Maternal and neonatal mortality in Moi Teaching and Referral hospital in Kenya

Faith Yego
MSc, BSc

This thesis is submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy (Gender and Health)
School of Medicine and Public Health
University of Newcastle, NSW 2308
Australia

July 2015
Statement of Originality

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to this copy of my thesis, when deposited in the University’s Digital Repository, subject to the provisions of the Copyright Act 1968. **Unless an Embargo has been approved for a determined period.

Statement of Authorship

I hereby certify that this thesis is submitted in the form of a series of published papers of which I am a joint author. I have included as part of the thesis a written statement from each co-author; endorsed by the Faculty Assistant Dean (Research Training), attesting to my contribution to the joint publications.

13/7/2015

Faith Yego Date
Acknowledgements

I would like to thank God for granting me grace and favour throughout my four year endeavour towards this achievement.

I would like to express my most sincere gratitude to my supervisors Catherine D’Este, Julie Byles and Jennifer Stewart Williams for their wisdom, guidance, encouragement, support, and for being enthusiastic about the research. I must say it was difficult merging three brilliant ideas into one, but each of their diversities made my research richer and more exciting to work on. Thank you for offering time, thoughts and willingness to read my work over and over again.

I appreciate the valuable inputs from my advisors Paul Nyongesa and Wilson Aruasa for their guidance and clinical advice and helping us understand the clinical depth of this work. I also thank Diana Menya for encouraging me to apply for the scholarship.

I thank University of Newcastle and Ministry of State for Public Service, Kenya for funding my four-year study program.

I express gratitude to the Moi Teaching and Referral Hospital administration for giving me an opportunity to undertake this research at the hospital and staff that assisted with data collection for this research. I also thank Jane McDonald for assisting with editing and formatting of this thesis.

I wish to acknowledge the Newcastle Community and the African Club at University of Newcastle of friends that I made who encouraged me and ensured I still had a social life.
I offer my heartfelt appreciation to my parents, parent in-law, relatives, friends and my husband Wycliffe Kosgei for standing by me and supporting me as I undertook this journey.
List of publications included as part of the thesis

List of published articles


List of manuscripts to be submitted

Yego, Byles, J., DEste, C., Stewart Williams, J. Completeness of maternal and neonatal hospital records at a tertiary level hospital in Kenya

Conference presentations

A retrospective review of maternal and early neonatal mortality at Moi Referral Hospital in Eldoret Kenya. Research Gender for Health and Ageing Conference in Newcastle Australia in 2011 (Poster Presentation)

Yego, F., Nyongesa, P., Aruasa, W., DEste, C., Byles, J., Stewart Williams, J.

“Determinants of maternal and early neonatal mortality at MTRH” (Abstract ID: R-1-025).

Presented at the 8th Annual International Conference of Moi University in 2012 (Oral presentation)
Statement of collaboration

I hereby certify that the work embodied in this thesis has been done in collaboration with other researchers, or carried out in other institutions. I have included as part of the thesis a statement clearly outlining the extent of collaboration, with whom and under what auspices.

As author of this thesis I conducted the work presented under the supervision of three supervisors: Professors Catherine D’Este and Julie Byles and Dr. Jennifer Stewart Williams

Dr. Paul Nyongesa and Dr. Wilson Aruasa were also instrumental advisors and contributed in some of the publications. I was a major contributor to all aspects of the study: planning, literature review, data collection, analysis and statistical modeling, interpretation of results, writing of manuscripts for peer-reviewed journals and writing of thesis.

13/7/2015

Faith Yego Date
Dedication

I dedicate this thesis to all women who have died as a result of childbirth or lost a child during childbirth.
# Table of Contents

Statement of Originality ............................................................................................................ ii  
Statement of Authorship ........................................................................................................... ii  
Acknowledgements .................................................................................................................. iii  
List of publications included as part of the thesis ................................................................. v  
Statement of collaboration ...................................................................................................... vii  
Dedication ................................................................................................................................ viii  
List of Tables ............................................................................................................................. xii  
List of Figures .......................................................................................................................... xiii  
List of Abbreviations .............................................................................................................. xiv  
Synopsis ..................................................................................................................................... 16  
Thesis Overview ....................................................................................................................... 19  
## Chapter 1 Introduction  
1.1 Significance of the study ......................................................................................... 24  
1.2 References.................................................................................................................. 26  
## Chapter 2 Overview of maternal and neonatal mortality ........................................... 28  
2.1 Maternal mortality and contributing factors ........................................................ 28  
2.1.1 Burden of maternal death ............................................................................... 28  
2.1.2 Causes of maternal mortality ......................................................................... 29  
2.1.3 Definitions and clinical criteria for direct causes of maternal death .......... 31  
2.1.4 Risk factors for maternal mortality ............................................................... 34  
2.2 Fetal and early neonatal mortality and contributing factors ............................. 37  
2.2.1 Burden of fetal and early neonatal death...................................................... 37  
2.2.2 Causes of fetal and early neonatal deaths .................................................... 37  
2.2.3 Definition, clinical criteria for the leading causes of deaths in the perinatal period 38  
2.2.4 Risk factors for fetal and early neonatal mortality ...................................... 41  
2.3 Study Justification................................................................................................... 45  
2.4 Theoretical framework for assessing the risk factors for maternal and early neonatal mortality ................................................................................................................... 46  
2.5 Study objectives ........................................................................................................ 52  
2.6 References.................................................................................................................. 53  
## Chapter 3 Methodology  
3.1 Study design .......................................................................................................... 59  
3.2 Setting ....................................................................................................................... 59  
3.3 Sampling and sample size determination ............................................................ 63  
3.4 Study variables ......................................................................................................... 65  
3.5 Logistics and Research Staff Training ................................................................... 67  
3.6 Statistical Methods ................................................................................................... 70  
3.7 Ethical approval ....................................................................................................... 72  
3.8 References.................................................................................................................. 73  
## Chapter 4 Paper One  
A retrospective analysis of maternal and neonatal mortality at a teaching and referral hospital in Kenya ................................................................. 74  
4.1 Abstract...................................................................................................................... 75  
4.2 Background ............................................................................................................... 76
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Paper One</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3</td>
<td>Methods</td>
<td>80</td>
</tr>
<tr>
<td>4.3.1</td>
<td>Data source and setting</td>
<td>80</td>
</tr>
<tr>
<td>4.3.2</td>
<td>Descriptive variables</td>
<td>81</td>
</tr>
<tr>
<td>4.3.3</td>
<td>Statistical Analyses</td>
<td>81</td>
</tr>
<tr>
<td>4.4</td>
<td>Results</td>
<td>82</td>
</tr>
<tr>
<td>4.5</td>
<td>Discussion</td>
<td>87</td>
</tr>
<tr>
<td>4.6</td>
<td>Conclusion</td>
<td>91</td>
</tr>
<tr>
<td>4.7</td>
<td>References</td>
<td>93</td>
</tr>
</tbody>
</table>

Chapter 5  Paper Two .......................................... 118

Risk factors for maternal mortality in a Tertiary Hospital in Kenya: a case-control study

| 5.1 | Abstract | 97 |
| 5.2 | Background | 98 |
| 5.3 | Methods | 101 |
| 5.3.1 | Statistical Analyses | 103 |
| 5.4 | Results | 104 |
| 5.5 | Discussion | 110 |
| 5.6 | Conclusions | 113 |
| 5.7 | References | 115 |

Chapter 6  Paper Three .......................................... 118

A case-control study of risk factors for fetal and early neonatal deaths in a tertiary hospital in Kenya .......................................... 118

| 6.1 | Abstract | 119 |
| 6.2 | Background | 121 |
| 6.3 | Methodology | 123 |
| 6.3.1 | Statistical Methods | 126 |
| 6.4 | Results | 127 |
| 6.5 | Discussion | 134 |
| 6.6 | Conclusions | 137 |
| 6.7 | References | 140 |

Chapter 7  Paper Four .......................................... 143

Completeness of maternal and neonatal hospital records at a tertiary level hospital in Kenya .......................................... 143

| 7.1 | Abstract | 144 |
| 7.2 | Introduction | 145 |
| 7.3 | Methods | 148 |
| 7.4 | Results | 151 |
| 7.5 | Discussion | 163 |
| 7.6 | Conclusion | 167 |
| 7.7 | References | 170 |

Chapter 8  Conclusion .......................................... 143

| 8.1 | References | 173 |

Appendices .......................................... 183

Appendix 1: Publications .......................................... 184

A1.1 Published paper 1 .......................................... 184
A1.2 Published paper 2 .......................................... 193
A1.3 Published paper 3 .......................................... 204
A1.4 Statements of contribution from each author ....................................................... 214
Appendix 2: Study Approvals..................................................................................... 220
  A2.1 Ethics approval................................................................................................. 221
  A2.2 Letter of approval for the study .................................................................... 226
  A2.3 Advisor approvals ......................................................................................... 227
Appendix 3: Study Questionnaire ............................................................................. 230
Appendix 4: Letter from MTRH .............................................................................. 235
List of Tables

Table 2-1 Estimates of Maternal Mortality Ratio and lifetime risk of death by regions in 2010. Adapted from a report by WHO, UNICEF, UNFPA and The World Bank estimates1. ................................................................................................................................... 28

Table 2-2: Stillbirth rates and early neonatal mortality rates in different regions in 2000 Adapted from WHO34 ............................................................................................................. 37

Table 4-1 Maternal and obstetric characteristics of maternal and early neonatal deaths .................................................................................................................................................... 84

Table 4-2 Pregnancy complications for maternal and early neonatal deaths .......... 85

Table 4-3 Neonatal complications for maternal and early neonatal deaths .......... 86

Table 4-4 Early neonatal and maternal characteristics ................................................................................................................................................ 86

Table 5-1 Individual and Socio-demographic risk factors for maternal mortality ...... 105

Table 5-2 Mother’s history of prevailing conditions and obstetric characteristics associated with maternal mortality ................................................................. 106

Table 5-3 Maternal admission factors associated with maternal mortality ............. 108

Table 5-4 Multivariable model showing risk factors for maternal mortality ............ 109

Table 6-1: Association between maternal and obstetric factors with fetal and early neonatal death ........................................................................................................................................... 129

Table 6-2: Association between maternal obstetric complications with fetal and early neonatal mortality ............................................................................................................................................... 130

Table 6-3: Association between neonatal complications with fetal and early neonatal mortality ................................................................................................................................................................. 131

Table 6-4: Association between neonatal characteristics with fetal and early neonatal mortality at MTRH ................................................................................................................................. 132

Table 6-5: Determinants of fetal and early neonatal mortality ........................................ 133

Table 7-1 Distribution of missing data for maternal sample and neonatal sample ...... 152

Table 7-2 Factors associated with missingness in the maternal records (n=450) ........ 157

Table 7-3 Factors associated with missingness in the neonatal records (n=600) .......... 160
List of Figures

Figure 2-1 Distribution of causes of maternal mortality in developed regions. Adapted from Say et al. .............................................................. 29

Figure 2-2 Distribution of causes of maternal mortality in developing regions. Adapted from Say et al. .......................................................... 30

Figure 2-3 Global causes of neonatal deaths. Adapted from Liu et al. ............... 38

Figure 2-4 Theoretical framework by Mosely and Chen of the five groups of proximate determinants on the health dynamics of a population.............................................. 47

Figure 2-5 Delay phases and factors affecting use of delivery care and maternal mortality by Gabrysch and Campbell, 2006. ........................................... 48

Figure 2-6 A Conceptual Framework for assessing risk factors for maternal and early neonatal mortality. Adapted from Mosley and Chen 1984 and McCarthy and Maine 1992....50

Figure 3-1 Levels of care in the Kenya Health System. Adapted from the Ministry of Health. ........................................................................................................... 60

Figure 3-2 Map of Eldoret, Kenya ........................................................................... 62

Figure 4-1 Annual neonatal mortality rates with 95% confidence intervals from January 2004 - to December 2011............................................................... 83

Figure 4-2 Annual neonatal mortality rates with 95% confidence intervals from January 2004 - to December 2011............................................................... 83

Figure 7-1 Percentage of missing values for each variable for maternal cases and control study: by case/control status ........................................... 153

Figure 7-2 Percentage of missing values for each variable for neonatal cases and control study: by case/control status ........................................... 154

Figure 7-3 Distribution of number of variables with missing data within observations in the maternal sample ........................................................................ 155

Figure 7-4 Distribution of number of variables with missing data within observations in the neonatal sample ........................................................................ 156
List of Abbreviations

ANC: Antenatal Care

APH: Antepartum Haemorrhage

BBA: Born Before Arrival

BP: Blood Pressure

EmOC: Emergency Obstetric Care

EMR: Electronic Medical Record

END: Early Neonatal Death

ENMR: Early Neonatal Mortality Rate

HDU: High Dependency Unit

HIV: Human Immunodeficiency Virus

HREC: Human Research Ethics Committee

ICD: International Classification of Disease

ICU: Intensive Care Unit

IREC: Institutional Research Ethics Committee

KNH: Kenyatta National Hospital

LND: Late Neonatal Death

MDGs: Millennium Development Goals

MMR: Maternal Mortality Rate

MMR: Maternal Mortality Ratio

MOH: Ministry of Health

MTRH: Moi Teaching and Referral Hospital
NMR: Neonatal Mortality Rate
NMR: Neonatal mortality Ratio
NBU: Newborn Unit
PAC: Post Abortal Care
PE: Preeclampsia
PPH: Postpartum Haemorrhage
PROM: Premature rupture of membranes
RA: Research Assistants
RAMOS: Reproductive Age Mortality Survey
RDS: Respiratory Distress Syndrome
SMI: Safe Motherhood Initiative
UN: United Nations
WHO: World Health Organization
Synopsis

The idea for this thesis originated while I was attending weekly mortality meetings at the Moi Teaching and Referral Hospital (MTRH) coupled with high maternal and neonatal mortality rates in Kenya. I shared the idea with two obstetricians who provided their support and willingness to help understand the problem. With support from the University of Newcastle and The Ministry of State for Public Service in Kenya, I received a scholarship to undertake my PhD at the University of Newcastle in Australia.

This thesis by publication is composed of seven chapters including: an introduction, methodology, four papers (each a separate chapter), and conclusion. All papers relate to factors surrounding maternal and neonatal mortality at a tertiary hospital in Kenya. At the time of submission three papers have been published and one is under review.

The first paper is a retrospective review of the incidence of maternal and neonatal mortality at MTRH and a description of characteristics of maternal and neonatal deaths at this hospital. The study identifies a range of socio demographic, clinical and health system factors as possible contributors to high maternal and neonatal mortality in Kenya. This paper was published in the Reproductive Health Journal.

The second paper is a case-control study following a manual review of maternal records at MTRH. The study identified antenatal care and maternal education as risk factors for maternal mortality at MTRH. This paper was published in BMC Pregnancy and Childbirth.
Paper Three is a case-control study of neonatal records at MTRH. Results showed that some risk factors for early neonatal mortality included: number of antenatal visits, gestational age, qualification of birth attendant, mother’s complication at birth, and low Apgar scores at five minutes, and congenital malformations. This paper has been published in BMC Pregnancy and Childbirth.

The fourth paper presents an assessment of completeness of maternity data at MTRH including factors associated with missing data. The results showed that a range of maternal neonatal and health system factors were associated with missing data in the maternal and neonatal sample. This paper will be submitted for publication in a reputable journal.

The support I received from my supervisors was overwhelming in terms of making the project more realistic. We prepared all the necessary documents and obtained necessary approvals and permission to undertake the study. I personally was involved in the data collection process which was the bulk of this thesis because we had to go through paper records to obtain data for this study. I also did the data analysis with the guidance of my supervisors.

The outcomes of this study have had a huge audience globally as well as health system policy implications for the hospital and nationally. More specifically, one of the obstetricians in the hospital who was the study advisor (PN) had this to say about the study. “This study has had an impact in more revision and development of new protocols in the maternity unit on pre-eclampsia, triage of patients at admission, involvement of paediatricians in management of newborns, establishment of High
Dependence Unit (HDU) in addition to the existing Intensive Care Unit (ICU), involvement of physicians in management of medical disorders in pregnancy and increased staffing of labour ward with more doctors. More population based studies of the same are underway to help clarify the study findings”. 
Thesis Overview

This thesis by publication contains an introduction; a chapter providing an overview of maternal and neonatal mortality including burden of disease, causes of and risk factors for mortality, and a conceptual framework for the thesis; a methods chapter; four papers and a conclusion chapter. The four papers focus on findings on maternal and neonatal mortality at the Moi Teaching and Referral Hospital (MTRH) in Kenya from 2004-2011. The papers are based on data collected from the maternity ward records at this hospital. Chapter Four presents the first of the journal articles (Paper One) which describes incidence and characteristics associated with maternal and neonatal mortality at MTRH. Paper Two presents a case-control study to examine risk factors associated with maternal mortality. A case-control study examining factors associated with fetal and early neonatal mortality at MTRH is provided in Paper Three. The final paper examines record completeness at MTRH and factors associated with missing data. The final chapter (Chapter 8) provides an overall conclusion to the work, discussing the directions for future research, study strengths and limitations. The appendices contain the publications, statements of contribution of authorship, study questionnaire, ethics approval, and a letter from MTRH.