto G, Daelmans B, de Francisco A, Fogstad H, Gupta N, Laski L, Lawn J, Maliqi B, Mason E, Pitt C, Requejo J, Starrs A, Victora CG, Wardlaw T: Countdown to 2015 decade report (2000-10): taking stock of maternal, newborn, and child survival. *Lancet* 2010, 375:2032-2044.
7. Bhutta ZA, Lassi ZS, Blanc A, Donnay F: Linkages among reproductive health, maternal health, and perinatal outcomes. *Semin Perinatol* 2010, 34:434-445.
8. Chopra M, Sharkey A, Dalmiya N, Anthony D, Binkin N, Unicef Equity in Child Survival H, Nutrition Analysis T: Strategies to improve health coverage and narrow the equity gap in child survival, health, and nutrition. *Lancet* 2012, 380:1331-1340.
9. Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L: Evidence-based, cost-effective interventions: how many newborn babies can we save? *Lancet* 2005, 365:977-988.
10. Darmstadt GL, Walker N, Lawn JE, Bhutta ZA, Haws RA, Cousens S: Saving newborn lives in Asia and Africa: cost and impact of phased scale-up of interventions within the continuum of care. *Health Policy Plan* 2008, 23:101-117.
11. Victora CG, Barros AJ, Axelson H, Bhutta ZA, Chopra M, Franca GV, Kerber K, Kirkwood BR, Newby H, Ronsmans C, Boerma JT: How changes in coverage affect

- equity in maternal and child health interventions in 35 Countdown to 2015 countries: an analysis of national surveys. *Lancet* 2012.
12. Countdown to 2015: Accountability for maternal, newborn and child survival: The 2013 Update. Geneva: WHO and UNICEF; 2013.
  13. Barros AJ, Ronsmans C, Axelson H, Loaiza E, Bertoldi AD, Franca GV, Bryce J, Boerma JT, Victora CG: Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries. *Lancet* 2012, 379:1225-1233.
  14. World Health Organization: Programming strategies for Postpartum Family Planning. Geneva; 2013.
  15. World Health Organization: WHO Antenatal Care Randomized Trial: Manual for the Implementation of the New Model. Geneva: DRHR/FCH/WHO; 2002.
  16. Do M, Hotchkiss D: Relationships between antenatal and postnatal care and postpartum modern contraceptive use: evidence from population surveys in Kenya and Zambia. *BMC Health Serv Res* 2013, 13:6.
  17. World Health Organization and UNICEF: Countdown to 2015: Maternal, Newborn and Child Survival. Building a Future for Women and Children - The 2012 Report. Geneva: WHO; 2012.
  18. National Institute of Population Research and Training (NIPORT): Bangladesh Maternal Mortality and Health Care Survey 2010: Summary of Key Findings and Implications. Dhaka: National Institute of Population Research and Training; 2011.
  19. Jahan R: Securing maternal health through comprehensive reproductive health services: lessons from Bangladesh. *Am J Public Health* 2007, 97:1186-1190.
  20. El Arifeen S, Christou A, Reichenbach L, Osman FA, Azad K, Islam KS, Ahmed F, Perry HB, Peters DH: Community-based approaches and partnerships: innovations in health-service delivery in Bangladesh. *Lancet* 2013, 382:2012-2026.
  21. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International: Bangladesh Demographic and Health Survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: National Institute of Population Research and Training, Mitra and Associates, and ICF International; 2013.
  22. World Health Organization, International Confederation of Midwives, International Federation of Gynecology and Obstetrics: Making pregnancy safer: the critical role of the skilled attendant. A joint statement by WHO, ICM and FIGO. Geneva; 2004.
  23. Rutstein S, Johnson K: The DHS Wealth Index. Calverton, Maryland: ORC Macro; 2004.

24. Adjiwanou V, Legrand T: Does antenatal care matter in the use of skilled birth attendance in rural Africa: a multi-country analysis. *Soc Sci Med* 2013, 86:26-34.
25. Pervin J, Moran A, Rahman M, Razzaque A, Sibley L, Streatfield PK, Reichenbach LJ, Koblinsky M, Hruschka D, Rahman A: Association of antenatal care with facility delivery and perinatal survival - a population-based study in Bangladesh. *BMC Pregnancy Childbirth* 2012, 12:111.
26. Ochako R, Fotso JC, Ikamari L, Khasakhala A: Utilization of maternal health services among young women in Kenya: insights from the Kenya Demographic and Health Survey, 2003. *BMC Pregnancy Childbirth* 2011, 11:1.
27. Akinlo A, Bisiriyu A, Esimai O: Influence of Use of Maternal Health Care on Postpartum Contraception in Nigeria. Calverton, Maryland: ICF International; 2013.
28. Hotchkiss DR, Rous JJ, Seiber EE, Berruti AA: Is maternal and child health service use a causal gateway to subsequent contraceptive use?: A multi-country study. *Population Research and Policy Review* 2005, 24:543-571.
29. Zerai A, Tsui AO: The relationship between prenatal care and subsequent modern contraceptive use in Bolivia, Egypt and Thailand. *Afr J Reprod Health* 2001, 5:68-82.
30. Hotchkiss DR, Magnani RJ, Rous JJ, Azelmat M, Mroz TA, Heikel J: The effects of maternal-child health service utilization on subsequent contraceptive use in Morocco. *J Biosoc Sci* 1999, 31:145-165.
31. Ahmed S, Mosley WH: Simultaneity in the use of maternal-child health care and contraceptives: evidence from developing countries. *Demography* 2002, 39:75-93.
32. Mullany BC, Becker S, Hindin MJ: The impact of including husbands in antenatal health education services on maternal health practices in urban Nepal: results from a randomized controlled trial. *Health Educ Res* 2007, 22:166-176.
33. Turan JM, Nalbant H, Bulut A, Sahip Y: Including expectant fathers in antenatal education programmes in Istanbul, Turkey. *Reprod Health Matters* 2001, 9:114-125.
34. Mangeni JN, Mwangi A, Mbugua S, Mukthar V: Male involvement in maternal health care as a determinant of utilization of skilled birth attendants in Kenya. Calverton, MD: ICF International; 2013.
35. Story WT, Burgard SA, Lori JR, Taleb F, Ali NA, Hoque DM: Husbands' involvement in delivery care utilization in rural Bangladesh: A qualitative study. *BMC Pregnancy Childbirth* 2012, 12:28.
36. Raj A: When the mother is a child: the impact of child marriage on the health and human rights of girls. *Arch Dis Child* 2010, 95:931-935.

37. Titaley CR, Dibley MJ, Roberts CL: Factors associated with underutilization of antenatal care services in Indonesia: results of Indonesia Demographic and Health Survey 2002/2003 and 2007. *BMC Public Health* 2010, 10:485.
38. Ahmed S, Creanga AA, Gillespie DG, Tsui AO: Economic status, education and empowerment: implications for maternal health service utilization in developing countries. *PLoS One* 2010, 5:e11190.
39. Khan MM, Kramer A, Khandoker A, Pruffer-Kramer L, Islam A: Trends in sociodemographic and health-related indicators in Bangladesh, 1993-2007: will inequities persist? *Bull World Health Organ* 2011, 89:583-593.
40. Countdown Equity Analysis G, Boerma JT, Bryce J, Kinfu Y, Axelson H, Victora CG: Mind the gap: equity and trends in coverage of maternal, newborn, and child health services in 54 Countdown countries. *Lancet* 2008, 371:1259-1267.
41. Quayyum Z, Khan MN, Quayyum T, Nasreen HE, Chowdhury M, Ensor T: "Can community level interventions have an impact on equity and utilization of maternal health care" - evidence from rural Bangladesh. *International journal for equity in health* 2013, 12:22.
42. Simkhada B, Teijlingen ER, Porter M, Simkhada P: Factors affecting the utilization of antenatal care in developing countries: systematic review of the literature. *J Adv Nurs* 2008, 61:244-260.
43. National Institute of Population Research and Training (NIPORT), Mitra and Associates, Macro International: Bangladesh Demographic and Health Survey 2007. Dhaka, Bangladesh and Calverton, Maryland, USA: National Institute of Population Research and Training, Mitra and Associates, and Macro International; 2009.
44. Nahar S, Costello A: The hidden cost of 'free' maternity care in Dhaka, Bangladesh. *Health Policy Plan* 1998, 13:417-422.
45. Adams AM, Rabbani A, Ahmed S, Mahmood SS, Al-Sabir A, Rashid SF, Evans TG: Explaining equity gains in child survival in Bangladesh: scale, speed, and selectivity in health and development. *Lancet* 2013, 382:2027-2037.
46. Zere E, Suehiro Y, Arifeen A, Moonesinghe L, Chanda SK, Kirigia JM: Equity in reproductive and maternal health services in Bangladesh. *International journal for equity in health* 2013, 12:90.
47. Nguyen HT, Hatt L, Islam M, Sloan NL, Chowdhury J, Schmidt JO, Hossain A, Wang H: Encouraging maternal health service utilization: an evaluation of the Bangladesh voucher program. *Soc Sci Med* 2012, 74:989-996.
48. Ahmed S, Khan MM: Is demand-side financing equity enhancing? Lessons from a maternal health voucher scheme in Bangladesh. *Soc Sci Med* 2011, 72:1704-1710.



49. Moran AC, Kerber K, Sitrin D, Guenther T, Morrissey CS, Newby H, Fishel J, Yoder PS, Hill Z, Lawn JE: Measuring coverage in MNCH: indicators for global tracking of newborn care. *PLoS Med* 2013, 10:e1001415.

## CHAPTER 4:

### Examining the relationship between the reproductive and maternal health continuum of care and neonatal mortality: A cross-sectional, multi-country analysis

McDougal, L.<sup>2,\*</sup>; Rusch, ML<sup>3</sup>; Silverman, JG<sup>2,4</sup>; Zúñiga, ML<sup>5</sup>;Raj, A<sup>4</sup>

<sup>1</sup> San Diego State University/University of California, San Diego Joint Doctoral Program in Public Health (Global Health), San Diego, CA USA

<sup>2</sup> Center on Gender Equity and Health, University of California, San Diego, San Diego, CA USA

<sup>3</sup> Island Health, Vancouver, BC Canada

<sup>4</sup> Division of Global Public Health, University of California San Diego School of Medicine, San Diego, CA USA

<sup>5</sup> School of Social Work, San Diego State University, San Diego, CA USA

#### ABSTRACT

**Background:** Nearly three million children die as neonates each year, globally. While evidence-based individual health care interventions to address the major causes of these deaths are known, the effect of serial interventions along the reproductive and maternal health continuum of care (RMH CoC) on neonatal mortality has been understudied. The goal of this study is to measure the association between RMH CoC service utilization and neonatal death.

**Methods:** The sample was comprised of data on the most recent births to women of reproductive age across 29 countries, selected from available Demographic and Health Survey

data since 2008 (n=188,087). We estimated the relationship between RMH CoC service utilization and neonatal mortality via logistic regression models. For this study, the RMH CoC was defined as receipt of pre-pregnancy contraception,  $\geq 4$  antenatal care visits and skilled birth attendance. The primary model assessed the odds of neonatal death among women receiving no services, 1-2 services and all three services. Sub analyses of different combinations of these services were also conducted. Models were run for the full sample, as well as stratified by national neonatal mortality level (low, moderate, high).

**Results:** Overall, only 14% of women reported receiving all three elements of the RMH CoC for their most recent birth; 20% of women received none of these three services. Receipt of all three services, relative to receipt of no services, was associated with reduced odds of neonatal death in the total sample (AOR=0.61, 95% CI 0.52-0.73), as well as for women living in countries with low and moderate NMR levels (AOR=0.34, 95% CI 0.23-0.53 and AOR=0.58, 95% CI 0.44-0.75, respectively). Receipt of 1-2 services was also protective against neonatal mortality in the overall sample, and among women living in countries with low and moderate NMR levels, though this effect was not as strong as the association seen with all three services.

**Conclusion:** Serial utilization of services along the RMH CoC was associated with reduced neonatal mortality in this sample, indicating that increased focus on retention within the RMH CoC is merited. Further examination of differences in these associations across neonatal mortality levels, as well as comparisons of these measures of association with previously published estimates, is needed to better inform programming aimed at reducing neonatal mortality in low and middle income countries globally.

## INTRODUCTION

In 2010, nearly three million children died before reaching one month of age; 98% of those deaths occurred in low and middle income countries [1, 2]. These neonatal deaths comprise 40% of all deaths to children under five years of age, and therefore make neonatal mortality reduction a critical component of efforts to achieve Millennium Development Goal 4, a two-thirds reduction in 1990 levels of child mortality by 2015 [1, 3]. While global neonatal mortality rates have declined at an average of 2.1% per year over the last decade, they represent an ever-increasing proportion of all under-five deaths, as neonatal mortality rates are declining more slowly than under-five mortality rates [1, 3, 4].

The majority of neonatal deaths are caused by preterm birth complications, intra-partum related complications and sepsis or meningitis [1]. Evidence-based interventions to address and prevent these causes have been well documented, and are increasingly being implemented as components of health services delivered along the reproductive, maternal, newborn and child health continuum of care [3, 5-8]. Family planning services [2, 9, 10], antenatal care [6, 8, 11, 12] and skilled birth attendance [6, 8] - key services along the reproductive and maternal health continuum of care (RMH CoC) - are the primary services in which these interventions are delivered. Postnatal care for babies is additional important point of contact for neonatal mortality reduction [6, 8, 13, 14], though estimates of coverage are hindered by major gaps in data availability [15, 16].

There is broad advocacy for the application of the continuum of care approach to improving the survival and health of women and children [7, 17, 18]. Previous research has documented an association between individual interventions along the RMH CoC and neonatal deaths [5, 9-12, 19-24]. Thus far, however, estimates of the effect of combined packages of health interventions on health outcomes, including neonatal mortality, have been

derived from mathematical modeling and expert opinion [5, 6, 21]. The majority of data on which the assumptions for mathematical modeling were based were research studies that measured associations in controlled settings, rather than data gathered from real-world settings which are more reflective of the expected impact of national programmatic and coverage changes [5, 6]. Measurement of the relationship between serial utilization of interventions across the RMH CoC and their combined impact on neonatal outcomes within national health systems contexts remain largely untested and of potential greater relevance to inform intervention development and its strategic application[17].

The goal of this analysis, therefore, is to measure the association between utilization of services along the RMH CoC and neonatal mortality among women living in low and middle income countries globally.

## **METHODS**

### **Sample**

Data were drawn from the Demographic and Health Surveys, publicly available survey data gathered in low- and middle-income countries globally by Measure DHS with information included on a range of reproductive, maternal and child health topics [25]. For this study, we selected countries that had a recently collected standard DHS (completed in 2008 or later), had collected reproductive calendar data, and were available as of October 2013. Twenty-nine countries were eligible for inclusion: Albania, Armenia, Bangladesh, Bolivia, Burkina Faso, Burundi, Cambodia, Colombia, Egypt, Ethiopia, Ghana, Guyana, Honduras, Indonesia, Kenya, Lesotho, Madagascar, Malawi, Maldives, Mozambique, Nepal, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Timor-Leste, Uganda and Zimbabwe. All countries interviewed all eligible women in selected households, excepting Bangladesh, Egypt

and the Maldives, who interviewed only ever-married women. Response rates among eligible women ranged from 85.3% (Maldives) to 99.7% (Egypt) (Table 4.1). The sample was further restricted to women aged 15-49 with a live birth in the past 5 years that occurred at least 1 month prior to their interview, to allow for completion of the neonatal period. Women with multiple births (e.g., twins) were excluded due to heightened risk of neonatal mortality [26]. Women with missing values for any dependent or independent variables were also excluded, for a total of 188,087 observations.

### **Measures**

Neonatal mortality, the death of a child within the first 28 days of life, was the dependent variable, and was operationalized as the death of the most recent child at less than one month after birth to avoid age heaping [27, 28].

The primary independent variable was RMH CoC utilization, which focuses on receipt of pre-pregnancy contraception,  $\geq 4$  antenatal care (ANC) visits and skilled birth attendance (SBA). To assess the level of utilization along the RMH CoC, the primary independent variable contained three categories: no services, 1-2 services, and all three services. Data on postnatal care for the baby, while an important aspect of neonatal mortality prevention [6, 8, 13, 14], was originally collected only for newborns born at home [15]. This approach has since been modified to include all newborns regardless of place of birth, but this adjustment was recent enough that only 9 of the surveys in this sample collected information on postnatal care for babies; this metric was therefore not included in this analysis. Pre-pregnancy contraception was defined as the use of modern contraception (the pill, IUDs, injections, diaphragm, implants, male condoms, female condoms, foam or jelly, female sterilization and male sterilization) in the time period between five years prior to interview and the most recent birth, or between the birth of the penultimate child and the most recent birth,

whichever window was shorter. ANC visits were measured as a discrete number of visits, irrespective of provider skill level, and categorized into  $<4$  (including none) and  $\geq 4$  (the current WHO-recommended minimum [29]). There is ongoing discussion as to the appropriate number of ANC visits in resource limited settings [30], but evidence indicates an increased risk of perinatal mortality and increased maternal dissatisfaction associated with reduced numbers of visits [31]. Country-specific definitions of skilled birth attendance were obtained from individual country DHS Final Reports[25], but generally included births attended by a doctor, nurse, midwife or auxiliary midwife; SBA was defined irrespective of delivery location.

Recognizing that major drivers of neonatal mortality include social inequities [11, 32-34], covariates included household wealth quintile (poorest/poorer/middle/richer/richest), residence (urban/rural), maternal education (none/any primary/any secondary or higher), as well as maternal age at birth of most recent child ( $\leq 17/18-24/35-49$ ) and parity ( $1/2/\geq 3$ ). Wealth quintile was calculated and provided by Measure DHS based on a principal components analysis of household assets and characteristics, and is a relative measure in each country [35].

### **Analysis**

Descriptive statistics were calculated to assess the frequency of neonatal mortality and RMH CoC service utilization in each country in this sample. Logistic regression was used to assess the overall relationship between RMH CoC utilization and neonatal mortality, with unadjusted models controlling only for country fixed effects, and adjusted models controlling for all covariates and country fixed effects. In addition to the overall estimates, stratified estimates were calculated by neonatal mortality rate (NMR) level. Women were categorized based on their national neonatal mortality rates at the year of survey administration [36].

Categorizations were created following Lawn et al.'s country-level NMR groups [37], with very low (n=0) and low (n=7) mortality, and high (n=6) and very high (n=1) collapsed due to sample size limitations. Categories were therefore low NMR ( $\leq 15$  neonatal deaths per 1000 live births), moderate NMR (16-30) and high NMR ( $\geq 31$ ) (Table 4.1). Separate unadjusted and adjusted regression models were run for each stratum. Unadjusted analyses are presented in Appendix Tables 4.2 and 4.3.

To better understand variability in the “1-2 services” continuum of care category, an exploratory analysis was conducted in which the primary independent variable had eight categories: No services, pre-pregnancy contraception only,  $\geq 4$  ANC visits only, SBA only, pre-pregnancy contraception and  $\geq 4$  ANC visits, pre-pregnancy contraception and SBA only,  $\geq 4$  ANC visits and SBA only, and all 3 services.

All analyses included adjustment for clustering and stratification used in the survey designs. Regression analyses and descriptive statistics for the overall sample and neonatal mortality groups were unweighted. Country-level descriptive statistics were weighted using individual sampling weights provided by Measure DHS. All analyses were conducted using Stata SE 13.

Ethical approval for this analysis was provided by the University of California, San Diego IRB.

## **RESULTS**

Among all women in this sample, 1.6% of the 188,087 singleton births resulted in neonatal deaths, ranging from 0.5% in Albania to 3.2% in Lesotho (Table 4.2). Across neonatal mortality groups, slightly less than 1% of women living in low NMR countries



experienced neonatal death at their most recent birth, compared to 2.3% of those living in high NMR countries.

With regard to RMH CoC, only 14% of the sample reported using all three services assessed, though this ranged from 33% among women living in low NMR countries to 8% and 6% among women living in moderate and high NMR countries, respectively (Table 4.2). In contrast, 20% of the sample reported no services for their most recent pregnancy (ranging from 4% among women from low NMR countries to 22% among women from moderate NMR countries to 36% among women from high NMR countries). Utilization of 1-2 services was reported by 66% of all women, ranging from 63% among women in countries with low NMR, to 71% among women living in countries with moderate NMR levels, and 58% among women in countries with high NMR.

In adjusted analyses, utilization of all three services was protective against neonatal deaths, as compared to no services, in the overall sample (AOR=0.61, 95% CI=0.52-0.73), as well as for women living in countries with low and moderate NMR levels (AOR=0.34, 95% CI 0.23-0.53 and AOR=0.58, 95% CI 0.44-0.75, respectively; Table 4.3), but not for women living in countries with high NMR levels. Utilization of 1-2 services followed the same pattern, but tended to be less protective than utilization of all three services; this difference was statistically significant for women living in countries with moderate levels of neonatal mortality.

To better explore the “1-2 services” category, this level was broken into all combinations of services contained therein (Appendix Table 4.1). Among the 1-2 services groupings,  $\geq 4$  ANC visits was the only health services variable that was more protective than no services for the overall sample as well as for all three NMR levels (ranging from a 65% lower odds for women living in low NMR countries to a 23% lower odds of neonatal death for

women living in high NMR countries) (Table 4.4). The combination of  $\geq 4$  ANC visits and SBA was more protective relative to no services for the overall sample (AOR=0.84, 95% CI 0.74-0.96) and for women living in countries with low and moderate NMR levels (AOR=0.46, 95% CI=0.31-0.70 and AOR=0.81, 95% CI=0.69-0.96, respectively). Women who reported pre-pregnancy contraceptive use and SBA had a 26% increased odds of neonatal mortality relative to women using no services in the overall sample, but not in any of the neonatal mortality level stratifications. Pre-pregnancy contraception alone and skilled birth attendance alone were not significantly associated with neonatal mortality.

## **DISCUSSION**

A minority of women (14%) across the 29 low and middle income countries included in the current analyses reported utilization of all three RMH CoC services, indicating that the continuum of care is not being used as a continuum in practice. Within the country-level NMR stratifications, utilization of all three services was over five times higher among women living in low NMR countries (33%) than women living in high NMR countries (6%). Utilization of no services was more than eight times lower among women living in low NMR countries (4%) compared with women living in high NMR countries (36%). Across the total sample, serial utilization of services along the reproductive and maternal health continuum of care was protective against neonatal mortality. While the use of 1-2 services was associated with reduced odds of neonatal death, the strongest association was seen in women who used all three services, who had a 39% lower odds of neonatal death relative to those who used no services. Across neonatal mortality groups, RMH CoC use was most protective for women living in low NMR countries, where the need is least. There was no significant protective

association for women living in high NMR countries, where the need for improved neonatal survival is greatest.

These findings suggest that for many women, particularly women living in low and moderate NMR countries, there is a neonatal survival benefit from accessing pre-pregnancy contraception, antenatal care and skilled birth attendance in serial combination, supporting an increased focus on retention within the continuum. Several factors may contribute to the lack of an association between RMH CoC use and neonatal death seen among women living in countries with high NMR. First, only 6% of women in this group used all three services, resulting in wider confidence intervals than seen in the low and moderate NMR groups. Second, there is likely substantial variation in the quality and contents of services – particularly skilled birth attendance[38] - across settings. These factors, including specific health care interventions offered, patient satisfaction, health care workers' knowledge, patient record quality, etc., influence both utilization and outcomes [38-44], and could not be measured with the data available. Finally, women living in high NMR countries were the only group for whom the combination of  $\geq 4$  ANC visits and SBA was not protective against neonatal mortality. Given that  $\geq 4$  ANC visits alone was associated with a 23% reduced odds of neonatal death in this group, it may be that utilization of skilled birth attendance is a marker for a higher risk pregnancy or complicated delivery in this population.

This lack of a protective effect of SBA alone on neonatal mortality, and indeed a non-significant trend towards higher risk, may thus be in part the result of women identified as higher risk at prior health care encounters and advised to seek skilled birth attendance, or who experienced delivery complications and reached a skilled attendant during a protracted or otherwise dangerous labor. This is consistent with the fact that 60% of antenatal care attendees in this sample reported being informed of signs of pregnancy complications, and

with other studies finding adverse outcomes associated with skilled birth attendance and facility deliveries, particularly in settings with low coverage of skilled birth attendance [12, 40, 45-47]. This does not suggest that skilled birth attendance is ineffective in reducing neonatal mortality, but rather that it may be an inadequate indicator of the quality and components of care received within that skilled attendance [48], and that access to and demand for patient safety and service efficacy are critical aspects of utilization, and consequently outcomes [49].

The only instance in which RMH CoC utilization was found to increase the odds of neonatal death was among the 4% of women who used only pre-pregnancy contraception and skilled birth attendance, who had a 26% increased odds of neonatal death. Neither of these services individually was significantly associated with a higher odds of neonatal death. Similar to the arguments made above relating to the lack of protective effect of SBA alone, this may again be a marker that many of the women receiving skilled birth attendance are at an increased risk of perinatal complications. This was an unexpected result with no clear explanatory mechanism, and warrants further investigation.

Antenatal care was the strongest individual driver of neonatal mortality reduction in this sample, both overall (32% lower odds) and across stratifications (65%/34%/23% lower odds among women living in countries with low, moderate and high NMR levels, respectively). Antenatal care was also protective when received with pre-pregnancy contraception (for women living in low NMR countries), when received with SBA (for the overall sample, as well as women living in low and moderate NMR countries) and when received with both pre-pregnancy contraception and SBA (for the overall sample, as well as women living in low and moderate NMR countries). While this exploratory analysis has wider confidence intervals due to smaller cell sizes, these patterns are consistent with previous

research [11, 50], and emphasize the importance of ANC within the RMH CoC. This is not to suggest that ANC is sufficient as a standalone intervention, but may again point to challenges in measuring the content and quality of services through point of contact coverage metrics [38-44].

This study has important limitations. Reductions in neonatal mortality are driven by the delivery of specific, quality interventions. The general service categories used in this analysis (pre-pregnancy contraception, antenatal care, skilled birth attendance) do not capture the contents or quality of health services and health education provided within these encounters; this information was not gathered as part of the DHS. Additionally, while the DHS are the best available data for assessing service utilization at the individual level across multiple countries, its measurements of utilization do not address availability of, or access to, services, both of which are necessary precursors to utilization; data on the latter were unavailable in assessed surveys, making it impossible to distinguish between access to vs. demand for assessed measures. Pre-pregnancy contraceptive use is not as sensitive a metric as unmet need for family planning (the percentage of women who want to avoid pregnancy but are not using contraception)[51]; however, unmet need cannot be calculated for timepoints in the past using data collected in the DHS. Skill level of the antenatal care provider, an important component of quality service delivery, was not included because it is not reported separately for each ANC visit. As previously mentioned, data on postnatal care for babies, a key step in the continuum of care as relates to neonatal mortality [6, 8, 13, 14], was not collected in an adequate number of surveys to be included in this analysis. These data are also subject to recall bias, and social desirability bias, though the use of the most recent birth in the last 5 years is intended to reduce the former. HIV status, a known barrier to maternal health service utilization due to stigma [52, 53], that also impacts child survival [37, 54], was only

measured at the time of survey in a subset of surveys used; it was therefore impossible to ascertain a woman's serostatus at the time she accessed the services examined.

Our results vary from published estimates, in which 20%-30% of neonatal mortality could be averted through skilled birth attendance [5]. These previous estimates relied heavily on research from controlled settings, rather than data from national health systems contexts [5, 6]. While our results are constrained by the aforementioned limitations, they do suggest that revisiting the assumptions on which modeled reductions in neonatal mortality are based could offer more accurate, "real-world" estimates of the effect of service utilization along the RMH CoC on neonatal mortality. In parallel, efforts are needed to more comprehensively assess the quality and components of interventions being delivered during skilled birth attendance in particular, and to ensure that services being provided are in fact "effective coverage" [43].

## **CONCLUSION**

Our findings empirically demonstrate that serial utilization of services along the reproductive and maternal health continuum of care is protective against neonatal mortality, that utilization of all three of the services assessed is overall more protective than one or two services, and that the strongest protective associations are seen for women living in countries with low and moderate levels of neonatal mortality. These results highlight the need for increased efforts to improve serial utilization of health services along the RMH CoC, as 86% of the women in this sample did not receive all three services. Although the associations between service utilization along the RMH CoC and neonatal mortality are weaker for women living in high NMR countries, this is also where there is the greatest need, and where there are greater opportunities for improvements in coverage across, and retention within, the RMH CoC. Further examination of the reasons for the variations in association strengths across

neonatal mortality levels, as well as the effect sizes themselves, in comparison with previously published, efficacy-based estimates, is needed to inform the burgeoning body of programmatic, policy and research initiatives aimed at reducing the 3 million annual neonatal deaths.

## ACKNOWLEDGEMENTS

This analysis was funded by an American Fellowship from AAUW and a grant from the David and Lucile Packard Foundation (No. 2013-39405).

Chapter 4, in full, is currently being prepared for submission for publication of the material. McDougal, L; Rusch, ML; Silverman, JG; Zúñiga, ML; Raj, A.: *Examining the relationship between the reproductive and maternal health continuum of care and neonatal mortality: A cross-sectional, multi-country analysis*. Lotus McDougal was the primary investigator and author of this material.



## TABLES

**Table 4.1:** Select background characteristics of countries included in analysis.

Country	Survey year	Eligible women response rate	Neonatal mortality rate <sup>1</sup> / 1,000 live births (in survey year)	NMR level <sup>2</sup>
Albania	2008-09	98.1%	9.4	Low
Armenia	2010	97.7%	11	Low
Bangladesh	2011	97.9%	25.6	Moderate
Bolivia	2008	95.9%	21.4	Moderate
Burkina Faso	2010-11	98.4%	29.4	Moderate
Burundi	2010-11	96.4%	36.9	High
Cambodia	2010-11	97.5%	19.7	Moderate
Colombia	2009-10	93.6%	12.2	Low
Egypt	2008	99.7%	13.9	Low
Ethiopia	2010-11	95.0%	31.1	High
Ghana	2008	96.5%	30.6	Moderate
Guyana	2009	90.1%	20.7	Moderate
Honduras	2011-12	93.2%	11.8	Low
Indonesia	2012	95.9%	15	Low
Kenya	2008-09	96.3%	28.9	Moderate
Lesotho	2009-10	97.9%	45.9	High
Madagascar	2008-09	95.6%	24.7	Moderate
Malawi	2010	96.9%	26.2	Moderate
Maldives	2009	85.3%	8.5	Low
Mozambique	2011	99.1%	31.3	High
Nepal	2011	98.1%	25	Moderate
Nigeria	2008	96.5%	42.2	High
Rwanda	2010-11	99.1%	23	Moderate
Senegal	2010-11	92.7%	26.3	Moderate
Sierra Leone	2008	94.0%	52.2	High
Tanzania	2009-10	96.4%	23.8	Moderate
Timor-Leste	2009-10	95.2%	26.6	Moderate
Uganda	2011	93.8%	23.6	Moderate
Zimbabwe	2010-11	93.3%	38.3	High

<sup>1</sup> Estimates from the UN Inter-agency Group for Child Mortality Estimation [36].

<sup>2</sup> Based on neonatal mortality rate groupings from Lawn (2009) [37].

**Table 4.2:** Frequency of neonatal deaths and reproductive and maternal health service utilization for most recent pregnancy in the past five years.

Grouping/ Country	Sample size (unwtd.)	Neonatal deaths (%)	Reproductive and maternal health continuum of care (%)		
			No services	1-2 services	3 services
Total <sup>1</sup>	188,087	1.6%	20.4%	65.6%	14.0%
<b>Neonatal mortality level<sup>1</sup></b>					
Low NMR <sup>2</sup>	50,303	0.9%	4.2%	63.1%	32.8%
Moderate NMR <sup>3</sup>	91,839	1.6%	21.6%	70.6%	7.8%
High NMR <sup>4</sup>	45,945	2.3%	35.7%	58.4%	6.0%
<b>Country<sup>5</sup></b>					
Albania	1,304	0.5%	0.7%	95.3%	4.0%
Armenia	1,114	0.6%	0.1%	88.4%	11.5%
Bangladesh	7,138	1.6%	32.8%	60.0%	7.2%
Bolivia	6,287	1.9%	14.3%	67.4%	18.3%
Burkina Faso	9,964	1.3%	22.1%	75.1%	2.8%
Burundi	4,772	1.9%	25.7%	71.5%	2.7%
Cambodia	6,302	1.7%	15.6%	75.5%	8.9%
Colombia	14,043	0.8%	1.3%	51.3%	47.4%
Egypt	7,701	0.9%	7.0%	66.7%	26.3%
Ethiopia	7,496	2.5%	64.3%	32.3%	3.4%
Ghana	2,009	1.7%	8.2%	78.9%	12.9%
Guyana	1,295	1.9%	0.8%	75.9%	23.3%
Honduras	8,548	1.2%	0.6%	50.2%	49.2%
Indonesia	14,783	0.8%	3.8%	66.8%	29.4%
Kenya	3,886	2.1%	26.8%	61.0%	12.2%
Lesotho	3,007	3.2%	9.5%	74.2%	16.4%
Madagascar	8,293	1.6%	23.9%	69.7%	6.5%
Malawi	13,159	1.8%	11.1%	77.6%	11.3%
Maldives	2,810	0.6%	0.4%	83.9%	15.7%
Mozambique	7,253	2.1%	25.1%	71.2%	3.7%
Nepal	4,007	1.8%	32.8%	59.4%	7.8%
Nigeria	16,056	2.5%	44.7%	51.3%	4.0%
Rwanda	6,161	1.3%	20.1%	76.3%	3.6%
Senegal	7,721	1.8%	21.4%	74.0%	4.6%
Sierra Leone	3,131	2.8%	23.0%	74.0%	3.0%
Tanzania	5,159	1.6%	25.9%	66.9%	7.2%
Timor-Leste	5,815	1.5%	32.9%	65.1%	2.0%
Uganda	4,643	1.7%	20.9%	70.8%	8.3%
Zimbabwe	4,230	1.7%	9.9%	69.6%	20.5%

<sup>1</sup> Percentages are unweighted.

<sup>2</sup> Albania, Armenia, Bolivia, Cambodia, Colombia, Egypt, Guyana, Honduras, Indonesia, Maldives.

<sup>3</sup> Bangladesh, Madagascar, Malawi, Nepal, Rwanda, Senegal, Tanzania, Timor-Leste, Uganda.

<sup>4</sup> Burkina Faso, Burundi, Ethiopia, Ghana, Kenya, Lesotho, Mozambique, Nigeria, Sierra Leone, Zimbabwe.

<sup>5</sup> Percentages are weighted.

**Table 4.3:** Adjusted relationship between reproductive and maternal health continuum of care utilization and neonatal mortality, overall and stratified by neonatal mortality level.

	All countries (n=188,087)	Low NMR <sup>1</sup> (n= 50,303)	Moderate NMR <sup>2</sup> (n= 91,839)	High NMR <sup>3</sup> (n= 45,945)
	AOR (95% CI) <sup>4</sup>	AOR (95% CI) <sup>4</sup>	AOR (95% CI) <sup>4</sup>	AOR (95% CI) <sup>4</sup>
No services	1.00	1.00	1.00	1.00
1-2 services	<b>0.90 (0.81, 0.99)</b>	<b>0.55 (0.38, 0.81)</b>	<b>0.87 (0.77, 0.99)</b>	0.98 (0.83, 1.15)
3 services	<b>0.61 (0.52, 0.73)</b>	<b>0.34 (0.23, 0.53)</b>	<b>0.58 (0.44, 0.75)</b>	0.85 (0.61, 1.20)

Bold indicates p<0.05

<sup>1</sup> Albania, Armenia, Colombia, Egypt, Honduras, Indonesia, Maldives.

<sup>2</sup> Bangladesh, Bolivia, Burkina Faso, Cambodia, Ghana, Guyana, Kenya, Madagascar, Malawi, Nepal, Rwanda, Senegal, Tanzania, Timor-Leste, Uganda.

<sup>3</sup> Burundi, Ethiopia, Lesotho, Mozambique, Nigeria, Sierra Leone, Zimbabwe.

<sup>4</sup> Adjusted for household wealth quintile, urban/rural residence, maternal education, maternal age at birth of most recent child, parity and country fixed effects.

**Table 4.4:** Adjusted relationship between reproductive and maternal health continuum of care utilization and neonatal mortality, overall and stratified by neonatal mortality level.

	All countries (n=188,087)	Low NMR <sup>1</sup> (n= 50,303)	Moderate NMR <sup>2</sup> (n= 91,839)	High NMR <sup>3</sup> (n= 45,945)
	AOR (95% CI) <sup>4</sup>	AOR (95% CI) <sup>4</sup>	AOR (95% CI) <sup>4</sup>	AOR (95% CI) <sup>4</sup>
No services	1.00	1.00	1.00	1.00
Pre-pregnancy contraception only	0.97 (0.78, 1.22)	0.62 (0.31, 1.26)	0.79 (0.58, 1.07)	1.43 (0.998, 2.06)
≥4 ANC visits only	<b>0.68 (0.59, 0.80)</b>	<b>0.35 (0.19, 0.66)</b>	<b>0.66 (0.54, 0.82)</b>	<b>0.77 (0.61, 0.96)</b>
SBA only	1.12 (0.99, 1.28)	0.76 (0.49, 1.19)	1.08 (0.92, 1.27)	1.18 (0.94, 1.49)
Pre-pregnancy contraception and ≥4 ANC visits only	0.86 (0.65, 1.15)	<b>0.40 (0.19, 0.87)</b>	0.88 (0.60, 1.30)	0.99 (0.61, 1.62)
Pre-pregnancy contraception and SBA only	<b>1.26 (1.05, 1.52)</b>	1.07 (0.67, 1.69)	1.09 (0.85, 1.39)	1.18 (0.76, 1.84)
≥4 ANC visits and SBA only	<b>0.84 (0.74, 0.96)</b>	<b>0.46 (0.31, 0.70)</b>	<b>0.81 (0.69, 0.96)</b>	0.99 (0.81, 1.22)
Pre-pregnancy contraception, ≥4 ANC visits and SBA	<b>0.62 (0.52, 0.75)</b>	<b>0.34 (0.22, 0.52)</b>	<b>0.59 (0.45, 0.77)</b>	0.89 (0.63, 1.25)

Bold indicates p<0.05

<sup>1</sup> Albania, Armenia, Colombia, Egypt, Honduras, Indonesia, Maldives.

<sup>2</sup> Bangladesh, Bolivia, Burkina Faso, Cambodia, Ghana, Guyana, Kenya, Madagascar, Malawi, Nepal, Rwanda, Senegal, Tanzania, Timor-Leste, Uganda.

<sup>3</sup> Burundi, Ethiopia, Lesotho, Mozambique, Nigeria, Sierra Leone, Zimbabwe.

<sup>4</sup> Adjusted for household wealth quintile, urban/rural residence, maternal education, maternal age at birth of most recent child, parity and country fixed effects.

## APPENDIX

**Appendix Table 4.1:** Individual reproductive and maternal health service utilization frequencies for most recent pregnancy in the past five years.

	No services	Pre-pregnancy contraception only	≥4 ANC visits only	SBA only	Pre-pregnancy contraception and ≥4 ANC visits only	Pre-pregnancy contraception and SBA only	≥4 ANC visits and SBA only	Pre-pregnancy contraception, ≥4 ANC visits and SBA
Total <sup>1</sup>	20.4%	3.1%	9.6%	15.3%	2.0%	4.1%	31.5%	14.0%
<b>Neonatal mortality level<sup>1</sup></b>								
Low NMR <sup>2</sup>	4.2%	1.8%	3.9%	7.1%	2.2%	4.3%	43.8%	32.8%
Moderate NMR <sup>3</sup>	21.6%	4.1%	10.6%	21.4%	2.0%	5.0%	27.6%	7.8%
High NMR <sup>4</sup>	35.7%	2.5%	13.9%	12.2%	2.0%	2.1%	25.6%	6.0%
<b>Country<sup>5</sup></b>								
Albania	0.7%	0.0%	0.0%	30.8%	0.0%	1.4%	63.1%	4.0%
Armenia	0.1%	0.0%	0.0%	4.7%	0.0%	0.4%	83.3%	11.5%
Bangladesh	32.8%	27.9%	4.7%	8.4%	5.2%	7.1%	6.6%	7.2%
Bolivia	14.3%	0.6%	9.0%	10.9%	1.2%	2.0%	43.8%	18.3%
Burkina Faso	22.1%	0.5%	4.5%	40.1%	0.1%	3.7%	26.2%	2.8%
Burundi	25.7%	1.9%	9.1%	35.4%	0.6%	3.5%	21.1%	2.7%
Cambodia	15.6%	2.3%	6.9%	18.9%	1.3%	3.6%	42.6%	8.9%
Colombia	1.3%	0.6%	1.4%	4.7%	0.9%	3.7%	40.0%	47.4%
Egypt	7.0%	5.8%	4.1%	10.4%	3.6%	10.0%	32.9%	26.3%
Ethiopia	64.3%	10.8%	9.7%	3.7%	2.6%	2.0%	3.7%	3.4%
Ghana	8.2%	0.9%	12.0%	9.1%	2.0%	1.8%	53.1%	12.9%
Guyana	0.8%	0.1%	3.0%	6.6%	0.8%	1.0%	64.4%	23.3%
Honduras	0.6%	0.4%	1.1%	5.6%	0.7%	4.6%	37.9%	49.2%
Indonesia	3.8%	1.5%	6.5%	3.9%	3.5%	2.1%	49.3%	29.4%
Kenya	26.8%	6.5%	13.3%	12.5%	4.9%	5.9%	18.0%	12.2%
Lesotho	9.5%	2.0%	10.4%	11.8%	3.9%	4.5%	41.5%	16.4%
Madagascar	23.9%	1.8%	12.1%	21.8%	1.3%	2.8%	29.9%	6.5%
Malawi	11.1%	4.0%	6.4%	26.7%	2.7%	12.2%	25.6%	11.3%
Maldives	0.4%	0.0%	3.4%	1.8%	0.3%	0.2%	78.2%	15.7%
Mozambique	25.1%	0.5%	15.9%	21.6%	0.8%	1.5%	30.9%	3.7%
Nepal	32.8%	5.0%	13.5%	10.1%	3.8%	1.8%	25.2%	7.8%
Nigeria	44.7%	0.5%	15.5%	5.0%	1.0%	0.4%	28.9%	4.0%
Rwanda	20.1%	1.5%	5.8%	37.1%	0.7%	5.9%	25.4%	3.6%
Senegal	21.4%	0.7%	10.8%	24.4%	0.5%	2.2%	35.4%	4.6%
Sierra Leone	23.0%	0.6%	32.6%	8.1%	1.2%	0.4%	31.1%	3.0%

Appendix Table 4.1: continued

	No services	Pre-pregnancy contraception only	≥4 ANC visits only	SBA only	Pre-pregnancy contraception and ≥4 ANC visits only	Pre-pregnancy contraception and SBA only	≥4 ANC visits and SBA only	Pre-pregnancy contraception, ≥4 ANC visits and SBA
Tanzania	25.9%	4.0%	13.3%	20.4%	2.3%	6.6%	20.3%	7.2%
Timor-Leste	32.9%	0.8%	31.6%	10.5%	1.3%	0.6%	20.4%	2.0%
Uganda	20.9%	3.3%	12.5%	21.8%	2.0%	5.6%	25.7%	8.3%
Zimbabwe	9.9%	6.0%	8.9%	10.0%	8.0%	8.1%	28.7%	20.5%

<sup>1</sup> Percentages are unweighted.

<sup>2</sup> Albania, Armenia, Bolivia, Cambodia, Colombia, Egypt, Guyana, Honduras, Indonesia, Maldives.

<sup>3</sup> Bangladesh, Madagascar, Malawi, Nepal, Rwanda, Senegal, Tanzania, Timor-Leste, Uganda.

<sup>4</sup> Burkina Faso, Burundi, Ethiopia, Ghana, Kenya, Lesotho, Mozambique, Nigeria, Sierra Leone, Zimbabwe.

<sup>5</sup> Percentages are weighted.

**Appendix Table 4.2:** Unadjusted relationship between reproductive and maternal health continuum of care utilization and neonatal mortality, overall and stratified by neonatal mortality level.

	All countries (n=188,087)	Low NMR <sup>1</sup> (n=50,303)	Moderate NMR <sup>2</sup> (n= 91,839)	High NMR <sup>3</sup> (n= 45,945)
	OR (95% CI) <sup>4</sup>	OR (95% CI) <sup>4</sup>	OR (95% CI) <sup>4</sup>	OR (95% CI) <sup>4</sup>
No services	1.00	1.00	1.00	1.00
1-2 services	0.92 (0.84, 1.01)	<b>0.54 (0.38, 0.77)</b>	0.90 (0.80, 1.02)	1.00 (0.87, 1.16)
3 services	<b>0.61 (0.51, 0.72)</b>	<b>0.34 (0.23, 0.50)</b>	<b>0.57 (0.44, 0.74)</b>	0.85 (0.62, 1.17)

Bold indicates p<0.05

<sup>1</sup> Albania, Armenia, Colombia, Egypt, Honduras, Indonesia, Maldives.

<sup>2</sup> Bangladesh, Bolivia, Burkina Faso, Cambodia, Ghana, Guyana, Kenya, Madagascar, Malawi, Nepal, Rwanda, Senegal, Tanzania, Timor-Leste, Uganda.

<sup>3</sup> Burundi, Ethiopia, Lesotho, Mozambique, Nigeria, Sierra Leone, Zimbabwe.

<sup>4</sup> Adjusted for country fixed effects, but no covariates.

**Appendix Table 4.3:** Unadjusted relationship between reproductive and maternal health continuum of care utilization and neonatal mortality, overall and stratified by neonatal mortality level.

	All countries (n=188,087)	Low NMR <sup>1</sup> (n=50,303)	Moderate NMR <sup>2</sup> (n= 91,839)	High NMR <sup>3</sup> (n= 45,945)
	OR (95% CI) <sup>4</sup>	OR (95% CI) <sup>4</sup>	OR (95% CI) <sup>4</sup>	OR (95% CI) <sup>4</sup>
No services	1.00	1.00	1.00	1.00
Pre-pregnancy contraception only	0.93 (0.75, 1.17)	0.63 (0.31, 1.27)	0.75 (0.55, 1.02)	1.37 (0.95, 1.97)
≥4 ANC visits only	<b>0.69 (0.60, 0.80)</b>	<b>0.35 (0.19, 0.65)</b>	<b>0.67 (0.54, 0.83)</b>	<b>0.77 (0.62, 0.96)</b>
SBA only	<b>1.16 (1.03, 1.31)</b>	0.78 (0.50, 1.21)	1.12 (0.97, 1.31)	1.21 (0.97, 1.51)
Pre-pregnancy contraception and ≥4 ANC visits only	0.83 (0.63, 1.10)	<b>0.39 (0.18, 0.83)</b>	0.85 (0.58, 1.25)	0.94 (0.58, 1.53)
Pre-pregnancy contraception and SBA only	<b>1.23 (1.02, 1.47)</b>	1.09 (0.70, 1.71)	1.05 (0.83, 1.34)	1.14 (0.74, 1.76)
≥4 ANC visits and SBA only	<b>0.88 (0.78, 0.98)</b>	<b>0.47 (0.33, 0.68)</b>	<b>0.85 (0.73, 0.99)</b>	1.02 (0.86, 1.21)
Pre-pregnancy contraception, ≥4 ANC visits and SBA	<b>0.61 (0.52, 0.72)</b>	<b>0.34 (0.23, 0.50)</b>	<b>0.57 (0.44, 0.74)</b>	0.86 (0.63, 1.19)

Bold indicates p<0.05

<sup>1</sup> Albania, Armenia, Colombia, Egypt, Honduras, Indonesia, Maldives.

<sup>2</sup> Bangladesh, Bolivia, Burkina Faso, Cambodia, Ghana, Guyana, Kenya, Madagascar, Malawi, Nepal, Rwanda, Senegal, Tanzania, Timor-Leste, Uganda.

<sup>3</sup> Burundi, Ethiopia, Lesotho, Mozambique, Nigeria, Sierra Leone, Zimbabwe.

<sup>4</sup> Adjusted for country fixed effects, but no covariates.



## REFERENCES

1. Liu L, Johnson HL, Cousens S, Perin J, Scott S, Lawn JE, Rudan I, Campbell H, Cibulskis R, Li M, Mathers C, Black RE, Child Health Epidemiology Reference Group of WHO, UNICEF: Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *Lancet* 2012, 379:2151-2161.
2. Save the Children: Surviving the First Day: State of the World's Mothers 2013. London; 2013.
3. Lawn JE, Kinney MV, Black RE, Pitt C, Cousens S, Kerber K, Corbett E, Moran AC, Morrissey CS, Oestergaard MZ: Newborn survival: a multi-country analysis of a decade of change. *Health Policy Plan* 2012, 27 Suppl 3:iii6-28.
4. Oestergaard MZ, Inoue M, Yoshida S, Mahanani WR, Gore FM, Cousens S, Lawn JE, Mathers CD, United Nations Inter-Agency Group for Child Mortality E, the Child Health Epidemiology Reference G: Neonatal mortality levels for 193 countries in 2009 with trends since 1990: a systematic analysis of progress, projections, and priorities. *PLoS Med* 2011, 8:e1001080.
5. Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L: Evidence-based, cost-effective interventions: how many newborn babies can we save? *Lancet* 2005, 365:977-988.
6. Darmstadt GL, Walker N, Lawn JE, Bhutta ZA, Haws RA, Cousens S: Saving newborn lives in Asia and Africa: cost and impact of phased scale-up of interventions within the continuum of care. *Health Policy Plan* 2008, 23:101-117.
7. Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE: Continuum of care for maternal, newborn, and child health: from slogan to service delivery. *Lancet* 2007, 370:1358-1369.
8. Lawn JE, Kerber K, Enweronu-Laryea C, Massee Bateman O: Newborn survival in low resource settings--are we delivering? *Bjog* 2009, 116 Suppl 1:49-59.
9. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, Haider BA, Kirkwood B, Morris SS, Sachdev HP, Shekar M, Maternal, Child Undernutrition Study G: What works? Interventions for maternal and child undernutrition and survival. *Lancet* 2008, 371:417-440.
10. Sharma V, Katz J, Mullany LC, Khatry SK, LeClerq SC, Shrestha SR, Darmstadt GL, Tielsch JM: Young maternal age and the risk of neonatal mortality in rural Nepal. *Arch Pediatr Adolesc Med* 2008, 162:828-835.
11. McCurdy RJ, Kjerulff KH, Zhu J: Prenatal care associated with reduction of neonatal mortality in Sub-Saharan Africa: evidence from Demographic and Health Surveys. *Acta Obstet Gynecol Scand* 2011, 90:779-790.

12. Titaley CR, Dibley MJ, Roberts CL: Type of delivery attendant, place of delivery and risk of early neonatal mortality: analyses of the 1994-2007 Indonesia Demographic and Health Surveys. *Health Policy Plan* 2012, 27:405-416.
13. WHO, UNICEF, USAID, Save the Children: WHO-UNICEF Joint Statement on Home Visits for the Newborn Child: a Strategy to Improve Survival. Geneva: World Health Organization; 2009.
14. Lawn JE, Kerber K, Enweronu-Laryea C, Cousens S: 3.6 million neonatal deaths-- what is progressing and what is not? *Semin Perinatol* 2010, 34:371-386.
15. Moran AC, Kerber K, Sitrin D, Guenther T, Morrissey CS, Newby H, Fishel J, Yoder PS, Hill Z, Lawn JE: Measuring coverage in MNCH: indicators for global tracking of newborn care. *PLoS Med* 2013, 10:e1001415.
16. Countdown to 2015: Accountability for maternal, newborn and child survival: The 2013 Update. Geneva: WHO and UNICEF; 2013.
17. Lassi ZS, Majeed A, Rashid S, Yakoob MY, Bhutta ZA: The interconnections between maternal and newborn health - evidence and implications for policy. *J Matern Fetal Neonatal Med* 2013, 26 Suppl 1:3-53.
18. Bhutta ZA, Lassi ZS, Blanc A, Donnay F: Linkages among reproductive health, maternal health, and perinatal outcomes. *Semin Perinatol* 2010, 34:434-445.
19. Barros FC, Bhutta ZA, Batra M, Hansen TN, Victora CG, Rubens CE: Global report on preterm birth and stillbirth (3 of 7): evidence for effectiveness of interventions. *BMC Pregnancy Childbirth* 2010, 10 Suppl 1:S3.
20. The Partnership for Maternal, Newborn and Child Health: Essential interventions, commodities and guidelines for reproductive, maternal, newborn and child health: A global review of the key interventions related to reproductive, maternal, newborn and child health (RMNCH). Geneva: WHO; 2011.
21. Bhutta ZA, Ali S, Cousens S, Ali TM, Haider BA, Rizvi A, Okong P, Bhutta SZ, Black RE: Alma-Ata: Rebirth and Revision 6 Interventions to address maternal, newborn, and child survival: what difference can integrated primary health care strategies make? *Lancet* 2008, 372:972-989.
22. Bhutta ZA, Cabral S, Chan CW, Keenan WJ: Reducing maternal, newborn, and infant mortality globally: An integrated action agenda. *Int JGynaecol Obstet* 2012, 119 Suppl 1:S13-17.
23. Carroli G, Villar J, Piaggio G, Khan-Neelofur D, Gulmezoglu M, Mugford M, Lumbiganon P, Farnot U, Bersgjo P: WHO systematic review of randomised controlled trials of routine antenatal care. *Lancet* 2001, 357:1565-1570.
24. World Health Organization: Packages of Interventions for Family Planning, Safe Abortion Care, Maternal, Newborn and Child Health. Geneva: WHO; 2010.

25. DHS Overview [<http://www.measuredhs.com/What-We-Do/Survey-Types/DHS.cfm>]
26. Keith LG, Oleszczuk JJ, Keith DM: Multiple gestation: reflections on epidemiology, causes, and consequences. *Int J Fertil Womens Med* 2000, 45:206-214.
27. Lawn JE, Cousens S, Zupan J, Lancet Neonatal Survival Steering T: 4 million neonatal deaths: when? Where? Why? *Lancet* 2005, 365:891-900.
28. Neal S: The measurement of neonatal mortality: How reliable is Demographic and Household Survey Data? Southampton, UK: Economic & Social Research Council Centre for Population Change; 2012.
29. World Health Organization: Integrated Management of Pregnancy and Childbirth: Standards for Maternal and Neonatal Care. Geneva; 2007.
30. World Health Organization: WHO Statement on antenatal care. Geneva: WHO; 2011.
31. Dowswell T, Carroli G, Duley L, Gates S, Gulmezoglu AM, Khan-Neelofur D, Piaggio GG: Alternative versus standard packages of antenatal care for low-risk pregnancy. *Cochrane Database Syst Rev* 2010:CD000934.
32. Kinney MV, Kerber KJ, Black RE, Cohen B, Nkrumah F, Coovadia H, Nampala PM, Lawn JE, Science in Action: Saving the lives of Africa's Mothers N, Children working g, Axelson H, Bergh AM, Chopra M, Diab R, Friberg I, Odubanjo O, Walker N, Weissman E: Sub-Saharan Africa's mothers, newborns, and children: where and why do they die? *PLoS Med* 2010, 7:e1000294.
33. Titaley CR, Dibley MJ, Agho K, Roberts CL, Hall J: Determinants of neonatal mortality in Indonesia. *BMC Public Health* 2008, 8:232.
34. Diallo AH, Meda N, Ouedraogo WT, Cousens S, Tylleskar T, Group P-ES: A prospective study on neonatal mortality and its predictors in a rural area in Burkina Faso: can MDG-4 be met by 2015? *J Perinatol* 2011, 31:656-663.
35. Rutstein S, Johnson K: The DHS Wealth Index. Calverton, Maryland: ORC Macro; 2004.
36. Child Mortality Estimates: CME Info [<http://www.childmortality.org/>]
37. Lawn JE, Lee AC, Kinney M, Sibley L, Carlo WA, Paul VK, Pattinson R, Darmstadt GL: Two million intrapartum-related stillbirths and neonatal deaths: where, why, and what can be done? *Int J Gynaecol Obstet* 2009, 107 Suppl 1:S5-18, S19.
38. Wall SN, Lee AC, Carlo W, Goldenberg R, Niermeyer S, Darmstadt GL, Keenan W, Bhutta ZA, Perlman J, Lawn JE: Reducing intrapartum-related neonatal deaths in low- and middle-income countries-what works? *Semin Perinatol* 2010, 34:395-407.
39. van den Broek NR, Graham WJ: Quality of care for maternal and newborn health: the neglected agenda. *Bjog* 2009, 116 Suppl 1:18-21.

40. Moyer CA, Dako-Gyeke P, Adanu RM: Facility-based delivery and maternal and early neonatal mortality in sub-Saharan Africa: a regional review of the literature. *Afr J Reprod Health* 2013, 17:30-43.
41. Moyer CA, Adanu RM, Engmann CM: The relationship between facility-based delivery and maternal and neonatal mortality in Sub-Saharan Africa. *Int J Gynaecol Obstet* 2013, 122:263-265.
42. Graham WJ, McCaw-Binns A, Munjanja S: Translating coverage gains into health gains for all women and children: the quality care opportunity. *PLoS Med* 2013, 10:e1001368.
43. Shengelia B, Tandon A, Adams OB, Murray CJ: Access, utilization, quality, and effective coverage: an integrated conceptual framework and measurement strategy. *Soc Sci Med* 2005, 61:97-109.
44. Nesbitt RC, Lohela TJ, Manu A, Vesel L, Okyere E, Edmond K, Owusu-Agyei S, Kirkwood BR, Gabrysch S: Quality along the Continuum: A Health Facility Assessment of Intrapartum and Postnatal Care in Ghana. *PLoS One* 2013, 8:e81089.
45. Ronsmans C, Chowdhury ME, Koblinsky M, Ahmed A: Care seeking at time of childbirth, and maternal and perinatal mortality in Matlab, Bangladesh. *Bull World Health Organ* 2010, 88:289-296.
46. Nathan R, Mwanyangala MA: Survival of neonates in rural Southern Tanzania: does place of delivery or continuum of care matter? *BMC Pregnancy Childbirth* 2012, 12:18.
47. Lohela TJ, Campbell OM, Gabrysch S: Distance to care, facility delivery and early neonatal mortality in Malawi and Zambia. *PLoS One* 2012, 7:e52110.
48. World Bank Independent Evaluation Group: Delivering the Millennium Development Goal to reduce maternal and child mortality: A systematic review of impact evaluation evidence. Washington, DC: World Bank; 2013.
49. World Health Organization: Quality of care: a process for making strategic choices in health systems. Geneva: World Health Organization; 2006.
50. Pervin J, Moran A, Rahman M, Razzaque A, Sibley L, Streatfield PK, Reichenbach LJ, Koblinsky M, Hruschka D, Rahman A: Association of antenatal care with facility delivery and perinatal survival - a population-based study in Bangladesh. *BMC Pregnancy Childbirth* 2012, 12:111.
51. Bradley SEK, Croft TN, Fishel JD, Westoff CF: Revising Unmet Need for Family Planning. Calverton, MD: ICF International; 2012.
52. Turan JM, Hatcher AH, Medema-Wijnveen J, Onono M, Miller S, Bukusi EA, Turan B, Cohen CR: The role of HIV-related stigma in utilization of skilled childbirth

- services in rural Kenya: a prospective mixed-methods study. *PLoS Med* 2012, 9:e1001295.
53. Turan JM, Nyblade L: HIV-related stigma as a barrier to achievement of global PMTCT and maternal health goals: a review of the evidence. *AIDS Behav* 2013, 17:2528-2539.
  54. Newell ML, Coovadia H, Cortina-Borja M, Rollins N, Gaillard P, Dabis F, Ghent International ASWGoHIViW, Children: Mortality of infected and uninfected infants born to HIV-infected mothers in Africa: a pooled analysis. *Lancet* 2004, 364:1236-1243.

## **CHAPTER 5:**

### **Conclusion**

As a body of work, these findings reveal limited utilization of the reproductive and maternal health continuum of care (RMH CoC) despite indications of its importance. The case study of Bangladesh highlights that serial utilization of, and retention within, the reproductive and maternal health services assessed is uncommon, and is further compromised by social inequities, with the poorest women being least likely to report both any care and serial utilization of services along the RMH CoC. Where serial utilization exists, it is more likely to be limited to services within a particular life stage (reproductive or maternal). Globally, although serial utilization of reproductive and maternal health services is generally very low, that utilization reduces the odds of neonatal mortality. These findings build upon prior work in this area by (1) offering an individual continuum approach to analysis, rather than service-specific or composite measures [1-3], (2) contextualizing linkages between reproductive and maternal health services within a continuum of care [4-11], and (3) assessing health outcomes in relation to that serial utilization in national health systems contexts rather than by examining individual interventions [12-21] or mathematical modeling/expert opinion derived from studies in controlled research settings [4, 12, 19, 22].

There are several direct implications for programs and policies based on this work. First, it is clear that programs attempting to implement the continuum of care should apply this approach to their metrics of success. Cross-sectional coverage estimates of individual health services generally paint an overly optimistic view of coverage at the individual level [23, 24], and fail to identify key drop-offs (and inequities within those drop-offs) within the continuum that require increased attention.

Second, identifying relationships between services along the RMH CoC is an opportunity to leverage existing synergies. Focusing efforts to increase service utilization on the earlier, rather than subsequent, components of those synergies along the continuum may increase serial utilization with a minimum expenditure of additional resources. Examining these cross-service relationships also highlights potential gaps across life stages, remediation of which will be contingent on the specific national contexts in which they exist. Identifying these linkages and gaps, in tandem with known drop-off points, will inform more strategic allocation of limited resources for reproductive and maternal health [25], by mitigating missed points of contact where they most prevalent, and by placing increased focus on building cross-service synergies where they are lacking.

Third, low retention and inconsistent relationships across the RMH CoC indicate a need for increased efforts to translate the continuum of care approach into programmatic pathways, rather than abstract, high-level policies. Early engagement and retention along the RMH CoC requires facilitated linkages between services at the community and facility level to help women understand the importance of sustained care, and to remove barriers to access and utilization, recognizing that those barriers may vary across services.

Finally, the variability seen in the relationship between RMH CoC utilization and neonatal mortality across national neonatal mortality levels suggests that point of contact service metrics may be a crude measure to use when attempting to relate service utilization to changes in health outcomes. While it may not be realistic to comprehensively assess the quality and components of these points of contact metrics within national surveys, governments would benefit from implementing routine assessments of these factors within their health management information systems. The results of this monitoring would inform our understanding of how variable the meaning of a service such as “skilled birth attendance”

is across different settings, would potentially allow for longitudinal tracking of individuals across services, and would enable governments to identify and subsequently address weaknesses therein.

These implications should be interpreted within the context of the limitations of this dissertation. The juxtaposition of Bangladesh's successes in health outcomes and challenges in coverage and equity [26] make it an important setting in which to examine RMH CoC utilization, but the results are not intended to be representative of other countries. All three papers rely on self-reported data, and are therefore subject to recall and social desirability bias. Measurements of the RMH CoC were limited by both what was collected within Demographic and Health Surveys, and the quality of that data. Despite these constraints, however, the data sources used are the most broadly representative measures of health service utilization collected in countries in this sample, and offer insights into RMH CoC utilization that are unavailable elsewhere.

There is a great need, and great opportunity, for further research in this arena. While the case study of Bangladesh offered interesting and relevant findings, broadening the exploration of serial utilization of services along the continuum of care to regional and global contexts will provide more generalizable conclusions regarding the current status of coverage and retention along the RMH CoC, as well as commonalities and differences in linkages between services across different countries. Similarly, expanding the global study of the association between continuum of care service utilization and neonatal mortality to look at more distal health outcomes, including post-neonatal and child mortality, would allow for a more complete understanding of these relationships within national health systems contexts. Both of these analyses would allow for the expansion of the RMH CoC into the reproductive,



maternal, newborn and child health continuum of care, thereby offering a more comprehensive perspective on service utilization and the implications thereof for women and their children.

The deadline for achieving the Millennium Development Goals (MDGs) is nearing, and a minority of the countries with the greatest burden of maternal and child deaths are on track to meet the global goals for mortality reduction set forth therein [27, 28]. This is a public health struggle that will clearly extend beyond 2015, and that will require a restructured approach to combat more effectively. Programs and policies that are therefore more strategically targeted to leverage diminishing resources [25] for the greatest benefit will become increasingly important. This examination of utilization of the reproductive and maternal health continuum of care model in national health systems contexts' offers policy makers and program managers a better understanding of the ways in which women are currently using the continuum of care, as well as how that utilization quantitatively relates to neonatal mortality. It is clear that the majority of women examined are not in fact utilizing the RMH CoC as a continuum, and that greater attention towards early adoption, continuity and retention are needed. Discussions on the best ways to address these gaps are critical components of the post-2015 development agenda as part of ongoing efforts to improve the health of women and children globally.

## REFERENCES

1. Barros AJ, Ronsmans C, Axelson H, Loaiza E, Bertoldi AD, Franca GV, Bryce J, Boerma JT, Victora CG: Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries. *Lancet* 2012, 379:1225-1233.
2. Victora CG, Barros AJ, Axelson H, Bhutta ZA, Chopra M, Franca GV, Kerber K, Kirkwood BR, Newby H, Ronsmans C, Boerma JT: How changes in coverage affect equity in maternal and child health interventions in 35 Countdown to 2015 countries: an analysis of national surveys. *Lancet* 2012.
3. Countdown to 2015: Accountability for maternal, newborn and child survival: The 2013 Update. Geneva: WHO and UNICEF; 2013.
4. Lassi ZS, Majeed A, Rashid S, Yakoob MY, Bhutta ZA: The interconnections between maternal and newborn health - evidence and implications for policy. *J Matern Fetal Neonatal Med* 2013, 26 Suppl 1:3-53.
5. Do M, Hotchkiss D: Relationships between antenatal and postnatal care and postpartum modern contraceptive use: evidence from population surveys in Kenya and Zambia. *BMC Health Serv Res* 2013, 13:6.
6. Akinlo A, Bisiriyu A, Esimai O: Influence of Use of Maternal Health Care on Postpartum Contraception in Nigeria. Calverton, Maryland: ICF International; 2013.
7. Hotchkiss DR, Rous JJ, Seiber EE, Berruti AA: Is maternal and child health service use a causal gateway to subsequent contraceptive use?: A multi-country study. *Population Research and Policy Review* 2005, 24:543-571.
8. Adjiwanou V, Legrand T: Does antenatal care matter in the use of skilled birth attendance in rural Africa: a multi-country analysis. *Soc Sci Med* 2013, 86:26-34.
9. Zerai A, Tsui AO: The relationship between prenatal care and subsequent modern contraceptive use in Bolivia, Egypt and Thailand. *Afr J Reprod Health* 2001, 5:68-82.
10. Hotchkiss DR, Magnani RJ, Rous JJ, Azelmat M, Mroz TA, Heikel J: The effects of maternal-child health service utilization on subsequent contraceptive use in Morocco. *J Biosoc Sci* 1999, 31:145-165.
11. Ahmed S, Mosley WH: Simultaneity in the use of maternal-child health care and contraceptives: evidence from developing countries. *Demography* 2002, 39:75-93.
12. Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L: Evidence-based, cost-effective interventions: how many newborn babies can we save? *Lancet* 2005, 365:977-988.
13. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, Haider BA, Kirkwood B, Morris SS, Sachdev HP, Shekar M, Maternal, Child Undernutrition

- Study G: What works? Interventions for maternal and child undernutrition and survival. *Lancet* 2008, 371:417-440.
14. Sharma V, Katz J, Mullany LC, Khattry SK, LeClerq SC, Shrestha SR, Darmstadt GL, Tielsch JM: Young maternal age and the risk of neonatal mortality in rural Nepal. *Arch Pediatr Adolesc Med* 2008, 162:828-835.
  15. McCurdy RJ, Kjerulff KH, Zhu J: Prenatal care associated with reduction of neonatal mortality in Sub-Saharan Africa: evidence from Demographic and Health Surveys. *Acta Obstet Gynecol Scand* 2011, 90:779-790.
  16. Titaley CR, Dibley MJ, Roberts CL: Type of delivery attendant, place of delivery and risk of early neonatal mortality: analyses of the 1994-2007 Indonesia Demographic and Health Surveys. *Health Policy Plan* 2012, 27:405-416.
  17. Barros FC, Bhutta ZA, Batra M, Hansen TN, Victora CG, Rubens CE: Global report on preterm birth and stillbirth (3 of 7): evidence for effectiveness of interventions. *BMC Pregnancy Childbirth* 2010, 10 Suppl 1:S3.
  18. The Partnership for Maternal, Newborn and Child Health: Essential interventions, commodities and guidelines for reproductive, maternal, newborn and child health: A global review of the key interventions related to reproductive, maternal, newborn and child health (RMNCH). Geneva: WHO; 2011.
  19. Bhutta ZA, Ali S, Cousens S, Ali TM, Haider BA, Rizvi A, Okong P, Bhutta SZ, Black RE: Alma-Ata: Rebirth and Revision 6 Interventions to address maternal, newborn, and child survival: what difference can integrated primary health care strategies make? *Lancet* 2008, 372:972-989.
  20. Bhutta ZA, Cabral S, Chan CW, Keenan WJ: Reducing maternal, newborn, and infant mortality globally: An integrated action agenda. *Int J Gynaecol Obstet* 2012, 119 Suppl 1:S13-17.
  21. World Health Organization: Packages of Interventions for Family Planning, Safe Abortion Care, Maternal, Newborn and Child Health. Geneva: WHO; 2010.
  22. Darmstadt GL, Walker N, Lawn JE, Bhutta ZA, Haws RA, Cousens S: Saving newborn lives in Asia and Africa: cost and impact of phased scale-up of interventions within the continuum of care. *Health Policy Plan* 2008, 23:101-117.
  23. Barker PM, Mphatswe W, Rollins N: Antiretroviral drugs in the cupboard are not enough: the impact of health systems' performance on mother-to-child transmission of HIV. *J Acquir Immune Defic Syndr* 2011, 56:e45-48.
  24. Stringer EM, Chi BH, Chintu N, Creek TL, Ekouevi DK, Coetzee D, Tih P, Boulle A, Dabis F, Shaffer N, Wilfert CM, Stringer JS: Monitoring effectiveness of programmes to prevent mother-to-child HIV transmission in lower-income countries. *Bull World Health Organ* 2008, 86:57-62.

25. Hsu J, Pitt C, Greco G, Berman P, Mills A: Countdown to 2015: changes in official development assistance to maternal, newborn, and child health in 2009-10, and assessment of progress since 2003. *Lancet* 2012.
26. Chowdhury AM, Bhuiya A, Chowdhury ME, Rasheed S, Hussain Z, Chen LC: The Bangladesh paradox: exceptional health achievement despite economic poverty. *Lancet* 2013, 382:1734-1745.
27. World Health Organization and UNICEF: Countdown to 2015: Maternal, Newborn and Child Survival. Building a Future for Women and Children - The 2012 Report. Geneva: WHO; 2012.
28. Lozano R, Wang H, Foreman KJ, Rajaratnam JK, Naghavi M, Marcus JR, Dwyer-Lindgren L, Lofgren KT, Phillips D, Atkinson C, Lopez AD, Murray CJ: Progress towards Millennium Development Goals 4 and 5 on maternal and child mortality: an updated systematic analysis. *Lancet* 2011, 378:1139-1165.