

**A MULTILEVEL ANALYSIS EXAMINING THE RELATIONSHIP
BETWEEN QUALITY OF ANTENATAL CARE AND MATERNAL-CHILD
HEALTH PROMOTION PRACTICES IN THREE EAST AFRICAN
COUNTRIES: A THREE-PAPER DISSERTATION.**

by

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A Dissertation Submitted in
Partial Fulfillment of the
Requirements for the Degree of

Doctor of Philosophy

in Public Health

at

The University of Wisconsin-Milwaukee

May 2023

ABSTRACT

A MULTILEVEL ANALYSIS EXAMINING THE RELATIONSHIP BETWEEN QUALITY OF ANTENATAL CARE AND MATERNAL-CHILD HEALTH PROMOTION PRACTICES IN THREE EAST AFRICAN COUNTRIES: A THREE-PAPER DISSERTATION.

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The University of Wisconsin-Milwaukee, 2023
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Background: Quality of health care is an emerging concern across many low-and-middle-income countries. Particularly, there is limited empirical guidance in measuring Antenatal care (ANC) quality and its influence on maternal health promotion practices.

Purpose: The overall aim of this three-paper dissertation is to examine the relationship of ANC quality on three maternal child health promotion practices outcome measures, which included child vaccination, appropriate diarrhea prevention practices, and breastfeeding, in three neighboring East African countries of Kenya, Uganda, and Tanzania.

Methods: Data from the latest demographic and health survey (DHS) program for Kenya (2014), Uganda (2015) and Tanzania (2015/16) were used in this study. The main dependent variable - maternal child health promotion practices consisted of three separate measures, a) full child vaccination, b) appropriate diarrhea prevention practices, and c) breastfeeding (early initiation of breastfeeding [EIBF], exclusive breastfeeding [EBF] & continued breastfeeding [CBF] past six months). The main independent variable, ANC quality, was assessed using two measures a) ANC utilization, and b) essential ANC health promotion care practices (ANC HPCPs). While the level of ANC utilization focused on the extent to which the women engaged with the healthcare

system (skilled care), the essential ANC HPCPs focused on the nature of interaction with the care providers by examining the type and level of care received across the pregnancy period. The analysis in all papers follow the same format beginning with descriptive statistics, bivariate analysis comparing the outcomes and other predictor variables and the results presented as crude(unadjusted) odds ratios and 95% confident intervals. Finally, multilevel binary logistic regression models to test the main hypothesis while adjusting for other covariates were conducted using Stata 16SE.

Results: The findings of this dissertation suggest that ANC quality is significantly associated with the various maternal health promotion practices tested in each of the three papers. While the association between ANC quality and each of the outcomes was comparable across all countries, the level of significance varied by country. Overall, the analysis of the pooled data showed that intermediate and adequate levels of ANC utilization were associated with higher odds of full vaccination compared to poor ANC utilization. Women with adequate ANC utilization had about six times greater odds of having their children fully vaccinated as compared to those with poor ANC utilization [AOR:5.90; 95% CI:(2.27,15.32)]. Moreover, the odds of full vaccination increased by 32% with every score on the number of essential ANC HPCPs [AOR: 1.32; 95% CI:(1.16,1.51)]. Similarly, women who had intermediate [AOR:1.31; 95% CI: (1.18,1.46)], and adequate ANC utilization, [AOR: 1.41; 95% CI: (1.23,1.63)], had greater odds of practicing appropriate diarrhea prevention measures. In addition, for every score in essential ANC HPCPs during pregnancy visit, the odds of women's diarrhea prevention practices increased by 16% [AOR:1.16; 95% CI: (1.13,1.20)]. Finally, across all breastfeeding outcomes, majority of women had poor ANC utilization while the least had adequate ANC utilization. Adequate ANC

utilization was significantly associated with 18% greater odds of early initiation of breastfeeding (EIBF) compared to poor ANC utilization [AOR:1.19; 95% CI (1.02,1.39)]. Although women with intermediate level of ANC utilization had significantly lower unadjusted odds (COR: 0.88; 95% CI (0.78,0.99) of exclusive breastfeeding (EBF) compared to those with poor ANC utilization, the association was not significant in the fully adjusted EBF model (AOR: 1.51; 95% CI (0.87,2.64). Compared to women with poor ANC utilization, women with intermediate [AOR: 1.74; 95% CI (1.07,2.85)] and adequate [AOR: 2.39; 95% CI (1.18,4.81)] ANC utilization had 74% and more than twice the odds of continued breastfeeding (CBF) past 6 months.

Conclusion: The findings provide additional evidence justifying the benefits of ANC quality on the health and growth trajectory of the child, especially in estimating the early initiation and progress in breastfeeding, vaccination coverage, and practice of diarrhea prevention measures. The findings also suggest that low maternal ANC service utilization may be an indication of future poor health seeking habits for children care services. Highlighting the importance of quality ANC and the possible social and structural factors that influence women decisions and child-health promotion practices is a step towards better child health and, eventually, reducing maternal and child mortality.

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Dedication

I dedicate this dissertation to my supportive family. I have spent over 90% of my teenage and adult life away from those who care most, in the pursuit of a better and meaningful life. I would not have made this far without their relentless support.

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LIST OF ABBREVIATIONS

ABBREVIATION	Explanation
ANC	Antenatal Care
SCT	Social Cognitive Theory
ANC HPCPs	Antenatal Care Health Promotion Care Practices
EIBF	Early Initiation of Breastfeeding
EBF	Exclusive Breastfeeding
CBF	Continued Breastfeeding
DHS	Demography and Health Survey
SSA	Sub-Saharan Africa
WHO	World Health Organization
EPI	Expanded Program of Immunization
PNC	Postnatal Care
EA	Enumeration Area
DPT	Diphtheria, Pertussis, and Tetanus
ICC	Intra-class Correlation Coefficient
AIC	Akaike's information criterion
BIC	Bayesian information criteria

ACKNOWLEDGEMENTS

Over the entire period of my dissertation journey, I have received inspiration and support from many individuals who provided thoughtful feedback and encouragement in times of uncertainty and celebration – big and small. In no particular order, I would like to begin by offering my appreciation to my academic advisor and research mentor, Dr. Emmanuel Ngui, who has seen me through the ups and downs in this journey. His spirited, genuine nature, dedication to students' success has been instrumental in my personal and professional growth. I would also like to thank my dissertation committee members of Dr. Young Cho, Dr. Amy Harley, Dr. Musa Yahaya, and Dr. Kaboni Gondwe for reviewing my work and ensuring my writing surpasses the University of Wisconsin Milwaukee doctoral dissertation standards.

Secondly, I would like to thank the current and former Joseph J. Zilber school of public health faculty whom I have worked with and benefited from their mentorship including Dr. Elise Papke, Dr. Linnea Laestadius, and Dr. Amanda Simanek. Thirdly, I also benefitted from graduate assistantships and scholarships from the generous donors for the Zilber school of Public Health. The various sources of funding were highly instrumental to my success as an international student.

Finally, I thank the army of supporters who have cheered me through this journey. I begin with my dear wife, Caroline, for her unwavering support of my goals, confidence in my potential, and humor in times of stress. I am also grateful for my son, Sean, who continues to motivate me to work harder and turns my low times into moments of joy. Special thanks to my parents and siblings for believing in my zeal for education and joining hands to give me the best education. Finally, the village of mentors, relatives, friends, and Zilber PhD colleagues – made this experience worthwhile.

CHAPTER ONE: INTRODUCTION

1.1 Statement of the problem

The suffering and dying of children remain immense and are a global daily tragedy that continues without receiving the adequate attention(1-3). The death rate of children younger than five years is an important marker of the general health and development of nations worldwide. Globally, 3.9% of all children die before their 5th birthday, which means that on average 15,000 children die every day(4, 5). Every nation is pursuing to reduce newborn deaths to at least 12 per 1,000 births and death of children five years or younger to at least 25 per 1,000 births, but these rates are still above what is needed to meet the recommended Sustainable Development Goal (SDG) target to end preventable deaths of neonates and young children by 2030(6). Moreover, despite the steady global progress in reducing under-five mortality since the 1950s(1), there is clear evidence of uneven trends with the low- and middle-income countries (LMICs) playing catch up(7-10). Approximately half (52%) of all deaths of children aged <5 years occur in Sub Saharan Africa (SSA)(2). In addition, as compared to other regions of the world, the African region shows the smallest reductions in mortality rates and the slowest down trend(2, 10, 11). Currently, 1 in 13 children in sub-Saharan Africa are likely to die before reaching their fifth birthday; this is 15 times higher than the risk for children born in high-income countries(3, 12).

In 2015, there were global agreements in setting goals towards socioeconomic and health prosperity, through the UN's Sustainable Development Goals (SDGs)(10, 13). Target 3.2 of the SDGs calls for reducing the level of under-five mortality to no more than 25 deaths per 1000 births, by the year 2030(14). This would mean that more than 97.5% of all newborns would survive the first five years of their life no matter where they are born(14). Five years into signing

the agreement, countries in Sub Saharan Africa lag towards achieving this goal. Apart from birth complications associated with neonatal deaths, most infants' deaths in SSA have been attributed to conditions such as diarrhea, acute respiratory illness, malaria, measles, and malnutrition, which are either preventable or treatable with low-cost interventions(15-17). These health outcomes are closely watched public health indicators, as they reflect the access of children and communities to basic health interventions such as vaccination, medical treatment of infectious diseases and adequate nutrition(9). Parallel to government-initiated supply factors for curbing child mortality, such as health infrastructure and delocalization of services, understanding the demand-side factors is key in curbing the persisted causes of death in young children(18-20). Part of the solution to reduce the global inequities in under 5 mortality is therefore to prioritize health promotive measures such as proper feeding practices (including exclusive breastfeeding), immunization, and environmental and human sanitation, to control diarrheal diseases(1, 12).

The health promotion practices are critical in child development and survival as they not only contribute to averting a myriad of childhood illnesses(21), but are also interconnected to aid in the overall developmental milestones of the child. Interventions such as the use of oral rehydration salts (ORS), breastfeeding and improvements in sanitation are measures that broadly target all causes of diarrhea(22-24), whereas vaccination and use of antibiotics are specifically effective against disease causative agents. Exclusive breastfeeding or a balanced diet ensures a healthy growth curve for the baby(25). This also has several benefits such as preventing infant malnutrition as well as building immunity against infectious diseases. Immunization on the other hand will boost immunity against vaccine-preventable diseases. For example, targeted immunizations such as rotavirus vaccination, combined with other sanitary measures have been found to be cost effective against diarrhea(26, 27).With the right sanitary conditions, good diet

and proper health, young children will be protected from diseases and diarrhea conditions(5), develop cognitively, the family saves in healthcare costs, hence reducing overall community poverty(4, 5).

While the health promotion interventions have been proved to achievable and cost-effective in ensuring better health for children, and ultimately reducing child mortality, there are, however, variations on the practices, within and between the different Sub-Saharan countries(28-31). At the individual level, the caregiver's(mother) practice and attitude towards each of the health promotion practices may, greatly, vary due to personal attributes such as mother's age, level of education, level of literacy, among others. Environmental factors such as the physical and neighborhood factors including the conditions at the place or region of residence as well as national policies on allocation of health services can also impact individual healthcare decisions(15). Closely bridging between the personal and environmental factors is the gap of accessing, understanding, and utilizing health information. Studies have shown that individuals in many low- and middle-income countries rarely utilize preventive health services, with many showing up in health facilities only when in need of critical healthcare(32-34). Use of natural remedies, self-medication through non-prescribed medicine, or hoping for natural body healing are common practices to counter diseases and illnesses. Indeed, events such as the pregnancy period create an initial connection between women and families to the healthcare system through the ANC visits. Women will likely seek health care service because of the perceived benefits or dangers associated with pregnancy and giving birth. (42,44) Appropriate health information is shared during the visits. This creates a great window of opportunity for sharing a wide array of health information and demystifying any perceived negative notions and myths against modern healthcare on child health promotion practices.

Previous studies have shown the positive association between Antenatal Care (ANC) and skilled delivery(35-39). This connection is, however, broken after the delivery. There is also a growing debate on how useful the ANC can be in sustaining health promotion and behavior during early child development(40-42). The postpartum period can prove challenging to the mother, especially if they are not equipped with enough knowledge and skills on how to care for the new baby(16). While several studies have explored the importance of ANC in ensuring birth preparedness and skilled delivery(43-46) as well as mitigating adverse birth outcomes(47-49), fewer studies have examined the influence of ANC in child protection during the postnatal period. This evidence builds up the rationale for examining whether the ANC experience has any behavioral influence on maternal child health promotion practices (MCHPP) beyond delivery. The documented evidence of improved health behavior post-delivery, based on quality of ANC received, could be a justification of adding health promotive information to the current obstetric care focused ANC. Previous encounter with the healthcare system e.g., during the antenatal care (ANC) period, can therefore be hypothesized as protective towards improved maternal-child health promotion practices (MCHPP) and may help in explaining individual and social differences in childcare practices, while accounting for other environmental factors.

1.2 Purpose of the Study

This three-paper dissertation empirically assesses the influence of quality of ANC on maternal child health promotion practices (MCHPP) of three main outcomes (vaccination, breastfeeding, and diarrhea prevention), while controlling for other sociodemographic and environmental factors that have been deemed to be likely associated with the outcomes. The outcomes are chosen as among the most important measures in curbing preventable child mortality in Sub-Saharan Africa. **Vaccination status** is a binary measure of whether the

children, aged 12-23 months have completed the required basic vaccination. It was binary categorized as “**Yes**” if the child was fully immunized (i.e., 1 dose of BCG, 3 doses of DTP-HepB-Hib, 3 doses of polio, and 1 dose of measles), and “**No**” otherwise. The **diarrhea prevention** outcome “Appropriate Diarrhea prevention practices” was a measure of the number of known diarrhea prevention practices undertaken to promote the health of the baby against diarrhea. These health promotive practices investigated included postnatal checkup of the child, vitamin A and Zinc supplementation, deworming, knowledge of ORS, and safe methods of disposing of the child’s stools. The binary outcome measure was coded as “0” for those without any of the practices and “1” to indicate a range of 1-5 of the practices (whether the respondent followed at least one of the five practices).

Finally, **breastfeeding** status was measured using three outcomes, namely a) *Early initiation of breastfeeding (EBF)* within the first hour, b) *Exclusive breastfeeding (EBF)* from birth to 6 months, and c) *Continued breastfeeding (CBF)* past six months up to 2 years. The early initiation of breastfeeding (EIBF) was a binary measure of whether the child was breastfed immediately (within 1 hour) after birth (coded 1) or afterwards (coded 0). Exclusive breastfeeding (EBF) outcome was categorized as 1 if a mother did not feed the baby anything else apart from breast milk, except syrups and medicines, during the first 6 months after birth and 0 otherwise. According to the definition by the World Health Organization (WHO), EBF entails feeding the infant only breast milk, excluding any other liquids or solids, not even water, except for oral rehydration solution, or drops/syrups of vitamins, minerals, or medicines(50). The variable was measured using a 24-hour recall among mothers with infants under 6 months of age. The third outcome involved continued breastfeeding (CBF) past 6 months coded as zero (0) for those who stopped breastfeeding before six months and 1 to represent continued breastfeeding

for children aged 6-24 months. These questions targeted mothers who were currently breastfeeding during the survey and also the baby was alive and was present in the household the night before the survey.

The main predictor, quality of ANC, is measured using two main variables.

1: Level of ANC utilization: A composite measure of several factors identified in the literature as key determinants of Quality of ANC, namely a) number of ANC visits, b) timely initiation of ANC, and c) the healthcare provider (skilled vs nonskilled). These combined measures are operationalized to indicate three levels of ANC utilization: *poor*, *intermediate*, and *adequate* ANC utilization. More details are provided in the methods sections of each individual paper (Chapters 3,4, & 5).

2. The essential ANC health promotion care practices (ANC HPCPs). These entail the nature of information shared with the woman, and services received during the pregnancy period.

The analysis is based on the Demographic and Health Surveys (DHS) data for three neighboring East African countries (Kenya, Uganda, and Tanzania). The study sample includes women and children who participated in the demographic and health survey of Kenya (2014), Uganda (2016) and Tanzania (2015-2016). The three studies comprising this dissertation are therefore secondary analyses of the DHS data examining the association of ANC quality on maternal child health promotion practices of vaccination, breastfeeding, and diarrhea prevention, using both individual country and pooled data for the 3 countries. All studies will have the same main predictor of ANC quality but will be distinguished by separate outcomes of either child vaccination, breastfeeding, or diarrhea prevention practices.

1.3 Situation Analysis of the targeted health outcomes

Based on their latest national reports from their recent demographic and health surveys, the full coverage of basic vaccination among children aged 12-23 months varies from 79% in Kenya, 75% in Tanzania, to 55% in Uganda.(56-58) Basic vaccination coverage involves, one dose of Bacille Calmette-Guérin (BCG) vaccine, which protects against tuberculosis, three doses of DPT-containing vaccine, which protects against diphtheria, pertussis (whooping cough), and tetanus, three doses of oral polio vaccine (not including the birth dose), and one dose of measles vaccine(56-58). Similar to evidence from previous studies and reports, the rate of vaccination varies by vaccine both in coverage and dosage. In all the 3 countries, there is a descending trend in coverage from the first vaccine, BCG, to each of the subsequent vaccines (56-58). There is also a similar trend (having drop out cases) among the vaccines requiring more than one dose. Current data shows that BCG vaccination is highest in Kenya (97%)(57) as compared to both Uganda (96%) and Tanzania (96%) (56,58). This high coverage for BCG is expected because the vaccine is provided at birth. All countries report drop-out cases i.e., decline in subsequent doses, among the polio and DPT-HepB-Hib vaccines which require 3 doses. While there is no observed difference in vaccination coverage based on gender, children whose mothers have completed primary or secondary education are more likely to complete the basic immunization coverage(56-58).

There are variations in feeding habits across the countries. For instance, based on the available national data for Kenya, 99% of children under the age of 5 have ever been breastfed and 61% of children aged less than 6 months are exclusively breastfed (57). About 72% of the children aged 12-59 months receive vitamin A supplementation while about half (51%) are dewormed. For Uganda, almost all children (98%) are breastfed at some point.(58) However, the

national data shows that about a third of children are not exclusively breastfed.(58) Moreover, among the Ugandan children introduced to complimentary feeding, only a small number (15%) are fed a minimum acceptable balanced diet(58). Children need proper nutrition for their physical growth, health and cognitive development(51). Adequate nutrition is essential both before and within the first 1000 days (critical window) after delivery(5, 52). At both periods, better nourishment helps in the growth and development of body organs and building immunity against disease causing agents(5). The best food for a child's growth and development during the 'critical window' is breast milk(17, 53, 54). Breast milk is highly nutritious with abundance of vitamins, minerals, enzymes, and antibodies needed by a child to grow and thrive and fight diseases(55-57).

According to global estimates, morbidity due to diarrhea remains high, especially among children aged less than 5 years(21). Indeed, diarrheal diseases are the third leading cause of mortality, after pneumonia and preterm birth complications, with over 30 million cases occurring in Sub Saharan Africa(21, 58). Like most countries in the region(21), the prevalence of diarrhea has been shown to drastically increase after 6 months of age in all of the 3 targeted countries of Kenya, Uganda and Tanzania. This is expected because children begin to crawl and walk at age 6-11 months and are exposed to a higher risk of infection from the environment. The introduction of other liquids and foods at the time of weaning also facilitates the spread of microbes that cause disease(24). On average, diarrhea cases are more pronounced in rural areas as compared to urban areas(59, 60). According to the WHO, socioeconomic risk factors such as lack of access to clean water and sanitation are among the most prevalent risk factors for diarrhea in many SSA countries(10). Previous research has also identified a wide array of other health conditions being associated with diarrhea such as low immunization, undernutrition and

infectious diseases(21). This complexity of risk factors makes it difficult to standardize case definitions for diarrheal disease, hence challenges in making reliable and comparable estimates of diarrhea morbidity and mortality(21, 61). However, the leading cause of the problem is environmental sanitation, hence infection through the fecal-oral route.

1.4 Organization of the paper

The dissertation is organized in 6 chapters. **Chapter 1** includes the background and statement of the problem as well as the focus of the study, as well as an overview of the theoretical framework. **Chapter 2** includes an overview of the country health care systems, the history, and current trends in antenatal care (ANC) and its linkage to maternal and child health promotion activities. **Chapter 3, 4, and 5** are individual papers formulated to answer the dissertation questions. Finally, **chapter 6** is the overall conclusion of the dissertation.

1.5 Theoretical Framework: Social Cognitive Theory

1.5.1 Historical overview of the model

The Social Cognitive Theory(SCT) was developed by Bandura in the mid-1980s to describe how people grow and how their behavior is affected by their interactions as well as interlinked with the influences of their environment(62). The SCT provides a framework for understanding, forecasting, and modifying human behavior by asserting that an individual's behavior is mostly learnt via interactions with his or her surroundings and by observing other people(63). The SCT stemmed from the Social learning theory, proposed earlier in 1941 by Miller and Dollard, which serves as the baseline foundation; under the premise that people acquire behaviors through watching others if they are motivated to do so(64, 65). In other words, people would desire to acquire behaviors that would lead to positive consequences. Individual observers may consolidate their learnt behavior by reproducing these seen acts, and they would get positive reinforcement as a result(62). The cognitive component of the SCT distances it from previous social learning theory by emphasizing the critical role of cognition in individuals' ability to understand information, self-regulate and direct their behavior(64, 66).

According to the SCT model, learning is heavily dependent on one's ability to regulate oneself(66). Individuals are able to consider and exert some control over their own behavior by integrating environmental, social, and personal variables(63, 64). Social cognitive theory was developed from an agentic viewpoint and is focused on human agency, or the manner in which individuals exert some kind of control over their own lives(63). According to Bandura, personal agency operates within a vast network of socio-structural forces(66). People participate in these agentic exchanges as both creators and beneficiaries of social systems. Individual agency can be presented in two ways whereby individuals are presented as both the “products” of the social

environment/system in which they live as well as the drivers of the social system(64). They have individual power to act independently in a given environment as well as collectively benefit from group efforts to achieve a given outcome. Wider networks are also important within a social system as they provide possible avenues for behavior distribution across larger populations(62, 67).

Many behavior theories employed in health promotion focus on behavior initiation with limited emphasis on habit maintenance(64). To measure the effectiveness of public health initiatives, its desired to measure how behavior is maintained instead of just focusing on the initiation(67). The SCT framework helps in explaining how people manage and reinforce their behavior in order to produce evidence-based outcomes that can be sustained over time(68). According to Bandura, a person's behavior is the outcome of the simultaneous interplay of their qualities, their behavior, and the setting or circumstance in which they engage in that behavior(62, 64). This draws a triadic and reciprocal relationship where behavior & cognition, personal factors, and environmental circumstances influence each other in a bi-directional manner(66, 68), as illustrated by figure 1 below,

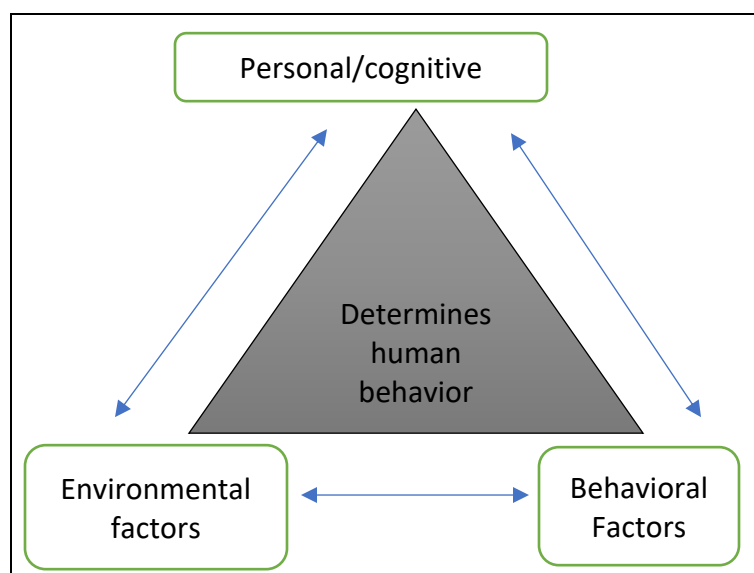


Figure 1: A diagrammatic representation of the SCT framework showing the reciprocal determinism

Even while the components (person, behavior, and environment/circumstance) on the vertices of the triangle seem to be equally spaced from one another in the depiction of this model, it should not be concluded that they all affect one another in the same way(65, 66). The power that each element wields changes depending on the reality, which is diverse. Moreover, reciprocal causality does not imply that all possible influences are equally powerful.

Additionally, the opposing effects do not work concurrently. It takes time for a causal factor to become active and start up the related impacts. Because we are dealing with dynamic processes that develop over time rather than one-directional causal links, reciprocal causation is probable(69, 70). In other words, rather than starting with single occurrences, it is necessary to first understand sequences of psychosocial experiences in order to explain these links. Everyone has their own ideas, experiences, and beliefs. They are also exposed to various settings and behaviors, which are filtered and have a variety of effects on each other(70). People have the ability to influence their own behavior, which gives them control over their ideas, emotions, and behavior(69, 71). Moreover, the characteristics of the person and the outside influences are always in conversation with one another(69).

1.5.2 SCT Constructs

The SCT has six main constructs, five of which were adapted as part of the Social Learning Theory(64, 65). The construct of self-efficacy was the main addition after the evolvement of the SCT from the Social Learning Theory(64, 72). The constructs are described as follows.

Reciprocal Determinism: This is the central principle of the SCT framework. According to Bandura, a person's behavior is impacted by their own personal circumstances as well as by the environment and the circumstances around them(62). The idea of reciprocal determinism illustrates that behavior is as a result of simultaneous of personal traits, the behavior and the environment or circumstances under which the behavior is performed(70). Therefore, a personal behavior is both influenced by, and in return, influences another person's personal traits as well as their environment. This draws a triadic relationship where behavior & cognition, personal factors, and environmental circumstances influence each other in a bi-directional manner(69).

Behavioral capability: This involves having the knowledge and skills to perform a particular behavior(66). To successfully complete a task, individuals must know how to execute it and understand the consequences of their activities.

Observational learning: This mode of learning occurs by observing the behavior of others. The targeted behavior is observed, memorized, and then internalized or mimicked. According to Bandura, imitation of other behaviors may lead to the development of particular personality traits, features, and behaviors(73). On the other hand, he also acknowledged that certain behaviors are in fact the product of direct instruction or some other kind of conditioning(65). According to Bandura, humans acquire behaviors as well as morals and judgment via modeling, which also aids in the development of cognitive skills(63). A good example is the ability of individuals to complete an activity successfully if they witness a presentation of the behavior.

Reinforcements: Involve the internal and external factors that determine if, or not, a behavior is sustained(68). Reinforcements can be either positive or negative and can come within personal factors or their surroundings(68, 74). As such, this construct closely identifies with the reciprocal relationship between behavior and the environment.

Expectations: These are the anticipated outcomes of a behavioral action and can be either positive or negative(74). People are likely to evaluate the consequences of their behavioral actions, and this consequently influences the nature of their action. Expectations are mostly based on the person's previous experiences, or lack of, and are subject to the individual's subjective importance placed on the outcome(62, 71, 75).

Self -efficacy: This is the construct that differentiates SCT from Social learning theory and refers to an individuals' belief in their ability to successfully, accomplish a task(69). Since its inception, self-efficacy has been defined in a variety of ways. Despite the fact that certain definitions may differ, most revolve on an individual's sense of their own skills(76). Self-efficacy was further developed by Bandura in 1995, when he defined it as a regulatory system that affects behavior in four different ways: by enacting cognitive processes, adopting objectives, increasing goal commitment, and expecting that goals would be accomplished despite setbacks(77).

1.5.3 Application in Prior Research

The SCT has been applied on various health promotion studies, including a cluster randomized controlled trial to promote physical activities whose results supported the effectiveness of an SCT-based physical activity intervention to reduce the risk of prediabetes among rural residents(74). Another study by Kazemi et al(78), applied the SCT to explain how opportunities for observational learning in physical activity behavior improved physical activity among women during pregnancy. Another study used SCT to investigate the factors influencing adherence to oral hygiene behaviors among elementary school children(79). The study found out that self-efficacy, measured on proper brushing techniques, and supportive family environment were strongly associated with flossing and brushing behaviors among children(79). Other

applications of the SCT model include studies investigating HIV prevention during pregnancy(80), bullying awareness and prevention(81), diet and obesity prevention(82, 83) as well as utilization of prenatal care services(84).

1.5.4 Application of SCT in this study

Figure 2 presents the diagrammatic representation of how the SCT model is applied in this study. Personal factors relate to the sociodemographic characteristics that are measured on the study population. These include measures such as maternal and child age, level of education, employment status, among others. The environmental factors include the social and physical attributes that measure access and utilization of health care. These include factors such as distance to the health facility, health insurance, cultural beliefs, empowerment & autonomy to healthcare access, residence, among others. The behavior can vary in different contexts based on practice of utilization of health services. In this study the overall behavior is ANC, and the expected outcomes of this behavior is child vaccination, breastfeeding, and diarrhea prevention. While we are measuring the influence of the behavior (ANC) on the outcomes, the dotted lines show the potential influences of other factors on the outcome(s). As such, we are controlling for other covariates that are potentially associated with both ANC uptake (reciprocal determinism) as well as each of the specific outcome.

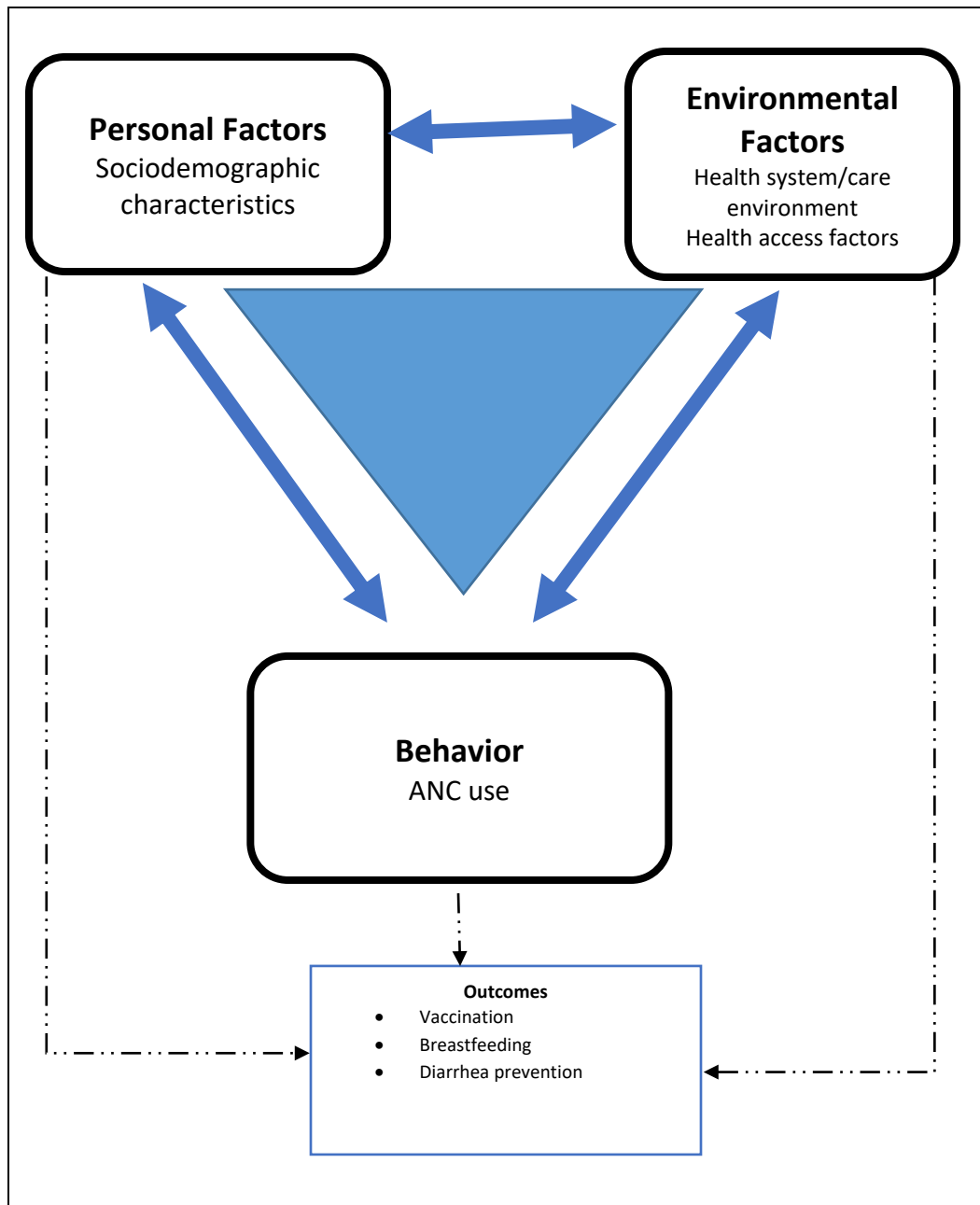


Figure 2: An illustration of the SCT model as applied in this study.

In the literature review, I apply the same model by broadly providing an overview of health system in the selected countries (environment), explore the ANC (behavior) and the population interrelationships that determine the rate of ANC utilization (personal factors). Towards the end of the literature review, I explore the extent to which previous studies have explained the

relationship between ANC and various health outcomes and ultimately identify the gaps in the literature that are to be filled by this study.

CHAPTER TWO: LITERATURE REVIEW

In this chapter, I applied the three components of the theoretical model (personal characteristics, environmental factors, and behavior) to organize the literature review while exploring the organization of the health infrastructure (healthcare environment) in the countries, the history and development of ANC utilization as well as the individual and sociocultural factors affecting access to care especially during pregnancy and after birth. In line with the focus of the study, I further explored the extent to which previous studies have linked ANC with specific pregnancy and overall health outcomes, including maternal health promotion practices such as breastfeeding, vaccination and diarrhea prevention. This examination of the literature also highlights the gaps in published research that is to be filled by the current study.

2.1 An Overview of the healthcare organization in East Africa

Introduction

A healthcare system's top priority is effectively delivering evidence-based services that satisfy patients' expectations for quality treatment while also addressing their needs. The ideal situation would be for clients to always have access to, be able to afford, and find adequate healthcare services (3). This is crucial for vulnerable groups, such as expectant mothers and young children. It is essential for health systems to create conducive environments for women's routine all-encompassing care throughout their pregnancy, as well as during childbirth and beyond, to reduce both adverse pregnancy-related outcomes and as well as perinatal deaths (24). Three overlapping components: cost, access and quality are key in examining the acceptability of healthcare services(25). Therefore, it is important to consider these characteristics while attempting to advance access equity and better health-seeking behavior.

This is because a population's ability to use services is influenced not just by proximity and availability of the desired infrastructure but also by social and organizational hurdles that hinder the utilization of the services (26). Considering this, efforts to improve the design and upgrade service provision should also factor the individual and social factors that determine usability, and vice versa, hence balance the reciprocity.

2.1.1 Organization of Health System in Kenya

Over 44.6 million people in Kenya are served by a pyramid-shaped health care system that includes care homes staffed by nurses and doctors, as well as dispensaries, health centers, sub-county hospitals, county hospitals, numerous private facilities, and national hospitals (27,28). The dispensary, which is run by accredited and licensed nurses, provides basic outpatient care, such as the distribution of medicines and vaccinations, and referrals (29). The health centers aim to reach at least 8000 people with vital services, including vaccinations and some preventative primary medical care (30). Other daily support staff members like drivers and housekeepers work there, including nurses, clinical officers, lab technicians, administrative officers, pharmacists, nutritionists, public health officers, and other professionals. These medical facilities are far more intricately organized, providing care for both in-patients and outpatients, running laboratory testing, caring for mothers and children, performing minor surgeries like circumcisions, and having an adjacent pharmacy (30).

The sub-county hospital, the next level of care in Kenya, offers more complex surgical procedures, like Cesarean-sections, overseen by junior doctors and nurses (30). The county hospital, located below the regional level and serves as a hub for referrals from lower-tier medical facilities, and is set up to provide more complex medical services and surgeries and is

managed by more senior medical professionals. The nation's eight provincial hospitals, which serve as sites of entry for patients at the bottom of the healthcare pyramid, provide the next level of care. These are local facilities that provide critical care that is more advanced and specialized, such as care for life support, along with expert advice and rehabilitation. At the pyramid's summit are the national hospitals, which provide all forms of care (27,30). The Ministry of Health oversees this well-organized healthcare system at the national executive and legislative levels (Ministry of Health, 2017). Medical coverage via the National Hospital Insurance Fund is required for all employed workers in Kenya. As a result, Kenya is seen as actively participating in the transition to a system based on universal insurance coverage, as guaranteed under the country's constitution (30).

2.1.2 Organization of Health System in Tanzania

Tanzania's healthcare system is organized from bottom to top, with local health services located throughout the nation and village dispensaries, and hospitals at the district, regional, and referral (consultant) levels (31,32). The village health services in Tanzania only provides primary health care (PHC) that can be provided even at home, exclusively serving the poorest and most remote villages. This level is run by locally selected health practitioners with basic training to deal with less urgent health concerns of the population. The second tier, or dispensary health services, provides more complex, location-specific preventive treatment. Sub-district hospitals offer more sophisticated services and cover a population akin to one administrative division. Additionally, they act as a source of patient referrals for the district hospital, higher up the rung (27). District hospitals offer surgery, emergent obstetric care, in-patient care, radiology services, and cutting-edge laboratory services. Summit-tier healthcare facilities in the country, such as referral hospitals, also serve as doctor training programs.

Analysts have noted that, in Tanzania, low-level clinics led by staff with minimal managerial and medical skills, such as junior doctors, clinical officers, and nurses, are the primary areas of concern (32). Additionally, despite the district's reported improved infrastructure for healthcare, the facilities are overrun by the volume of patients who travel there for treatments, many of whom have urgent medical requirements. In other terms, the resources do not adequately meet the demands of the population(27). Furthermore, there is a significant degree of centralization because the Ministry of Health and Social Welfare offers oversight for all hospitals. Due to the primary care strategy's fragmentation and the management system's excessive centralization, this has been noted as one of the flaws of the organizational framework in service delivery (27).

2.1.3 Organization of Health System in Uganda

Health care is structured and operated differently in Uganda as compared to Kenya and Tanzania. At the most fundamental level, village health teams give patients basic medical advice and refer them up the chain (33). Next is the parish health facility II, which offers pregnancy care and treats a small population for ailments like malaria and the flu. This level is operated by a nurse or midwife (34). Health center III, at the sub-county, features laboratories supervised by clinical officers. Health centers IV, intended to service counties, have emergency operation theatres, admit in-patients, and are managed by senior doctors. The next stage is the local referral hospital. The referral hospitals include specialist clinics, dental and mental health facilities, and several consultant doctors, hence cater for a variety of preventive and clinical care services (35). Uganda's national referral and teaching hospitals are top of the pyramid and provide a wide of outpatient and in-patient care (27).

The countries share some similarities in the organization and structure of the national health system, common maternal and childcare programs and health policies, relatively face similar health infrastructural issues such as inadequate health personnel and facilities' distribution and finally are economically at par, with reference to their GDP. However, while the countries are, fairly, socioeconomically homogenous(55), there is a possibility of differences in individual perceptions about certain health promotion practices as well as variance in access and utilization of care based on sociodemographic characteristics within and between country. To better understand the nature and magnitude of difference in the association between ANC quality and the various outcomes, the data from the three countries will be pooled together to increase power in the analysis, as well as run separately for each country to compare the results among countries.

2.2 ANC and Maternal health promotion practices

2.2.1 An overview of ANC

Antenatal care (ANC) is a global health system approach for improving both maternal and child health and reducing mortality a) directly through detection and treatment of illness and b) indirectly through improving the health behaviors of the mother during and after delivery(85-88). ANC practice dates back in the 18th century, a period marked by the beginning of many medical advances in midwifery in the current day Europe(89). The conventional approach in antenatal care in Europe was developed in the 1900s(89) and operated under the assumption that multiple ANC visits were better in the care of pregnant women and their babies than few visits(35). This model was later evaluated and adopted by the World Health Organization (WHO) in the 90's to deliver Focused Antenatal Care (FANC) during pregnancy particularly in

the developing nations, including SSA(90). The FANC model included delivering 4 ANC visits; the first ANC visit occurring before 12 weeks of pregnancy, the second around 26 weeks, the third around 32 weeks, and the fourth between 36 and 38 weeks of gestation(90). Several evaluation studies later challenged the effectiveness of the FANC model associating it with more perinatal deaths than models that comprised of more ANC visits(35, 39).

Further research on ANC utilization based on number of visits continuously suggested that ANC models with a minimum of eight visits, irrespective of the resource setting, were highly associated with better maternal outcomes than less ANC visits(35). This led to the latest 2016 WHO guidelines recommending a minimum of 8 ANC contacts (1 during 1st trimester, 2 during 2nd trimester, and 5 during the 3rd trimester)(37). A notable change in the current model is the reference of the terms ‘contacts’ instead of “visits”, with the former implying an active connection between the pregnant mother and the health professional; more than just attending an appointment(37). The guidelines highlight the importance of a woman's connection to her physician being more than simply a routine appointment but rather an opportunity for excellent care, including hospital treatment, support, and prompt and pertinent health education during pregnancy. This connection focuses on the supportive and respectful interaction between the provider and the pregnant woman leading to a positive experience(8). Some of the key services promoted during ANC visits based on the new model include nutritional interventions, maternal and fetal assessments, prevention measures such as vaccinations, diagnosing and treating common health problems, and interventions to scale up the utilization of ANC(90).

These recommendations have been extremely effective in promoting assistance and correspondence between health care providers and pregnant patients, increasing the likelihood of

safer pregnancy outcomes. Other key services promoted during ANC visits based on the new model include nutritional interventions, maternal and fetal assessments, prevention measures such as vaccinations, diagnosing and treating common health problems, and interventions to scale up the utilization of ANC(74) . Despite these global measures, many women continue to miss out on these essential benefits, which not only impact their progress during pregnancy but also the associated benefits of secondary health assessments and sharing of health information applicable before and beyond the pregnancy and delivery period.

2.2.2 The critiques for ANC

The ANC practice has received a fair share of critiques about its effectiveness in the goal of maternal and child health outcomes(37, 39) and in relation to the dissemination of services in LMICs. Some scholars argue that there is no clear and informative way of universally measuring the magnitude of change associated with ANC in the multi-culturally and politically diverse countries in the developing world, especially in SSA(37, 88). While the models were adopted from antenatal programs of developed countries, with only minor adjustments, some studies have questioned the usefulness of the approach in the developing countries where there are limited recourses of reproductive care, low utilization of the available resources(35, 104), as well as the irregular, quality and timing visits by the pregnant mothers(39). Some studies have also highlighted the issue of communication between and within the different departments to provide comprehensive care for the mother e.g., between antenatal care clinics, nutrition, obstetric and maternity units. While there is will power and continuous efforts to formulate interventions(86, 87), minimal short- and long-term targets may not be achieved due to factors such as disjointed activities, many actors and stakeholders with conflicting or parallel goals, inadequate planning and evaluation of projects, and, most importantly, less reference to research findings while

addressing health care utilization(86). It is important to note that these critiques tend to address the operational difficulties as opposed to the usefulness of the ANC model. Moreover, while there could be universal ways to formulate and translate intervention activities into improved health worker practices, little is known about to what extent improvements in quality of ANC could be translated into changes in health behaviors among women(105).

2.2.3 Demand – Supply determinants of ANC utilization

Efforts to understand ANC service utilization have focused on either demand factors, supply factors or a blend of both(91). Supply factors aim at understanding the public health interventions that ensure provision of quality services to the populations(92). These include geographic distribution and delocalization of health facilities(93) infrastructural issues including availability of adequate obstetric services in the health facilities(37), as well as training and need-based allocation of health professionals(86, 87). Demand factors tie on the social patterns and population characteristics such as culture, financial support, women's empowerment, knowledge and expectations from ANC visits, among others(92, 94).

2.2.3.1 Supply factors for ANC access

Interventions to mitigate the highlighted issues have been addressed in several papers. Many obstacles prevent women from accessing ANC services, among them geographical access(95, 96). Distance to health facilities, combined with transportation, is a big factor towards access to health services especially in the rural areas(91, 95). However, there are disparities in urban areas based on social economic status and residential neighborhood(97). While the problem of access due to distance is typically low in urban areas (compared to rural), it may be greater for women living in slums (often located at the periphery of cities) than for those living

in middle- and higher-income residential neighborhoods(97). Decentralization of services is one key approach that has been identified in several countries as a potential intervention to increase access to health services(87, 95, 98). Delocalization of services by proportionally introducing health facilities and key services across a country has the potential to save expectant mothers from the need to travel long miles seeking service(86, 95). On the other hand, local health facilities can be empowered with some degree of autonomy to manage their human and financial resources(86) This is beneficial in several ways. The management committee can hire locals who 1)are well familiar with the community with regards to language and cultural practices, 2) have a sense of belonging, hence the urge push for reforms towards positive health outcomes, and 3) can act as role models and opinion leaders for positive behavior change(86, 99). Moreover, the health management teams can tailor services and resources to cater for their community's challenges and needs(95). While it is difficult to measure the impact of decentralization in many analyses, studies have found some improvement in ANC utilization ANC services(100) as well as overall maternal health outcomes(101), following the decentralization of services.

Health professionals are pivotal towards supervising the progress of mothers throughout their pregnancy period(8). The strides made by many western countries in lowering maternal mortality rates are attributed to the recognition given to skilled care in those countries(35). In the African region, there is chronic paucity of skilled healthcare personnel across all cadres(86, 97). Overworking by health care staff directly reflects onto the quality of services provided to the patients(102). It is not uncommon for women to complain of poor services after their interaction with the health care provider(s)(8, 102). While there are incidences of individual negligence, unethical, and unprofessional practices among some health professionals, there are genuine cases

of burnout(102). Burnout is a syndrome of emotional exhaustion, depersonalization, and a sense of low personal accomplishment resulting from chronic job-related stress that can lead to decreased quality of care rendered(103). Burnout among Health care workers has been shown to be associated with physical and mental illness as well as increased absenteeism, decreased job performance, poor patient practices, and medical errors(103). Strategies identified as potential for averting this problem include training more health promotion workers who are equipped with basic knowledge on leading public health problems(87, 103). An alternative method is establishment and funding for rural and distant sites for training health professionals(91).

2.2.3.2 Demand factors for ANC access and utilization

Relative to the attention given to improving the quality of and access to maternal health services (supply-oriented factors), there is a growing concern that health intervention programs tend to ignore the individual and socio-cultural aspects(87). These involve both social and cultural elements of the society that influence individuals' attitudes, lifestyle and health seeking behaviors(87). Some of these factors include religion, socio-economic status, family structure, politics, cultural values etc. Moreover, there is specifically limited empirical work assessing the socio-cultural aspects of women's empowerment (such as gender inequality, literacy, economic growth, educational status, employment, age at marriage etc.), and how they influence women's attitudes and perceptions towards seeking certain maternal health services which also translate to child health promotion practices(85, 97). I explore deeper on how some of these sociocultural issues affect women's ANC utilization and experience and how this trickles down to child health promotion behavior beyond the pregnancy period.

Sociocultural norms affecting Quality ANC utilization

Autonomy in decision making

The traditional necessity for women to have the permission of husbands or their relatives, before leaving the home has been noted as a norm in various studies conducted in Malawi(106), Nigeria(107) , Ethiopia(108), and Ghana(109). Despite having the knowledge about the need to attend skilled ANC(110), women reported that their limited autonomy with regard to decision making and freedom of movement was one main factor that influenced their decision to seek care or not(108, 111, 112). Lack of basic delivery supplies did not only have an impact on the decision to deliver in a health facility but also rolled back into the partner's decision to support the wife in attending ANC in the first place. The reason for the latter is because attending ANC would in the long term mean extra cost of hospital delivery, as those who attend ANC would most likely deliver in a health facility(108, 109, 111). Negotiations for skilled care during pregnancy and childbirth proved futile for most women, especially those who had a history of 'successful' delivery outside the health facility(113). When asked why some men support their wives to attend ANC while others are reluctant, reasons included: lack of money(114), lack of income generating activities(113), lack of income to meet health center costs, and lack of personal transport means. Whether resources are available, and who controls access to those resources, are a result of both poverty and gender dynamics(113).

Gender roles & inequality

Gender, as a power relation and driver of inequality, can be understood by how power is constituted and negotiated in relation to access to resources, division of labor, social norms and

decision-making(109, 113). Several studies have explored how women empowerment efforts also address gender-based inequities by increasing opportunities, and social inclusion of women(109, 114, 115). Gender dynamics in relation to division of labor affecting maternal health and health care were women's workload during and after pregnancy(113, 116), and lack of male involvement at both at home and support in attending healthcare(116). One of the new strategies applied to reduce gender-based inequalities, as discussed by in 4 of the reviewed articles, is male-partner support and participation in ANC(108, 116-118). According to Mkandawire (2018), men's involvement mainly entails being engaged with the woman and the process of pregnancy, eagerness to learn about the process, and maintaining a sound relationship with the woman regardless of the marital status(116). One of the main facilitators of men's involvement in maternal and child health was men's recognition of the benefits of their involvement(108).

Information sharing is importance as it was shown to improve men's participation on issues concerning the health of the mother and the baby(116). In fact, the male-partner participation was associated with ultimate benefits such as delivery in a healthcare facility, seeking postnatal care services, and improved communication among the partners(113, 115, 119). However, these efforts are met with various socio-cultural challenges such as societal defined roles of male and place of women(113), as well as traditional beliefs surrounding pregnancy(120-122). One study, conducted in Malawi, specifically discussed the common perception of men about pregnancy being a woman's responsibility(116). On a similar note of social perceptions, some studies highlighted the plight of men being ridiculed for engaging in 'women activities' such as accompanying their women to ANC(113, 123, 124).

Family Support

Women's participation in key decision-making at the household level has been found to contribute immensely on their influence on major decisions, such as getting skilled prenatal care(123, 125). Results from a qualitative study by Manda et al(106), indicated that even though there a mutual agreement with regard to equal exercise of power at the household level, it was expected that men had a greater responsibility to provide for the family as well as support the woman during the pregnancy and preparations of labor(106). This common assumption that expenses are the responsibility of the husband is a possible indication that the society and some traditions, do not provide enough power to women to make them independent and autonomous (101); this is according to a study conducted by Some (2013) in Burkina Faso.

Studies by Mkandawire(116) and Morgan et al(113), found a contrast in the nature of male support; although men might successfully be encouraged to participate on activities such accompanying their partners to the health facilities, this cooperation did not necessarily translate to decision making, and assistance with house chores(113, 116). This is due to the continued assumption that child care is 'women's work(116). A new dimension less explored as highlighted in a study conducted in Uganda(113) and Malawi(126) is the impact of patrilocal marriage pattern; relating to a pattern of marriage in which the couple settles in the husband's home or community especially in the rural areas. While the authors cited the potential of the woman being voice-less in her new environment, there is limited evidence to support that.

Partner violence

Domestic violence has been discussed as a key reason why some women miss out on seeking ANC care services(106, 113). Some of the highlighted precursors for domestic violence

included women's delay at the health clinics when they attend antenatal services(113), failure to perform their household chores(106), as well as decreased interest in sex when pregnant(113). The first two reasons clearly indicate the negative impact of not having autonomy on decision-making on access to care as well as lack of partner support and division of roles/labor in the household. Violence against women was measured by focusing on whether a woman had been a victim of violence, or alternatively whether she considered marital violence to be acceptable within the household or community in general(113). Level of education appeared to have a protective effect against domestic violence according to the two studies.

Cultural beliefs & Practices

Traditions heavily influence the decision-making-process(113, 115, 124). The cultural norm of not revealing the pregnancy until the pregnancy is visible was identified in some papers as a reason for not seeking care in the first trimester(121, 124, 126). This cultural belief is predicated on the idea that disclosing pregnancy too early to nonfamily members or distant relatives could put the woman in danger from witchcraft, which would cause a mother to miscarry(126). A study by Roberts et al cited the influence of strong religious beliefs which demanded that mothers seek care from religious leaders and not the health facility(124). The paper noted that going to the clinic while pregnancy was only necessary when the mother was feeling unwell(124). A study by Kea et al(121), found a similar perception that health facilities are usually reserved for severe illness and not normal conditions like pregnancy(121). In such a case, giving birth at health facilities was considered a sign of weakness, and exposed one to surgical procedures and even death(121).

The beliefs surrounding marriage and the woman status in the household also had a great impact on their autonomy in healthcare decisions. One case study conducted in Burkina

Faso(115), discussed a scenario where marriage occurs without the woman's consent; the woman is 'kidnapped' by the 'husband' and families later plan for a ceremony. Similar traditions of women having no legitimate involvement in marriage proceedings and decisions (not necessarily with the kidnapping) were discussed in studies conducted in Malawi(126), and Ethiopia(121). Such conditions constrain the women to a total dependency on men and do not permit women to participate effectively in decision-making concerning their health(115). However, sometimes the women are not only on the receiving end of having the pregnancy being affected by the beliefs of partners or social environment, but also actively participate and belief on the same I.e. not always victims of social beliefs but influencers of the same(124).

2.3 Exploring the influence of ANC on health outcomes

An overarching aim of the ANC process is to monitor the pregnancy development and identify any potential pregnancy complications with a goal of ensuring a safe pregnancy(8, 92, 127). There are different dimensions of ANC, including time of initiation, the total number of visits and their spacing, the nature of services provided during the visits, the type of the provider and the setting they are operating from, schedule for medical screening and the inclusion of medical, nutrition and other health information/education support services(8, 37, 88, 92, 94). Specific care provided during ANC visit includes screening for, and treatment of any infections that might affect the fetal development(128-130), anti-tetanus immunizations(131, 132), screening for malaria(130), testing and prevention of mother-to-child transmission (PMTCT) of HIV(133, 134), and provision of supplements such as iron and folate to prevent anemia(133-136). Prenatal care providers may also provide consultation on breastfeeding, nutrition, smoking and drinking, drug use, and food safety, as well as support to relieve maternal stress(137).

However, not all prenatal care providers include all this content, and little of this content is usually provided in LMICs(138, 139).The expected benefits therefore vary based on the availability of the services from the facility's standpoint as well as the access and behavior towards utilization of the services, from the consumers end.

Previous studies have documented some the benefit of the ANC in reducing maternal deaths(140-142), ensuring skilled delivery(44, 143-145), reducing the prevalence of neonatal deaths(146-148), reducing birth complications such as pre-eclampsia(149, 150), low birthweight, and developmental delays(151, 152). It is estimated that ANC alone reduces neonatal mortality by 10–20% (39), though the utilization of those services in SSA is inadequate(145, 153). Other studies have explored the possible benefits of ANC to maternal child health promotion behavior after delivery(30, 38, 153-157). Some studies have observed that a mother's own use of health-care services is a strong predictor of her children use of health services(153, 156, 157). For example, McGlynn et al (156) demonstrated the association between ANC visits with skilled delivery and complete immunization as well as early infant care.

Other studies have associated the ANC with better mental and emotional preparedness of the woman to both the pregnancy and motherhood(158-161). For example, according to Kingston et al(158), new mothers might experience psychological distress because of fear and uncertainties about pregnancy. This can be as a result of changes within their body as well as the lack of social support within their close relationships(161). Without correct measures, or support, the psychological distress, (including stress, anxiety, depression) during pregnancy may continue to the postpartum period(161). It may not only affect the fetal development but also the mother's care for the child after birth(159). The ANC can play a big role in the identification of any signs of distress, health information sharing, and assurance of the mother of a skilled-care support

during and after the pregnancy(158, 162). Moreover, some important benefits of ANC may only appear in later life. For example, some micronutrients included in recommended prenatal vitamins are important for fetal brain development and for children's cognitive skills(163). In this regard, ANC utilization can be associated with important developmental outcomes later in life, specifically higher height-for-age at 24 months and higher attained school grades(30). These results suggest the relevance of ANC visits in developmental growth and productivity over the lifecycle. However, these benefits beyond the postnatal and child development period are scantily researched and therefore more work is needed.

2.4 Addressing the gap in the literature

Notwithstanding the potential benefits and continued emphasis of ANC by global organizations such the WHO, the effectiveness of prenatal care in SSA is still debated especially on how to maximize the information provided across the pregnancy period(38). The evidence from LMICs is limited, with many studies focusing on certain aspects of ANC or dwelling on single countries, or small area comparisons that cannot be a representative of entire population at the national level(30). This makes it difficult to make comparisons based on cross-country analysis of the available literature.

The literature identifies utilization practices such as early initiation of ANC, utilization of skilled services during the antenatal period, and frequent or more than 4 visits, as critical in ensuring safe pregnancy and delivery for the mother, as well as healthy fetal growth, and developmental milestones during the post-natal period. These factors are part of key indicators for quality of ANC. The point of initiation of ANC has been examined as a great opportunity of connecting most women in Sub-Saharan Africa with the healthcare system(38, 105). The earlier

the women access healthcare during the pregnancy period, the better the opportunity to assess any underlying conditions that might affect their pregnancy(92). In addition to early initiation of ANC services, the frequency of the ANC visits is important as more contacts with the ANC provider provides more opportunities for information sharing about skilled delivery and caring for the baby after birth(92, 164). Skilled care is valued as any care from a clinically trained professional operating from any level of government or private or NGO facility. According to the WHO recommendations, skilled care is provided by different tiers of professionals operating from government, private and non-governmental organizations, who also operate at different skill and capacity level(37, 165). All these facilities run by skilled providers can provide the minimum ANC services. While studies have widely examined the association between the individual measures of quality and varied outcomes, there is scarcity of literature measuring the compound effect of these quality measures on maternal and child health outcomes, specifically on maternal health promotion behaviors. This study is therefore structured to fill this gap.

Findings from systematic reviews also provide conflicting reports of the influence of ANC on various outcomes(166-168). Moreover, other studies show positive effects of ANC in preventing newborn deaths(169, 170). The literature, therefore, is not conclusive on the benefits or the influence of ANC on women's health promotive behavior after the delivery(129) The literature is also sparse regarding infant outcomes after deliveries by mothers without prenatal care, particularly regarding the women's behavior, and abilities, towards disease preventive measures such as immunization, breastfeeding and sanitation(146). Considering the different and conflicting results concerning the effect of ANC on neonatal and child mortality in SSA countries(146, 152, 168, 171, 172), there is a need for further exploration of the impact in

reducing preventable deaths that can be controlled through affordable measures such as breastfeeding, vaccination, and diarrhea prevention practices.

2.5 Overview of the studies

The first study examined to what extent ANC quality is associated child vaccination among children aged 12-23 months. The binary vaccination outcome measured the completion of the basic routine immunization, or not. The minimum age of the children measured in the study is set to 12 months as that marks the minimum age when all the basic immunizations are expected to be administered. The second study examines the extent to which ANC quality is associated with diarrhea prevention measures as practiced by women to protect their children against diarrhea episodes. The third study is a multivariate analysis examining to what extent ANC quality is associated with 1) exclusive breastfeeding, 2) early initiation of breastfeeding and 3) continued breastfeeding after 6 months.

2.7 References

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CHAPTER THREE: MANUSCRIPT 1 OF 3

Title: Examining the influence of Antenatal Care (ANC) quality on child vaccination in three East African countries: A multilevel Analysis

Abstract

Introduction

*In SSA, there is a growing concern for many children delaying or missing out on basic vaccinations due to their parents' conscious decision, sociocultural beliefs surrounding hesitancy, or because of limited access to vaccines. Access and utilization of health services has been associated with improved health behavior. It is however not clear how services such as ANC influence maternal behavior towards vaccination of their children. The **primary objective** of this study, therefore, is to examine the influence of ANC quality on the completion of basic vaccination among women in three East African countries (Kenya, Uganda, Tanzania).*

Methods

Data for this study was obtained from the demographic and health surveys (DHS) collected in Kenya (2014), Uganda (2016) and Tanzania (2015-2016). The operationization of the main predictors (ANC quality) is detailed explained in the methods. The binary outcome measure was based on the completion of basic vaccination, or not for children aged 12-23 months. We conducted descriptive and binary logistic regression to assess the effect of the predictors on full vaccination, after controlling for other covariates. The analysis included separate modelling for each country as well as pooled analysis.

Results

Approximately a fifth of the women in Kenya (20%) and Uganda (23%) had adequate level of ANC utilization, compared to less than 5% of women in Tanzania. In Kenya, the adjusted odds of full vaccination were 1.17 greater with every unit increase in essential ANC health care practices [AOR: 1.17; 95% CI: [1.03,1.32]. Similarly, in Tanzania, the odds of the outcome were 1.15 times greater with every unit increase in essential ANC health promotion care practices (ANC HPCPs) [AOR: 1.15; 95% CI: [1.04,1.28].

Conclusion

The results of this study provide a clear emphasis on the influence of ANC on child vaccination and the suggestion to come up with strategies on increasing the utilization of ANC services among women while educating them on the importance of childhood vaccination. Our findings are therefore influential not only in solidifying the proven importance of ANC but also opening a path for further exploration on how to tailor health information during ANC visits to include detailed information on child protective practices beyond the pregnancy period.

3.1 INTRODUCTION

From the historical plagues, centuries ago, to the current pandemics of emerging infections, researchers have continued to explore and test solutions against disease causing pathogens(1). Apart from safe water, no other intervention has had such a major effect on mortality reduction and population growth compared to immunization in low- and middle-income countries(2-4). Edward Jenner is accredited as a pioneer in the concepts of vaccines; with the first invention of the smallpox vaccination (5). However, attempts to “vaccinate” date back many centuries ago into Indian, Asian and African cultures(6). Some of these ancient practices included inoculation of scratched matter from sores e.g., smallpox sore, into the skin to prevent people from getting sick. Another method utilized in earlier 1700s involved use of variolation, the introduction of dried pus from pustules into the skin of the patient(7). While this procedure was initially recorded in ancient Turkey, the practice of using dried pus was a common procedure identified among African slaves(1); pointing to the possibility of applied similar techniques to ancient African cultures before it spread to Europe and Americas.

The 20th century was marked by great progress in the control of many childhood illnesses(1, 8). Significant contributions of vaccinations included the eradication of smallpox, global steps towards eradication of poliomyelitis, and decrease in other infections such as diphtheria, tetanus, measles mumps and rubella.(1, 6, 9). Diseases like smallpox had a high mortality rate (killed every fourth victim) and threatened 60% of the world’s population(6). Global campaign efforts by the WHO in the late 60s led to the eradication of the disease(9). Following the success of the smallpox eradication program, an invention accredited to Edward Jenner whose initial innovation of using material from cowpox pustules to provide protection against smallpox paved way for the invention of modern vaccination(5), the World Health

Assembly (1974), established the Expanded Programme on Immunization (EPI) to ensure all children globally benefited from live-saving vaccines.(1, 10).

Initially, the EPI recommended vaccination against the following six diseases: tuberculosis (BCG), diphtheria, tetanus, pertussis/whooping cough (DTP vaccine), measles and poliomyelitis(10). Across the years, other vaccines have been added with slight variation between countries based on risk(1, 6). Some of these vaccines include hepatitis B and Hemophilus influenzae type b(Hib), pneumococcal conjugate and rotavirus vaccines(11). The program has expanded the targeted groups to include older children, adolescents and adults and work in synergy with other public health programmes in order to control disease and achieve better health for all populations, particularly the underserved populations(11). However, despite the continued campaigns on immunization, many low- and middle-income countries continue to experience low immunization coverage and subsequent reemergence of communicable diseases. Based on the national reports from the demographic and health surveys, the full coverage of basic vaccination from a sample of children aged 12-23 months stand at approximately 72% in Kenya, 76% in Tanzania, and 57% in Uganda(12). Basic vaccination coverage involves, one dose of Bacille Calmette-Guérin (BCG) vaccine, which protects against tuberculosis, three doses of DPT-containing vaccine, which protects against diphtheria, pertussis (whooping cough), and tetanus, three doses of oral polio vaccine (not including the birth dose), and one dose of measles vaccine(12-14).

Assessing determinants of vaccination coverage

In SSA, there is a growing concern for many children delaying or missing out on basic vaccinations due to their parents' conscious decision, sociocultural beliefs surrounding immunization, or because of limited access to vaccines(14). The following review of the

literature highlights the influence of these personal, and environmental determinants of vaccine uptake. We begin by reviewing the individual characteristics that likely influence vaccination access and behavior, followed by sociocultural factors (mainly traditional beliefs and religion) and finalize with political environment and health infrastructure factors affecting access and acceptability of modern vaccines.

Individual characteristics affecting Access to immunization.

Some of the key sociodemographic factors highlighted in the literature include maternal education, household wealth status, place of residence, child, and maternal age, as well as gender of the child, among others. Prior research illuminates the different pathways through which maternal education influence healthcare-seeking behavior. Despite the proven positive association of maternal education and higher vaccination coverage, some studies have demonstrated inverse relationships between educational attainment and acceptance of vaccination. In a study using the demographic and health survey across 43 low- and middle-income countries, Karlsson et al(15) found a weakening association between parental education and child immunization. This indicated that some highly educated parents may be more critical about vaccination, a disposition that can negatively affect their acceptance of childhood vaccination. Other scholars like Balogun et al(16) argue that what matters in enhancing vaccine decision-making is not just educational achievement, but also an effective communication system to improve the practical knowledge and perception of parents about vaccination. This finding is consistent with the findings by Lawrence M(17) where the greatest reason for unimmunized children was the scarcity of information about vaccines and immunization services. Accordingly, Balogun et al (16) advocated that apart from formal education, there is

need to institute a health literacy system to enlighten parents on the importance of immunization for the survival of their children.

There is an increasing body of literature connecting household wealth status and immunization coverage rates(18-20). In a study, by Arsnauld et al (18), using the demographic and health survey across 45 countries and examining inequalities in vaccination coverage, level of wealth index was one of the dimensions found to be associated with the largest inequalities in childhood immunization coverage. In the East African region, a wide gap in accessing health care persists between the rich and the poor even at public health facilities(19-21). It has also been proved that complete vaccination probability is higher among children from highest wealth quintile households compared with the poorest(22, 23).

According to a study in Kenya by Kimani-Murage(23) wealth is potentially correlated with place of residence such that majority of those who live in the rural areas or urban slums are most likely to be in the poorer health quintiles. This finding is echoed by Bbaale(19) in Uganda who added that the inequality gap becomes wider if the place of residence is far from the health facility. In an instance where the location of such facility is far from home of an impoverished mother, lack of transportation can deprive her from immunizing her child(23). Likewise, repeated failed attempts as a result of vaccine and equipment shortage can be equally discouraging for a mother striving to immunize her child in a facility(22, 23). These circumstances all have dire implications on completeness of immunization of the child.

In addition to socioeconomic status, there other maternal and child characteristics that are highly cited as key determinants of immunization coverage across the East African countries. Increasing maternal age has been associated with complete immunization coverage(19, 24). This finding signifies that children of the younger women are less likely to receive complete

immunization compared to the children of the older women. Reduction in the odds of child vaccination among younger women has been documented in earlier studies(25). Experience of older women in childcare provision and knowledge of the benefits of immunization with increasing age are likely possible reasons for these findings. Gender preferences also seem to play a big role in vaccination coverage. Several studies have demonstrated inequities in health coverage based on gender(20, 25, 26) Boys are more likely to receive care compared to girls(27). This could be due to cultural gender preference of boys, or the susceptibility of boys to disease and injury. Moreover, Restrepo et al (28)explains that children with multiple advantage are more likely to be fully immunized. Examples include children of parents who are highly educated, employed, have health insurance and dwell in urban areas, compared to children of parents in the lower spectrum of these qualities(28).

Sociocultural characteristics affecting Vaccination.

Historically majority of African communities followed the traditional religious beliefs and possibility of spiritual and supernatural life in determining the health and fate of individuals(29). Many traditional beliefs and religions perceived disease as punishment from the gods, bad omen or bewitchment or spell of spirits by evil members of the community(30). As a result, the belief system favored rituals for spiritual healing and other sacrifices to appease the gods for favor against diseases(31). Morbidity and mortality were associated with elements such as bad spirits, ancestral curse, angry gods or going against taboos(32). Cleansing rituals and other customary rights were carried out to weed out the bad spirits and appease the gods. There were wise men and traditional healers who, by luck or inheritance, acquired the skills to communicate with the spirits and provided solutions to disease and unwarranted deaths(31, 33). As such, the health seeking behavior, communication about illness, or overall decision-making of health measures

was socially determined and varied from culture to culture(34). Subsequently, there are remnants of communities who continue to abide by this traditional belief system, hence most likely to influence parental decisions in responding to childhood illnesses.

Consequently, the traditional African religion was blended with modern religion, whereby traditional beliefs continue to clash with modern medicine, despite the presence of majority Christian and Muslim missions sensitizing against some of the traditional beliefs(31). Religion has played a big role in vaccination coverage and hesitancy in SSA region(29, 35). The region has a record high proportion of population being affiliated to either of the many religious groups and subsequently engaging in religious practices(36). These religious affiliations include the world's largest religions, Christianity and Muslim(25, 36), as well as other indigenous practices unique to certain populations and regions(37). There are also other local religious formations that vary within countries or across regions in the continent(37-39). The smaller religious affiliations are often omitted in national surveys despite having great influence on individual behavior(36). Moreover, respondents may have more than one affiliation and fail to report the indigenous religious practices. The Catholic Church mostly accepts and indeed advocates for vaccination as a means of disease prevention(38). The denomination, however, has in the past prohibited the use of vaccines questioning the contents and government's motivation behind mass vaccination campaigns(40-42).

In Kenya, the catholic church has in the past disrupted government efforts towards tetanus (2014) and polio vaccination (2015) campaigns citing suspicions of the tetanus vaccine being laced with contraceptives and polio vaccine containing cell tissues from aborted fetuses(42). During the 2015 mass polio vaccination in Kenya, the Catholic clergy advised their congregants to boycott the mass vaccination campaign(41). The clergy questioned the safety of the vaccines

and claimed the medical consignments had not been confirmed through scientific tests, and the government had disregarded their (clergy's) request for further laboratory review(41). This message not only went to the denomination faithful (23 % of the total population) but also to other members of public(41); potentially affecting the mass immunization campaign and polio eradication. Similar denominational proclamations have happened in Uganda and Tanzania, Nigeria(40) and Zimbabwe(43). Other religious reasons for vaccine refusal include unethical interference with the body as the temple of the lord(29). As such, some churches believe in prayer as the sole path to healing and despise any administration of manufactured drugs which they are unaware of the contents. On the contrary, other protestants accept vaccinations as a God given gift of ensuring longer life through the spiritual wisdom of doctors and other healthcare providers(29).

The Muslim religion has also been associated with uptake of vaccines in both Muslim minority and majority countries(34, 43, 44). In Nigeria, the pledge to boycott polio vaccination was a major setback to the global polio eradication as it led to major outbreaks(40). The vaccines were deemed to spread the HIV virus and contained contraceptive components for population control(40). A deeper review of the study by Ghinai et al(45) regarding the “religious” vaccine objection in Nigeria revealed the masked political power struggles and inadequate public health system which surrounded the vaccination campaigns(45). Other studies have associated being a Muslim with low immunization coverage in Tanzania(46) and in Indonesia(44). On the contrary, some studies have disassociated Islam with low vaccination coverage, citing a majority Muslim nation like Saudi Arabia where there is low vaccine objection(47). This strengthens the argument that there might be other confounding factors such as cultural, infrastructure or economic

conditions that may also affect the low vaccination coverage especially in low-income Muslim communities and countries.

Political skepticisms & Propaganda surrounding vaccine acceptability

Politics and governance have been shown to play a big role in influencing parental decision-making on vaccinations for their children(45, 48-50). This can be based on 1) government's approach in formulating and operationalizing health policies and community mobilization for vaccination, or 2) people's level of trust to the government or public institutions(48). In a multi-ethnic and cultured communities, tactical formulation and dissemination of health messages is critical in achieving cultural humility and dispelling any rumors or suspicion(48).

The history of colonialism and continued fear of imperialism continue to affect the local government's policies on health as well as the operationalization of international guidelines such as those from WHO on immunization and global eradication of notifiable infectious diseases(30, 31). Numerous skepticism and conspiracy theories surrounding vaccination are common and they root back into the era of slave trade and exploitation of Africans for resources(51). This history of imperialism therefore continues to raise suspicion and negative sediments among lobby groups and communities regarding the motivation behind the mission of the Western world on various health projects and campaigns(50). The periodic health promotion campaigns such as vaccination, and other forms of humanitarian aid are therefore purported as ill motivated and commonly associated with issues such as population control i.e., sterilizing men and making women infertile(29, 41), unethical trial of "foreign" medicine on Africans(41, 42), and importing foreign diseases to the locals(36). With these negative perceptions, proper health communication from the authorities is key to win the trust of diverse communities, otherwise the government

may come out as acting against the will of the people leading to unsuccessful implementation of the vaccination programs.

Accessibility of local health facilities

Health professionals are pivotal towards supervising the progress of mothers throughout their pregnancy period and after childbirth(52). The strides made by many western countries in lowering maternal mortality rates are attributed to the recognition given to skilled care in those countries(53). In the African region, there is chronic paucity of skilled healthcare personnel across all cadres(54). Overworking by health care staff directly reflects onto the quality of services provided to the patients such as vaccination campaigns(55). It is not uncommon for women to complain of poor services after their interaction with the health care provider. Cultural insensitivity, incompetence and the influence of politics when recruiting healthcare workers are among the key factors responsible for poor immunization services and utilization among the community members(52, 55).

Issues affecting healthcare workers, and especially in a government funded healthcare infrastructure, trickle down to poor services being provided to most of the population. Indeed, healthcare workers play a big role and sensitizing the population about public health initiatives such as being up to date with vaccination and creating awareness about adverse events following vaccination and reducing vaccine hesitancy. Real evidence of historical or current children's adverse reactions to vaccination is a potential reason for low vaccination coverage(21, 24, 56). While vaccines used in the immunization programs are generally safe and effective, they still carry a percentage of risk. Children might also naturally react to the vaccines, despite them being safe(11, 57). These negative reactions experienced after the administration of vaccines are referred to as adverse events following immunizations (AEFI)(11, 51, 58) and definitely a key

factor for parental decision to vaccinate their children. The specific manifestation of AEFI depends on the vaccine administered, whether the vaccine is made of life-attenuated or killed organisms and the type of medium in which the vaccine is prepared(21). Given that vaccines administered during routine immunization are usually administered to healthy children(20, 51), the potential for the occurrence of AEFIs can be a major determinant of parental decision to accept or reject the immunization of their children(56). This situation, however, carries a two-sided dilemma. Both the parent rejecting the vaccination and the health worker advocating for vaccination are acting on the interest of the child(30, 51) i.e. parents are protecting their children from any potential harm while the health worker is focusing on protecting the child from preventable diseases. Therefore, persuasive communication by health workers is essential to maintain public confidence(1). The AEFIs should be carefully explained to the mother, with the proper follow-up to ensure any severe AEFIs are taken care of (1).

In 2016, the WHO advisory group on immunization issues approved the missed opportunities for vaccinations (MOV) strategy to counter the slow pace of vaccination coverage globally(14). The MOV was defined as the action of missing the benefit of being immunized by an eligible individual who is either unvaccinated or partially vaccinated (without any contraindication), despite the individual having contact with the health services(13, 14). Studies show that the prevalence of MOV has not changed across the years in most parts of the developing world, including SSA. MOV can occur because of failures from the health systems such as improper screening, vaccine shortages and organizational frameworks separating curative and preventive services, such as vaccinations, or due to parental or community resistance, or hesitancy, to vaccinations(14). On the population side, continued contact with the

healthcare system such as attending ANC visits and having a vaccination card have been found to increase the chances of being vaccinated among children of vaccination age(13).

Focus of current study

The prior research demonstrates that the determinants of vaccination in the SSA region are multifaceted. There are both individual and sociocultural factors that have been discussed as potential influencers to vaccination behavior. At the center of these individual and sociocultural norms is the health infrastructure that can play a role in enhancing health literacy and bridging the gap between conventional and traditional health beliefs and practices. Many studies have focused on individual level sociodemographic factors, hence minimal explanation on the linkage between demand and supply factors for affecting child vaccination. The health infrastructure plays a key role as a supply factor in vaccination coverage. Overall, access and utilization of health services has been associated with improved health behavior. It is however not clear how services such as ANC influence maternal behavior towards vaccination of their children. The **primary objective** of this study, therefore, is to examine the influence of ANC quality on the completion of basic vaccination among women in three East African countries (Kenya, Uganda, Tanzania).

Study hypothesis

We hypothesize that adjusting for other covariates:

1. *Vaccination among children will vary by level of ANC utilization such that children of mothers with intermediate and adequate ANC utilization are likely to have higher odds of being fully vaccinated compared to the children of mothers with poor ANC utilization.*
2. *Children of mothers who had higher scores on the essential ANC health promotion care practices (ANC HPCPs) would be more likely to be fully vaccinated, as compared to children of women with lower scores on essential ANC health promotion care practices (ANC HPCPs). i.e., the odds of being fully vaccinated will increase with every additional score on the essential ANC HPCPs*

A **secondary objective** of the study is to examine the influence of socio-demographic and health access and utilization factors, as well as region and country of residence on child vaccination status, while factoring the influence of ANC quality measures. According to the findings from the literature review, the decisions to vaccinate a child are not necessarily made solely by the mother or caregiver of the child(59), but they can also be determined by other factors such as sociocultural norms, economic, political, and other environmental forces that influence the decision-making process and determine the outcome of the decision(57, 59, 60). Larson et al adds that parental vaccination decisions do not just fall into dual categories of either rejection or acceptance, but rather a continuum between the two extremes(51). Therefore, following the concept of the socio-cognitive theory, we posit that individual, and environmental factors arguably play a huge role in parental informed decision making on child vaccination. We will therefore adjust for several predictor variables based on the results from the bivariate analysis as well as their theoretical association with the outcome as per the previous literature.

3.2 METHODS

Data Source

Data for this study was obtained from the demographic and health surveys (DHS) collected in Kenya (2014), Uganda (2016) and Tanzania (2015-2016). The DHS program collects nationally representative data through more than 400 surveys across over 90 countries. The DHS surveys use a two-stage cluster sampling procedure; a primary sampling unit (PSU) at the cluster level followed by a secondary sampling unit at the household level (SSU). Households were randomly selected with equal probability from a household list in each cluster. The interviewers visited only the preselected households, and no replacement of the preselected households was allowed during the data collection period. The surveys cover a variety of topics that explore maternal and child health outcomes. Vaccination coverage is one of the main modules in the survey questionnaire and assesses the progress of countries in expanding coverage on mandatory and recommended vaccines across different countries. There are also questions on ANC experience during pregnancy as well as sociodemographic questions assessing health behavior and household characteristics. The data for this study targeted women of reproductive age (15-49 years old) and their young children aged 12-23 years.

Ethical approval

Permission to use the DHS public use dataset in this study was obtained from the DHS program. All the data were de-identified before publishing on the DHS website. The DHS program follows strict IRB and ethical protocols while planning and collecting the data. Therefore, no further protocols are required from the final users of the de-identified public use data, except the written request to gain access to the data storage website.

Study Measures

Outcome Variable

The outcome was completion of basic vaccinations among children aged 12-23 months. We chose a minimum age of 12 months as it is the lowest age expected for children to have received all the recommended age-appropriate basic vaccinations (namely BCG, Pentavalent, OPV and measles). The interviewers assessed vaccination status of each of the vaccines based on the report from the child's immunization card or mother's verbal recall. The outcome was binary categorized as "***Yes***" if the child was fully immunized (i.e., 1 dose of BCG, 3 doses of DTP-HepB-Hib, 3 doses of polio, and 1 dose of measles), and "***No***" otherwise.

Main independent Variable

The main independent variable, ANC quality, was assessed using two measures a) ANC utilization, and b) essential ANC health promotion care practices.

a. ANC Utilization

ANC utilization as a measure of quality was operationalized as a composite measure consisting of 1) *timely initiation of ANC*, 2) *type of provider for ANC*, and 3) *number of ANC visits*. The WHO recommends that pregnant women should initiate contact with healthcare provider at the earliest time possible in their pregnancy-during their first trimester, seek service from a skilled healthcare provider in a government or registered/authorized private facility, and make at least 8 contacts with a healthcare provider during their pregnancy period. However, during the period of data collection for the 3 countries, the WHO recommended a minimum of 4 ANC visits as the optimal effective visits for pregnancy monitoring; hence applied in this study to assess utilization level. In this study, the ANC variable was categorized into either *poor*,

intermediate, or adequate ANC utilization based on the women's experience in their last pregnancy. **Poor ANC utilization** meant the woman did not achieve either of the 3 measures. i.e., did not initiate ANC during their first trimester, did not seek services from a skilled provider, and attended less than 4 visits during their entire pregnancy period. **Intermediate ANC utilization** was indicative of achieving either one or a combination of two of the measures, while **adequate ANC utilization** signified that the woman attained all the 3 measures i.e., initiated ANC during their first trimester, saw a skilled provider, and attended at least 4 visits. For the analysis, Poor ANC utilization is coded as 1, Intermediate ANC utilization is coded as 2, and Adequate ANC utilization was coded 3.

b. Essential ANC health promotion care practices (ANC HPCPs)

The essential ANC HPCPs otherwise referred to in this study as “ANC HPCPs”, involve the content of information shared, or service administered through the interaction with healthcare provider during the ANC visit. This measure was a continuous score of whether the ANC HPCPs were covered during ANC visit, as stipulated in the WHO guidelines (ref). The six ANC HPCPs were blood pressure measurement, blood test, urine test, whether the woman received information on nutrition, whether she was informed of possible complications during pregnancy, and finally whether she was given advice on a birth preparedness plan. Each of these questions had a binary response of (Yes=1, and No=0). A continuous variable was created to measure the individual attainment of these measures with a scoring of 0 to 6.

The overall ANC Quality measures are illustrated in the **TABLE a** .

Other Sociodemographic and health access factors

We analyzed the effect of other sociodemographic, health access, and utilization factors as control measures. The choice of the variables was guided by the review of the literature as well as the WHO framework on epidemiology of the non-immunization of children(43).The WHO frameworks categorizes different predictors into different categories such as sociodemographic factors, information and health access factors, and area factors. In this study, the **sociodemographic characteristics** included maternal, child and household characteristics that we controlled for in the statistical models. These included child factors: age (months), gender (Male=0, Female=1), birth size (Small=1,Average=2,Large=3); maternal factors: education(No education=0, Primary=1, Secondary=2, Higher=3), maternal age at first birth(years), marital status(Single/Never married=1, Married=2, Divorced/Separated/Widowed=3), as well as household wealth index(Poorest=1,Poorer=2, Rich=3, Richer=4, Richest=5). In addition to the individual and household characteristics, we included other factors related to **access and utilization of health services**. These included measures to ensure routine immunization follow-up such as possession of vaccination card (No card=0, Card seen=1, Has card but not seen=2), and other avenues of health information dissemination such as mass media (combined measure for access to either of the following Radio, television or newspaper). We also included **healthcare access factors** namely, insurance coverage (Yes=1, No=0), problem with distance to health facility (Yes=1, No=0), money/cost related problem (Yes=1, No=0), as well as **healthcare utilization factors** such skilled delivery (Yes=1, No=0), postnatal checkup after last delivery (Yes=1, No=0), and contraceptive use(Yes=1, No=0). The influence of higher factors including place of residence (Urban=0, Rural=1), region and country of residence were also measured.

Statistical Analysis

Prior to the commencement of the analysis, data cleaning, labelling, and recoding was done for the variables using SAS statistical software; SAS 9.4. Categorizing of variables was done using information from the country reports for easier reference, representativeness, and accuracy of the categorization. The sociodemographic characteristics and general information were presented by frequency and percentage for categorical variables as well as mean and standard deviation was used to report continuous explanatory variables. In addition, we performed cross tabulation to explore the proportion of different categories of each of the predictor variables against the binary outcome of child vaccination status. The analysis included separate modelling for each country as well as pooled analysis. While we compared each country separately for the comparison of the population characteristics against the outcome, as well as bivariate(crude) and adjusted multilevel regression analyses, the pooled data was only applied in the adjusted multilevel regression models. STATA 16 software was used in the bivariate and regression analyses.

Bivariate multilevel regression analysis

Bivariate analysis was performed to assess the relationship between the independent variables and the main outcome, vaccination. The level of significance of the independent associations were checked at significance level of 0.05 and 95% CI. Variables which were statistically significant in bivariate analysis, or theoretically important based on the review of the literature, were considered, and applied in the adjusted models.

Model specification in the regression analysis

The surveys were collected by stratified cluster sampling resulting in hierarchical data where respondents were nested within clusters. Respondents within the same cluster are likely to

be more similar to each other. Running an ordinary logistic regression would therefore ignore the independence between clusters by assuming an equal population. This leads to having small standard errors. For this reason, we applied binary logistic multilevel analysis techniques to account for the clustering nature of the data as well as the binary response of the vaccination status outcome variable.

Four models were fitted in this multilevel regression analysis as demonstrated in figure 1. **Model 0** (the null/unconditional) was empty with no explanatory variable. This model assessed the variation due to cluster differences without any explanation variable. This model was the initial step in providing evidence of whether it's justifiable to assess random effects at the cluster level. **Model 1** contained only the main predictor i.e., ANC Quality (includes ANC utilization and ANC HPCPs). We consequently adjusted for maternal, child and household characteristics, and other health access factors in the full model without interaction (**Model 2**). We finally tested for interaction between the two main predictors because the number of ANC visits may influence or increase opportunities more HPCPs among pregnant women. Moreover, we examined for other potential interactions because the overall quality of ANC may vary by different levels of some of the other explanatory factors such as maternal education, residence etc. As such, we included an interaction model (**Model 3**) for Kenya, Uganda, and the pooled data analysis.

The fixed and cluster variation random effects were performed based on the following equation:

$$Logit[P(Y_{ij} = 1)] = \gamma_{00} + \gamma_{10}X_p + \gamma_{01}Z_q + U_{0j}$$

In the equation, subscripts *i* and *j* represent for the individual *i* from group(cluster) *j*. Y_{ij} denotes the dichotomous outcome variable for level-one-unit *i* in level 2-unit (cluster) *j*. That is, vaccination status of *ith* child in the *jth* group(cluster). γ_{00} is the grand average intercept; that

is the log odds of being fully vaccinated in the absence of explanatory variables. The terms X_p and Z_q are individual (fixed effects) and group (cluster) measures, respectively. γ_{10} is the regression coefficient of the individual level variable X_p and finally, γ_{01} is the regression coefficient of the group(cluster) level variables Z_q . The term U_{0j} is the cluster level residuals.

Parameter Estimations

The results of fixed effects were presented as adjusted odds ratios (AORs) with 95% percentage confidence intervals (CIs). The statistical significance was set at a P value ≤ 0.05 (25,26) The random effects measured the variation of childhood full vaccination across clusters and were estimated in Intraclass Correlation Coefficient (ICC). Moreover, model comparison was done using Bayesian information criteria (BIC) and Akaike's information criterion (AIC). Generally, the model with minimum BIC and AIC value is considered a better fit.

3.3 RESULTS

Overall, a total of 9505 children in the pooled data nested within 185 clusters were included in the analysis. This included a total of 4209 children in 92 clusters in Kenya, 3055 children in 34 clusters in Uganda and 2241 children in 59 clusters in Tanzania.

3.3.1 Univariate analysis

Participant Characteristics

Table 1 summarizes the full immunization coverage among children aged 12-23 months disaggregated by the sociodemographic health access and utilization and area factors. Approximately a fifth of the women in Kenya (20%) and Uganda (23%) had adequate level of ANC utilization, compared to less than 5% of women in Tanzania. The interviewers were expected to make a confirmation of mother's possession of the vaccination by asking to see it.

Over 80% of women across all the three countries were able to produce a vaccination card. Similarly, a comparison of the 3 countries showed that almost two thirds had skilled care delivery in their last birth, approximately 90% had no insurance coverage and used contraceptive, and more than half had children of normal size at birth. More than half of women in Uganda and Tanzania indicated that both money and distance were a problem in accessing health facility services. The proportion was slightly higher in Kenya with close to two thirds (60%) declaring both money and distance as hindrances to accessing health care. Children in the sample were fairly equally distributed (approximately 50/50 ratio across all countries), and over 50% had a normal size at birth.

Moreover, more than 80% of the women were married, and a higher proportion had completed primary school as the highest level of education i.e., 56% in Kenya, 61% in Uganda and 64% in Tanzania. The sample was fairly distributed across the 5 wealth quintiles with approximately a quarter in each of the 5 wealth quintiles. Finally, two thirds of the population resided in the rural areas (64% in Kenya, 77% in Uganda, and 71% in Tanzania), and this is also indicated by the larger population distribution in the rural regions/zones.

Vaccination coverage

Table 1 also shows the prevalence of full vaccination across all the population characteristics. In Kenya, a larger proportion of women whose children were fully vaccinated had intermediate ANC utilization (43%), possessed a vaccination card (96%), had skilled delivery in their last birth (67%), and had post-natal checkup within 6 months after birth (69%). The case was similar in Uganda with 45% of women, whose children were fully vaccinated, having intermediate level of ANC utilization, 95% showing evidence of a vaccination card and over 80% giving birth in a skilled health facility. While over two thirds (71%) of women in

Tanzania, whose children were fully vaccinated, had given birth in a skilled care facility, and almost all (94%) had a vaccination card, three quarters (75%) had poor ANC utilization. More than half of women in Kenya still had their children fully vaccinated despite stating distance (72%) and money (61%) as a problem. A similar higher proportion was noted in Uganda with 60% and 54% of women with complete child vaccination indicating distance and money, respectively, as a problem in accessing healthcare services. The case was opposite in Tanzania with a larger proportion (54%) of women whose children were fully vaccination stating that money was not a problem in accessing care. Approximately two thirds of women in Kenya (61%) and Uganda (67%) had their children fully vaccinated despite having no access to mass media. Across all the three countries, over half of the women whose children were fully vaccinated had completed primary education, were married, and lived in rural areas. The prevalence of full vaccination was almost equally distributed across all the 5 wealth quintiles in each of the 3 countries.

3.3.2 Bivariate Analysis Results

Table 2 summarizes the results of the bivariate analysis comparing the crude (unadjusted) odds ratios (COR) and confidence intervals between the sociodemographic and health access factors and the vaccination status outcome among the three countries. In both Kenya and Uganda, women who had intermediate level of ANC utilization had increased odds of having their children fully vaccinated compared to women with poor ANC utilization. The statistically significant results were [COR:1.45;95% CI: (1.15,1.82)] for Kenya, and [COR:1.31; 95% CI: (1.05,1.63)] for Uganda. Adequate ANC utilization was also associated with increased odds of complete vaccination compared to poor ANC utilization across all the 3 countries. This association, however, was not significant. With every unit increase in the ANC HPCPs, the Odds

of full vaccination were higher by 35% in Kenya [COR:1.35;95% CI:(1.23,1.48)], 10% greater in Uganda [COR:1.10;95% CI: (1.03,1.18)], and 23% greater in Tanzania [COR:1.23;95% CI:(1.14,1.33)].

In all the 3 countries, having a vaccination card, which was verified by the interviewer and delivery in a skilled care facility (last birth) was associated with increased odds of full vaccination. Among other health access and utilization related factors that were significantly associated greater odds of the outcome included postnatal check-up within 6 months after birth [COR:1.74;95% CI:(1.23,2.42)], insurance coverage [COR:1.68;95% CI:(1.07,2.66)], and contraceptive use [COR:4.82 ;95% CI: (2.88,8.04)], and access to mass media [COR:1.41 ;95% CI: (1.15,1.74)]., among women in Kenya, as well as insurance coverage in Uganda [COR:2.4 ;95% CI: (1.01,5.72)].

Among the sociodemographic and household characteristics, a child with “large” birth size in Tanzania had lower odds of being full vaccinated compared to children with “normal” size at birth. In addition, the odds of children being fully vaccinated increased with every unit increase in women’s age at first birth in Kenya [COR: 1.06 ;95% CI: (1.03,1.10)], Uganda, [COR:1.05 ;95% CI:(1.02,1.08)] and Tanzania [COR 1.06 ;95% CI:(1.02,1.11)]. The odds of full vaccination increased with every level of education completed among Kenyan women. Indeed, compared to women with no education, the women with the higher education above secondary school had more than 4 times greater odds of having their children fully vaccinated [COR:4.33 ;95% CI: (2.40,7.83)]. Other evidence of significant associations between education and greater odds of child full vaccination were estimated in Uganda among women with higher level of education [COR:1.71 ;95% CI:(1.11,2.64)]., and in Tanzania among women with secondary

education [COR:1.86 ;95% CI:(1.14,3.04)], compared with women with no education in both countries.

There results demonstrate an increasing trend in the odds of child full vaccination status from the poorest to the richest wealth quintiles in both Kenya and Tanzania. In Kenya, compared to the women in the poorest wealth quintile, the odds of the outcome increased from 1.67 times [COR:1.67 ;95% CI:(1.3,2.12)] among those in the poorer wealth quintile to more than double among those in the richer wealth quintile [COR:2.07;95% CI:(1.5,2.9)]. In Tanzania, there was a clear in increasing odds of child full vaccination from the poorest to the richest wealth quintile, ranging from 1.62 among the poorer [COR:1.62 ;95% CI:(1.09,2.39)] to twice among the richest. [COR:2.05 ;95% CI:(1.32,3.18)]. The association between wealth index and full vaccination was not statistically significant in Uganda.

3.3.3 Multilevel logistic regression

Comparison of models and models fit statistics.

The random effects for full vaccination are presented in tables 3a-3c for each country and pooled analysis summary in table 3d. The ICC in the empty models indicate the percentage of total variance in full vaccination that is attributed to differences between communities(clusters). The ICC comparison help in the empty model help in the determination of whether the completion of basic vaccination (full vaccination) among children significantly varied between clusters, hence a justification of whether a multilevel model is required in this analysis. As reported in the output summary in tables 3a (Kenya), table 3b(Uganda), and table 3c (Tanzania), the empty (unconditional) model ICC outputs indicate that about 15%, 8% and 22% of the total variation in the odds of full vaccination among women in Kenya, Uganda, and Tanzania,

respectively, was due to differences between communities(clusters). Similarly, the ICC of the empty model in the pooled analysis indicate that 17% of the total variance in full vaccination across the 3 countries is attributed to differences between communities. ICC values between 0.05 and 0.20 have been recommended for cross-sectional studies(61). This therefore provided the rationale for factoring the hierarchical nature of the data by performing multilevel analysis.

Model 1 included only the main independent variables (ANC quality measures). The ICC indicate that 15%, 7% and 21% of the total variance in childhood full vaccination in Kenya, Uganda, and Tanzania, respectively, is attributed to cluster differences. Similarly, in Model 2, 11%, 3% and 26% of the variance in child vaccination in Kenya, Uganda, and Tanzania, respectively, was attributed difference between clusters. Finally in model 3, the ICC show that 14% and 3% of the total variance in full child vaccination in Kenya and Uganda, respectively, is attributed to between cluster differences. The case was the same with 16% in the pooled analysis. The tables also show the AIC and BIC summaries comparing all models. The model with the lowest AIC/BIC across all models was considered to be the better model.

Multilevel logistic regression (Country specific)

Table 3a,3b, and 3c compares the separate multilevel regression analysis for Kenya, Uganda, and Tanzania, respectively. All tables include Model 0 (unconditional model), Model 1 (ANC quality measures) and Model 2 (ANC quality adjusted for other sociodemographic and health access/utilization, and area factors. We ran several possible interactions and found positive interaction between level of ANC utilization and ANC HPCPs in Kenya as well as two forms of interaction in Uganda between level of ANC utilization and essential ANC health promotion practices, and between highest level of education completed and essential ANC HPCPs. Similar interaction measures were tested for Tanzania, but the results were non-

significant. The interaction models (model 3) are presented on table 3a and 3b for Kenya and Uganda, respectively.

The empty models (Model 0) for all countries indicate significant cluster differences signifying between cluster variation. Model 1 contains only the ANC quality measures, the level of ANC utilization and essential ANC HPCPs. While the odds of full vaccination across all the 3 countries were higher for intermediate and adequate ANC utilization, compared to low, the relationship was not statistically significant. However, the odds of full vaccination were 34% higher in Kenya, [AOR: 1.34; 95% CI:(1.21,1.48)] and 23% greater in Tanzania [AOR: 1.23; 95% CI:(1.13,1.33)], for every additional unit of essential ANC HPCPs.

We tested both of our hypotheses based on the results for model 2 and 3. Model 2 included the ANC quality measures adjusted for other sociodemographic, sanitation, health access and residence and region factors. In Kenya, the adjusted odds of full vaccination increased by 17% with every unit increase in essential ANC HPCPs [AOR: 1.17; 95% CI:(1.03,1.32)]. Similarly, in Tanzania, the odds were 1.15 times greater with every unit increase in ANC HPCPs [AOR: 1.15; 95% CI:(1.04,1.28)]. The findings were in line with our second hypothesis (hypothesis #2) where we predicted that children of mothers who had higher scores on the essential ANC HPCPs would be more likely to be fully vaccinated, as compared to children of mothers with lower scores on the essential ANC HPCPs. There were no significant association between the ANC quality measures and full vaccination in the adjusted model (without interaction) for Uganda, hence not supporting our hypothesis #2.

In the interaction models (Model 3) for Kenya and Uganda, the results varied widely between the two countries. Among women in Kenya (table 3a, model 3), we found a significant interaction between intermediate ANC utilization and ANC HPCPs such that for every additional

score in ANC HPCPs, the odds of full child vaccination significantly reduced by 31% among the women with intermediate ANC utilization as compared to those with poor ANC utilization. In the Uganda interaction model (table 3b, Model 3), there was a significant interaction between adequate ANC utilization and ANC HPCPs such that for every additional score on ANC HPCPs, the odds of the full vaccination reduced by approximately 30% among the women with adequate ANC utilization compared to those with poor ANC utilization. Similarly, there was a significant interaction between higher level of education completed and essential ANC HPCPs on full vaccination such that with every unit increase in essential ANC HPCPs the odds of full child vaccination decreased by a factor of 0.55 (45%) among the women with higher education as compared to those with no education. The reduction in the odds of vaccination with increase in the scores of ANC HPCPs between the women with adequate vs poor ANC utilization, justifies how useful ANC HPCPs is to women even if they have poor ANC utilization.

Pooled analysis regression results

Table 3d summarizes the results of the pooled multilevel logistic regression analysis of the association between ANC quality and vaccination status among women in Kenya, Uganda, Tanzania, adjusted for other covariates. In the model with only ANC quality measures (Model 1), intermediate and adequate ANC utilization was associated with lower odds of full vaccination compared poor ANC utilization. This association was, however, not significant. On the other hand, the odds of the full vaccination increased by 21% with every unit increase in ANC HPCPs [AOR 1.21; 95% CI:(1.15,1.27)].

Model 2 was adjusted for other sociodemographic and household characteristics, health access and utilization factors, as well as place and country of residence. Factors associated with lower odds of full vaccination included not having a vaccination card (compared to those with

card), being divorced/widowed/separated (compared to married) and being from Uganda (compared to those from Kenya). On the other hand, giving birth with the assistance of a skilled professional [AOR:1.60; 95% CI:(1.32,1.95)], contraceptive use [AOR:3.43; 95% CI:(1.51,7.80)], and increasing age at first birth [AOR:1.04; 95% CI:(1.02,1.1)] were associated with higher odds of complete vaccination.

Women with no vaccination card available at the time of the interview, or no confessed of not possessing any vaccination card, had lower odds of full child vaccination compared to those who showed proof of their vaccination cards. In addition, women who had delivered with the assistance of a skilled professional (last birth) had greater odds of having their children fully vaccinated. Similarly, women who used contraceptive had about 3.5 times higher odds of full child vaccination [AOR:3.45; 95% CI:(1.49,8.00)]. Being widowed/separated/divorced was associated with significant lower odds of full vaccination. Compared to women from Kenya, those from Uganda had reduced odds of child full vaccination [AOR: 0.51; 95% CI:(0.40,0.65)] while the women from Tanzania had increased odds of child vaccination [AOR: 1.44; 95% CI:(1.10,1.89)].

Finally, we found a significant interaction between ANC utilization and ANC HPCPs and as well as between highest education for the women and essential ANC HPCPs. The association between poor ANC utilization and the full child vaccination was not influenced by the number score of the essential ANC HPCPs. On the other hand, the effect of adequate ANC utilization on the outcome reduced by 30% with every unit increase in essential ANC component [AOR: 0.70; 95% CI:(0.57,0.84)]. Moreover, the influence of higher level of education on full child vaccination reduced by approximately 38% with every unit increase in ANC HPCPs [AOR: 0.63; 95% CI:(0.396,0.99)].

3.4 DISCUSSION

The primary objective of this study was to measure the extent to which ANC quality; operationalized as the level of ANC utilization during pregnancy and the number of ANC HPCPs i.e., service administered, or information shared, across the pregnancy period, were associated with immunization status of children. Immunization status was measured on whether children were able to receive all basic vaccines, or not. While the level of ANC utilization focused on the extent to which the women engaged with the healthcare system (skilled care), the ANC HPCPs provided an understanding of the type and quality of care received. Results from both the bivariate and adjusted logistic regression models showed that higher levels of ANC utilization, either intermediate or adequate, were significantly associated greater odds of complete immunization among children aged 12-23 months.

The country specific adjusted models indicated a significant association between the ANC quality measures and the outcome. This finding supported our first hypothesis (hypothesis#1) that children of women with higher ANC quality (intermediate or adequate ANC vaccination), are more likely to fully vaccinated, compared to the children of women with poor ANC quality. In our second research hypothesis(hypothesis#2), we predicted that children of mothers who had higher scores on the essential ANC HPCPs would be more likely to be fully vaccinated, as compared to children of mothers with lower scores on the essential ANC HPCPs. This hypothesis was supported by the analytical results for Kenya, Tanzania, and the pooled analysis. While there is paucity of literature examining the influence of ANC on children beyond the pregnancy period such as vaccination status, which can directly be compared to our significant findings, there are multiple studies examining the association between ANC utilization and skilled delivery or pregnancy outcomes for both the mother and the child. Our

findings are therefore comparable with other studies that documented the benefit of ANC in reducing maternal deaths(62-64), ensuring skilled delivery(65-68), reducing the prevalence of neonatal deaths(69-71), reducing birth complications such as pre-eclampsia(72, 73), as well as low birthweight, and developmental delays(74, 75). The results of the association between the level of ANC utilization and full vaccination were not statistically significant in Tanzania. This could be due to the low sample size in the intermediate and adequate ANC utilization categories as shown in table 1. However, in both Kenya and Tanzania, the effect of the ANC quality measures in the adjusted multilevel models remained significant with greater odds of the outcome. Indeed, the odds of the full vaccination were more than 5 times greater among both women with adequate ANC utilization in Uganda as well as those with intermediate ANC utilization in Kenya, compared to women with poor ANC utilization in both countries.

Among the significant covariates across all the 3 countries included possession of a vaccination card as confirmed by the interviewer, as well as having had skilled delivery in their last delivery. Women with no vaccination card or claimed to have one but couldn't produce it during the interview were less likely to have their children fully vaccinated, across all countries. These findings are consistent with previous studies that found a positive association between having a vaccination card and increased likelihood of complete vaccination among children(3, 4, 76, 77). Not having a vaccination card could be an indication of either not receiving it in the first place or lost it. A vaccination card acts as a calendar on the child's vaccination schedule and records both the vaccines that have already been administered as well as the date for the next vaccination visit(3). Not having the card, therefore increases the likelihood of missing vaccination appointments. In countries with limited and fragmented electronic medical records systems, vaccination cards are critical source of records for parent and providers, who can look

at the cards and determine which vaccinations have been given. The cards help ensure continuity of vaccination care across multiple providers, because the parents carry their children's vaccination record with them when seeking care.

A skilled delivery was also associated with greater odds of full vaccination among children across all the 3 countries. Our findings are similar with other studies conducted in Rwanda(78), Uganda (79)and Tanzania(22). Malande et al adds a twist in this findings and argues that having a delivery with the help of a skilled professional may be associated with higher odds of immunization, not because of the mother's efforts but more because the first doses of vaccines such as BCG and OPV are likely to be offered as long as the delivery occurs in a skilled care facility(24). There are greater chances that skilled health professionals would insist on administering the first dosages immediately after delivery. However, given that the outcome of this study focused on completion of all basic vaccinations, completing the immunization schedules for the remainder of the vaccination doses is accomplished through the mother's effort. The birth in a health facility, with a skilled provider, is therefore a possible way of kick-starting women's trust in the health system and educating them towards completing the full set of vaccinations.

Unlike our expectations, some explanatory variables that have highly be shown in the literature as having great positive impact on child vaccination status, were either not significant and/or inconsistent across the countries. These included maternal education, wealth index, urban vs rural residence, mass media access, and marital status. Although maternal education was fairly associated with greater odds of full child vaccination in Kenya and Uganda, the results were not statistically significant, except for increased odds of the outcome among the Kenyan women with primary education compared to those with no education [AOR: 1.884; 95% CI: [1.097,3.235].

Several studies have confirmed that children of mothers with at least secondary education or higher are more likely to be fully vaccinated compared to children of lesser or non-educated mothers(16, 19, 26). Other strengths associated with maternal education include changes on beliefs and practices towards health seeking behaviors(16, 20), increased household decision-making autonomy(26, 80, 81), contribution on (and control over) resources(80), accessibility to a well-paying job and educated spouses(80), and control over their fertility behavior(77, 82). All these are measures that contribute to autonomy and empowerment of women on various social issues including health seeking behaviors.

On the contrary, and an explanation to our majorly nonsignificant findings, some authors have contested the notion that educated people are more likely to utilize preventative services more than the less educated individuals. Basu et al(83) counter this argument by indicating that being educated does not necessarily, or automatically, lead to exposure to health promotive behaviors on child health, as this may not be part of the curricular. Moreover, a mother's skills and experience in taking care of a child is mostly likely to occur later in life, with a higher likelihood of understanding the information if provided at this later stage in life(84). This can partly explain our results where the influence of education level on child vaccination does not incrementally increase with level of education completed. Nevertheless, other studies have highlighted that schooling provides learners with tools to understand and contextualize information from various sources(19, 25, 26, 35) either by reading, observation, or access through mass media. This information can then aid in decision making on child-health practices. A study by Van M et al (80) in Kenya revealed that more educated mothers were more likely to appreciate innovative ideas and have more confidence in internalizing health information.

Even though not statistically significant, our results show that the odds of full vaccination were greater among women in the higher wealth quintiles compared to those in the poorest wealth quintile. Previous studies conducted in Kenya, Uganda and Tanzania have demonstrated the positive association between increased household wealth status and complete immunization status among eligible children(19, 22, 80). A study by Van et al(80) associated high cost of immunization services as a barrier to adequate immunization. Another study conducted in Uganda by Bbaale(19) explained the possible role of insurance being a contributor to increased likelihood of completion of immunization. In most cases, insurance coverage in many African countries is offered through employment and comes as a perk from selected well established employers(18). Therefore, those with insurance coverage are likely to be of higher socioeconomic status hence qualifying to be in the higher wealth quintiles. Moreover, financial difficulties among the rural poor have been found to be great risk factors for incomplete immunization schedules for children as parents delay or totally avoid the trip to the hospital due to financial constraints(16, 18).

Closely related to education and wealth is the influence of mass media on vaccination status. None of the results in each of the three countries were statistically significant but the odds of full child vaccination were greater among the women with exposure to mass media in both Kenya and Tanzania. Previous studies have shown positive relation between mass media and completion of vaccination among children(23, 24, 85, 86). A study by Tesema(86) found that women in East Africa who had access to radio and tv were most likely to vaccinate their children. Similar results were recorded in other parts of Africa including Nigeria(17) and Senegal(3). Those who are consistently exposed to mass media are likely to come across mass immunization campaigns, be aware of common health issues affecting the country or region and

how to plan mitigation measures, and this becomes an ongoing behavior change towards multiple health promotive practices. Media exposure is also closely related to wealth and education level(84) as caregivers who own television or buy/subscribe to a newspaper frequently are more likely to be more educated or higher in socioeconomic status(84), which circles back to the earlier discussed influence of wealth and education on vaccination status.

Place of residence and geographical location can be either a benefit or hindrance to accessing and receiving care as it determines proximity to, or availability of critical services to the area population. Our results did not show any statistically significant differences on full vaccination between urban and rural residence. A greater number of studies have associated urban residence with higher likelihood of children being vaccinated. A multi-country study by Arsenault et al(18) using the demographic and health surveys found that children living in the urban areas were almost 12 times more likely to be fully immunized as compared to the children from rural areas. The authors attributed the difference to the fact that parents in urban areas generally have higher education and are therefore either exposed to, or in a position to understand, information and opportunities for child immunization compared to rural residents. There are other studies supporting this association in Uganda and Kenya(19, 80, 87). Distance to health facilities, combined with transportation, is a big factor towards access to health services especially in the rural areas(59, 88). However, there are disparities in urban areas based on social economic status and residential neighborhood(89). While the problem of access due to distance is typically low in urban areas (compared to rural), it may be greater for women living in slums (often located at the periphery of cities) than for those living in middle- and higher-income residential neighborhoods(89). On the contrary, a few studies have implied that rural residence is protective to completion of vaccination schedule. This includes the works of Ames(2) in a study

conducted in rural Cameroon. A likely explanation to this finding is the mass vaccination campaigns and outreach programs by NGOs targeted to specific marginalized communities in the rural areas. These scales up the vaccination status as well as other targeted health outcomes.

The results of the pooled data analysis showed more variables being statistically significantly associated with the outcome compared to running each country independently. The increase in the number of variables associated with the outcome, is reflected by the joint contribution of each country's effect in the pooled data. In the model with interaction, the results strongly show that, considering the average score in ANC HPCPs, women with adequate ANC utilization were more than 5 times likely to have their children fully vaccinated compared to those with poor ANC utilization. We also found an interaction between adequate ANC utilization and number of ANC HPCPs. The results show that with every unit increase in ANC HPCPs, the odds of full vaccination among women with adequate ANC utilization decreased by approximately 30% as compared to the women with poor ANC utilization. This shows the positive impact of ANC HPCPs among women with poor ANC utilization, whereby their interaction with providers and receiving of the ANC HPCPs, despite having poor ANC utilization, contributed to their children being fully vaccinated. There was also an interaction between having higher level of education and number of ANC HPCPs. While higher education was association with higher odds of full vaccination at the mean score on ANC HPCPs, the odds of full vaccination among women with higher education reduced by approximately 38% with every unit increase in essential ANC care practice compared to women with no education. This shows that despite women having no education, interacting with the health system, and receiving essential ANC HPCPs was beneficial on their decision to fully vaccinate their children.

In comparing the differences between the 3 countries, the significant results showed that, children from Tanzania were more likely to be fully immunized compared to those from Kenya. On the other hand, children from Uganda were less likely to be fully immunized compared to those in Kenya. These results are supported by a recent study by Tesema et al which found completion of basic vaccination being 71.8% in Kenya, 76.2% in Tanzania, and 57.4% in Uganda(86). While the levels of ANC utilization are generally higher in Kenya compared to Tanzania, a study by Olorunsaiye et al(90), assessing the characteristics of immunization services in facilities found that public facilities in Tanzania scored better on certain factors such lower fee for immunization service, and higher facilities offering daily immunization services(90). However, the pattern changes when comparing the receipt of BCG or first doses of vaccines with multiple doses (BCG, polio and pentavalent), with Kenya having higher rates of first doses followed by Uganda and finally Tanzania(86).

Strengths and limitations

Several factors have contributed to the strength of this study. First, compared to closely related studies in the literature, this study utilized a large sample size, from national studies as well as using a standard questionnaire. This makes the results generalizable at the country level as well as comparable between countries. The study utilized a variety of variables to measure ANC quality. Previous studies have focused on effect of single measures that as ANC visits or timely initiation of ANC(65-68). This study factors the cumulative effect of a variety of measures and experiences during ANC. There are paucity of studies investigating the influence of ANC on maternal and child practices beyond the pregnancy period. This study is therefore a resourceful addition to this area of research.

Beyond the direct influence of ANC, this study further adds to the literature by providing a recent comprehensive estimate on the sociodemographic and health access factors associated with full immunization among children in 3 east African countries, using standard national data. The results reveal many areas to be targeted to improve better child protective actions such as increasing vaccination coverage among eligible children. Finally, the use of a standard questionnaire makes the results comparable to other parts of SSA hence contributing to the estimation of regional and continental health outcomes.

Notwithstanding the great contributions of this study to the current research, this study also has some limitations. The first is the limitations of using publicly available secondary data. As a result, we were limited to the available variables to measure our predictor and outcome variables. The DHS surveys have great strengths, but we had not much control on the framing of the study questions and/or responses; something possible with primary data. Being a cross-sectional study, it is not possible to assess causation or control for outside factors. Follow up studies can utilize panel data across survey periods and measure any change across the years.

Conclusion

While the goal for this study was to investigate the direct influence of ANC on child vaccination, the significant association of other health access and utilization factors with the outcome could explain other mechanisms through which the influence of ANC on child vaccination could possibly happen. The bottom line of these mechanisms is access to information and familiarization with the health care system which can happen through; a) prior experiences with services and operation of the healthcare system which translates into easiness in subsequent future use of services, b) improving maternal knowledge and health literacy through patient-provider interactions during ANC visits which further translates to practice on child health

promotion practices, and c) a possible combination of both. A study by Makinde in Nigeria discussed that women with minimal or no access to maternal health services at the peak hour of need such as during pregnancy, may demonstrate a general unwillingness to seek maternal and child health services in the future(91). As such, women with poor ANC utilization are likely to avoid health services in general. Factors such as trust, confidence, and mass awareness on modern healthcare, as well as applying cultural humility while delivering care are some of the strategies to foster more confidence and trust on skilled providers; hence improve access to essential ANC services and health information through adequate utilization of ANC.

Implications for future research

The results of this study provide a clear emphasis on the influence of ANC on child vaccination and the suggestion to come up with strategies on increasing the utilization of ANC services among women while educating them on the importance of childhood vaccination. Our findings are therefore influential not only in solidifying the proven importance of ANC but also opening a path for further exploration on how to tailor health information during ANC visits to include detailed information on child protective practices beyond the pregnancy period. The explanatory factors applied in this study are far from exhaustive. There is need to continue exploring other factors and utilize the results to develop strategies for improving vaccination coverage. The literature review explored the influence of several sociocultural factors hindering the overall utilization of health services and especially modern strategies such as vaccination. There is also scarcity of qualitative and mixed methods studies exploring population stand on some of these beliefs and practices. This is an area where future studies can focus to better understand the determinants of aspects such as vaccine hesitancy and low vaccination coverage.

3.5 Tables and Figures

3.5.1 Table a: A summary of the ANC Quality measures.

1. ANC Utilization	Number of ANC Visits		Skilled ANC Provider		Early ANC Initiation
• Adequate ANC utilization	4 or more visits	“and”	YES	“and”	First Trimester
• Intermediate ANC utilization	4 or more visits	“or”	YES	“or”	First Trimester
• Poor ANC utilization	3 or less visits	“and”	NO	“and”	Second/third trimester or never
2. Essential ANC health promotion practices “ANC HPCPs”	Continuous score of the following components: ✓ Blood pressure measurement ✓ Blood test done ✓ Urine test ✓ Nutrition information ✓ Information on Pregnancy complications ✓ Discussion on birth preparedness				

0 No	541(28)	169(29)	372(28)	1166(39)	542(38)	624(40)	1050(47)	322(52)	728(46)
1 Yes	1380(72)	421(71)	959(72)	1821(61)	870(62)	951(60)	1163(53)	302(48)	861(54)
Money Problem									
1 No	775(40)	251(43)	525(39)	1364(46)	632(45)	732(46)	1221(55)	355(57)	865(54)
2 Yes	1145(60)	339(58)	806(61)	1624(54)	781(55)	843(54)	993(45)	269(43)	724(46)
Mass Media Access									
0 No	2316(64)	819(69)	1498(61)	1951(68)	935(69)	1016(67)	845(40)	254(43)	591(39)
1 Yes	1325(36)	364(31)	961(39)	914(32)	423(31)	491(33)	1251(60)	339(57)	912(61)
Gender									
1 Male	2050(52)	651(52)	1399(52)	1540(52)	713(50)	827(50)	1125(51)	316(51)	809(51)
2 Female	1894(48)	608(48)	1286(48)	1448(48)	699(48)	748(50)	1089(49)	309(49)	780(49)
Birth Size									
1 Small	504(27)	144(25)	360(27)	793(27)	399(29)	395(25)	428(20)	125(20)	303(19)
2 Normal	1082(57)	310(55)	772(58)	1501(51)	683(49)	818(53)	1538(70)	413(67)	1125(72)
3 Large	308(16)	114(20)	194(15)	637(22)	299(22)	338(22)	227(10)	82(13)	144(9)
Maternal Education									
0 No Education	445(11)	223(18)	222(8)	273(9)	131(9)	142(9)	421(19)	148(24)	273(17)
1 Primary	2190(56)	696(55)	1494(56)	1823(61)	899(64)	925(59)	1411(64)	396(63)	1015(64)
2 Secondary	974(25)	269(21)	705(26)	684(23)	306(22)	378(24)	360(16)	76(12)	284(18)
3 Higher	335(8)	70(6)	264(10)	208(7)	77(5)	131(8)	22(1)	4(1)	18(1)
Marital Status									
1 Single Never Married	296(7)	93(7)	202(8)	186(6)	85(6)	101(6)	182(8)	53(9)	129(8)
2 Married	3311(84)	1043(83)	2267(84)	2485(83)	1138(81)	1347(86)	1791(81)	490(79)	1300(82)
3 Divorced /Separated	338(9)	122(10)	216(8)	317(11)	190(13)	127(8)	241(11)	81(13)	160(10)
Wealth Index									
1 Poorest	982(25)	403(32)	579(22)	656(22)	311(22)	345(22)	495(22)	182(29)	314(20)
2 Poorer	787(20)	230(18)	557(21)	634(21)	305(22)	329(21)	463(21)	142(23)	321(20)

3 Rich	700(18)	206(16)	494(18)	557(19)	257(18)	300(19)	433(20)	110(18)	323(20)
4 Richer	694(18)	179(14)	515(19)	521(17)	248(18)	273(17)	441(20)	109(18)	331(21)
5 Richest	782(20)	241(19)	541(20)	621(21)	291(21)	329(21)	383(17)	82(19)	301(19)
Residence									
1 Urban	1403(36)	458(36)	945(35)	697(23)	330(23)	367(23)	633(29)	145(23)	488(31)
2 Rural	2541(64)	800(64)	1741(65)	2291(77)	1083(77)	1208(77)	1580(71)	479(77)	1101(69)

3.5.3 Table 2: Bivariate association between the explanatory factors and vaccination status outcome

	KENYA			UGANDA			TANZANIA		
	COR	[95% CI]		COR	[95% CI]		COR	[95% CI]	
ANC utilization									
Poor (Ref)	1.00			1.00			1.00		
Intermediate	1.45**	1.15	1.82	1.31*	1.05	1.63	1.13	0.80	1.60
Adequate	1.08	0.77	1.54	1.27	1.00	1.62	1.25	0.50	3.14
Essential ANC HPCPs	1.35***	1.22	1.48	1.10**	1.03	1.18	1.23***	1.14	1.33
Vaccination Card									
No card	0.11***	0.05	0.23	0.02***	0.01	0.06	0.01***	0.01	0.04
Card seen	1.00			1.00			1.00		
Card not seen	0.19***	0.12	0.30	0.08***	0.06	0.11	0.08***	0.06	0.13
Skilled delivery (Yes)	1.65***	1.33	2.05	1.41**	1.15	1.74	2.14***	1.59	2.87
Postnatal Checkup (Yes)	1.74***	1.26	2.42	0.88	0.72	1.08	1.22	0.89	1.65
Insurance (Yes)	1.68*	1.07	2.66	2.40*	1.01	5.72	1.76*	0.99	3.12
Contraceptive Use (Yes)	4.82***	2.89	8.04	3.13	0.74	13.25	2.63	0.53	13.04
Distance to facility (Problem)	1.00	0.72	1.38	0.96	0.80	1.15	1.20	0.92	1.58
Money Problem (Yes)	1.17	0.86	1.60	0.96	0.81	1.14	1.15	0.89	1.51
Mass Media Access (Yes)	1.41**	1.15	1.74	1.07	0.87	1.32	1.24	0.95	1.62
Gender (Female)	1.04	0.86	1.26	1.07	0.90	1.27	0.97	0.76	1.22
Birth Size									
Small	1.10	0.77	1.55	0.85	0.68	1.06	0.90	0.67	1.22

[illegible]

3.5.5 Table 3a: Multilevel logistic regression results (Kenya).

	Model 0	Model 1		Model 2		Model 3	
		AOR	[95% CI]	AOR	[95% CI]	AOR	[95% CI]
Level of ANC utilization							
Poor		1	[1.00,1.00]	1	[1.00,1.00]	1	[1.00,1.00]
Intermediate		1.14	[0.82,1.58]	1.01	[0.71,1.42]	5.46*	[1.23,24.27]
Adequate		1.11	[0.70,1.72]	0.87	[0.53,1.42]	3.96	[0.42,37.63]
Essential ANC HPCPs		1.34***	[1.21,1.49]	1.17*	[1.03,1.32]	1.32***	[1.15,1.53]
Vaccination Card Possession							
None				0.30	[0.09,1.09]	0.43	[0.12,1.60]
Yes (seen)				1	[1.00,1.00]	1	[1.00,1.00]
Yes (Not seen)				0.15***	[0.07,0.31]	0.14***	[0.07,0.29]
Skilled Delivery (Yes)				1.29	[0.89,1.89]	1.28	[0.87,1.89]
Postnatal Check-up (Yes)				1.32	[0.92,1.88]	1.36	[0.95,1.95]
Health insurance cover (Yes)				1.02	[0.57,1.82]	1.02	[0.57,1.81]
Contraceptive use (Yes)				2.27	[0.86,6.00]	2.22	[0.85,5.79]
Distance problem (Yes)				0.87	[0.60,1.27]	0.86	[0.59,1.27]
Money Problem (Yes)				0.91	[0.64,1.30]	0.92	[0.64,1.32]
Mass media access (Yes)				1.30	[0.88,1.90]	1.33	[0.90,1.97]
Child gender (Male)				0.84	[0.62,1.16]	0.84	[0.61,1.16]
Birth size							
Small				1.00	[0.67,1.46]	1.03	[0.70,1.53]
Average				1	[1.00,1.00]	1	[1.00,1.00]
Large				0.79	[0.48,1.28]	0.80	[0.49,1.31]
Highest education level							
No education				1	[1.00,1.00]	1	[1.00,1.00]
Primary				1.88*	[1.12,3.15]	1.88*	[1.10,3.24]
Secondary				1.60	[0.82,3.10]	1.55	[0.78,3.08]

Higher				1.71	[0.63,4.62]	1.76	[0.63,4.91]
Age at 1st birth (Woman)				1.04	[0.99,1.09]	1.04	[0.99,1.09]
Marital Status							
Single/Never married				0.91	[0.48,1.72]	0.92	[0.47,1.78]
Married				1	[1.00,1.00]	1	[1.00,1.00]
Divorced/Separated/widowed				0.69	[0.40,1.21]	0.66	[0.37,1.18]
Wealth Index							
Poorest				1	[1.00,1.00]	1	[1.00,1.00]
Poorer				1.67*	[1.02,2.72]	1.70*	[1.03,2.81]
Rich				1.58	[0.93,2.68]	1.61	[0.94,2.76]
Richer				1.72	[0.91,3.18]	1.72	[0.91,3.23]
Richest				1.28	[0.58,2.83]	1.32	[0.59,2.96]
Place of residence							
1 Urban				1	[1.00,1.00]	1	[1.00,1.00]
2 Rural				1.33	[0.86,2.06]	1.320	[0.84,2.07]
Interaction							
Poor ANC*HPCPs						1	[1.00,1.00]
Intermediate ANC*HPCPs						0.69*	[0.50,0.94]
Adequate ANC*HPCPs						0.72	[0.46,1.12]
/							
variance	1.79***	1.83*	[1.05,3.17]	1.53	[0.78,3.01]	1.70	[0.84,3.45]
ICC	0.15	0.15		0.11		0.14	
Model fit statistics							
<i>AIC</i>	5344.80	2308.34		1927.19		1928.56	
<i>BIC</i>	5351.14	2330.55		2112.79		2125.08	

Outcome: Completion of all basic vaccinations according to either source

Abbreviations: ICC, intra-class correlation, AIC, Akaike's information criterion; BIC, Bayesian information criteria.

Model 0 (Empty model) was fitted without predictor variables.

Model 1 includes ANC quality measures only

Model 2 is ANC quality measures adjusted for other covariates.

Model 3 is the full model testing for interaction.

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.5.6 Table 3b: Multilevel logistic regression results (Uganda)

	Model 0	Model I		Model 2		Model 3	
		AOR	[95% CI]	AOR	[95% CI]	AOR	[95% CI]
Level of ANC utilization							
Poor		1	[1.00,1.00]	1	[1.00,1.00]	1	[1.00,1.00]
Intermediate		1.25	[1.00,1.56]	1.14	[0.87,1.49]	0.88	[0.36,2.16]
Adequate		1.20	[0.94,1.55]	1.26	[0.94,1.71]	5.97**	[2.05,17.45]
Essential ANC HPCPs		1.08	[1.00,1.16]	1.01	[0.92,1.12]	1.20	[0.94,1.53]
Vaccination Card Possession							
None				0.02***	[0.01,0.06]	0.02***	[0.01,0.06]
Yes (seen)				1	[1.00,1.00]	1	[1.00,1.00]
Yes (Not seen)				0.08***	[0.05,0.11]	0.07***	[0.05,0.106]
Skilled Delivery (Yes)				1.35*	[1.05,1.75]	1.36*	[1.05,1.75]
Postnatal Check-up (Yes)				0.86	[0.68,1.10]	0.87	[0.68,1.11]
Health insurance cover(Yes)				1.55	[0.47,5.09]	1.67	[0.47,5.93]
Contraceptive use (Yes)				2.93*	[1.03,8.32]	2.90	[0.95,8.88]
Distance problem (Yes)				0.92	[0.73,1.16]	0.93	[0.74,1.17]
Money Problem (Yes)				0.90	[0.71,1.13]	0.88	[0.70,1.12]
Mass media access (Yes)				0.98	[0.78,1.25]	0.99	[0.77,1.27]
Child gender (Male)				1.15	[0.93,1.42]	1.13	[0.92,1.40]
Birth size							
Small				0.92	[0.70,1.19]	0.91	[0.70,1.18]
Average				1	[1.00,1.00]	1	[1.00,1.00]
Large				1.06	[0.82,1.37]	1.06	[0.82,1.37]
Highest education level							
No education				1	[1.00,1.00]	1	[1.00,1.00]
Primary				0.89	[0.61,1.32]	1.45	[0.50,4.21]
Secondary				1.08	[0.69,1.69]	2.32	[0.55,9.73]
Higher				1.19	[0.62,2.27]	21.91*	[1.31,367.1]
Age at 1st birth (Woman)				1.01	[0.98,1.05]	1.01	[0.98,1.05]
Marital Status							

Single/Never married				0.99	[0.63,1.58]	0.98	[0.62,1.55]
Married				1	[1.00,1.00]	1	[1.00,1.00]
Divorced/Separated/widowed				0.59**	[0.43,0.82]	0.59**	[0.43,0.82]
Wealth Index							
Poorest				1	[1.00,1.00]	1	[1.00,1.00]
Poorer				1.14	[0.83,1.56]	1.13	[0.83,1.55]
Rich				1.24	[0.87,1.77]	1.21	[0.84,1.74]
Richer				1.12	[0.77,1.62]	1.13	[0.78,1.63]
Richest				1.18	[0.75,1.86]	1.17	[0.74,1.84]
Place of residence							
Urban				1	[1.00,1.00]	1	[1.00,1.00]
Rural				1.01	[0.74,1.36]	1.02	[0.75,1.39]
Interaction 1							
Poor ANC*HPCPs						1	[1.00,1.00]
Intermediate ANC*HPCPs						1.05	[0.85,1.30]
Adequate ANC*HPCPs						0.71**	[0.57,0.89]
Interaction 2							
No education*HPCPs						1	[1.00,1.00]
Pri education*HPCPs						0.89	[0.70,1.14]
Sec education*HPCPs						0.84	[0.62,1.14]
Higher education*HPCPs						0.55*	[0.31,0.98]
/							
Variance	1.35***	1.31**	[1.11,1.54]	1.09	[0.91,1.31]	1.11	[0.91,1.34]
ICC	0.08	0.07		0.03		0.03	
Model fit statistics							
<i>AIC</i>	4219.95	3851.54		2939.59		2935.46	
<i>BIC</i>	4225.97	3875.29		3204.38		3179.28	

Abbreviations: ICC, intra-class correlation, AIC, Akaike's information criterion; BIC, Bayesian information criteria.

Model 0 (Empty model) was fitted without predictor variables.

Model 1 includes ANC quality measures only

Model 2 is ANC quality measures adjusted for other covariates.

Model 3 is the full model testing for interaction.

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.5.7 Table 3c: Multilevel logistic regression results (Tanzania)

Table 3c: ML regression Tanzania

	Model 0	Model I		Model 2	
All basic vaccinations according to either source					
		AOR	[95% CI]	AOR	[95% CI]
Level of ANC utilization					
Poor		1	[1.00,1.00]	1	[1.00,1.00]
Intermediate		1.02	[0.72,1.45]	0.94	[0.63,1.41]
Adequate		1.16	[0.46,2.90]	1.25	[0.56,2.78]
Essential ANC HPCPs		1.23***	[1.13,1.34]	1.15**	[1.04,1.28]
Vaccination Card Possession					
None				0.02***	[0.00,0.06]
Yes (seen)				1	[1.00,1.00]
Yes (Not seen)				0.07***	[0.04,0.12]
Skilled Delivery (Yes)				2.40***	[1.61,3.60]
Postnatal Check-up (Yes)				1.10	[0.78,1.56]
Health insurance cover(Yes)				0.97	[0.46,2.07]
Contraceptive use (Yes)				4.28	[0.69,26.39]
Distance problem (Yes)				1.00	[0.70,1.42]
Money Problem (Yes)				0.89	[0.61,1.28]
Mass media access (Yes)				1.24	[0.88,1.75]
Child gender (Male)				0.92	[0.67,1.25]
Birth size					
Small				0.78	[0.53,1.14]
Average				1	[1.00,1.00]
Large				1.03	[0.59,1.81]
Highest education level					
No education				1	[1.00,1.00]
Primary				0.99	[0.68,1.48]

Secondary				0.99	[0.56,1.79]
Higher				1.05	[0.23,4.77]
Age at 1st birth (Woman)				1.06*	[1.01,1.12]
Marital Status					
Single/Never married				0.61	[0.32,1.18]
Married				1	[1.00,1.00]
Divorced/Separated/widowed				0.78	[0.47,1.30]
Wealth Index					
Poorest				1	[1.00,1.00]
Poorer				1.27	[0.81,2.00]
Rich				1.40	[0.85,2.31]
Richer				1.22	[0.61,2.44]
Richest				1.05	[0.45,2.42]
Place of residence					
Urban				1	[1.00,1.00]
Rural				0.91	[0.49,1.68]
/					
Variance	2.57***	2.40***	[1.52,3.78]	3.14***	[1.65,5.98]
ICC	0.22	0.21		0.26	
Model fit statistics					
<i>AIC</i>	2706.39	2446.44		1876.10	
<i>BIC</i>	2712.11	2469.05		2071.56	

Outcome: Completion of All basic vaccinations according to either source

Abbreviations: ICC, intra-class correlation, AIC, Akaike's information criterion; BIC, Bayesian information criteria.

Model 0 (Empty model) was fitted without predictor variables.

Model 1 includes ANC quality measures only

Model 2 is ANC quality measures adjusted for other covariates.

Model 3 is the full model testing for interaction.

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.5.8 Table 3d: Multilevel logistic regression results (Pooled East Africa data)

	Model 0	Model 1		Model 2		Model 3	
		AOR	[95% CI]	AOR	[95% CI]	AOR	[95% CI]
Level of ANC utilization							
Poor		1	[1.00,1.00]	1	[1.00,1.00]	1	[1.00,1.00]
Intermediate		0.96	[0.812,1.124]	1.04	[0.86,1.26]	1.23	[0.64,2.37]
Adequate		0.85	[0.690,1.046]	1.08	[0.83,1.39]	5.90***	[2.27,15.32]
Essential ANC HPCPs		1.21***	[1.146,1.270]	1.12***	[1.05,1.19]	1.32***	[1.16,1.51]
Vaccination Card Possession							
None				0.03***	[0.02,0.064]	0.03***	[0.02,0.07]
Yes (seen)				1	[1.00,1.00]	1	[1.00,1.00]
Yes (Not seen)				0.09***	[0.07,0.11]	0.08***	[0.06,0.11]
Skilled Delivery (Yes)				1.60***	[1.32,1.95]	1.60***	[1.32,1.94]
Postnatal Check-up (Yes)				1.05	[0.87,1.25]	1.06	[0.88,1.27]
Health insurance cover (Yes)				1.13	[0.74,1.74]	1.14	[0.75,1.75]
Contraceptive use (Yes)				3.43**	[1.51,7.80]	3.45**	[1.49,7.10]
Distance problem (Yes)				0.94	[0.79,1.12]	0.95	[0.80,1.13]
Money Problem (Yes)				0.85	[0.72,1.01]	0.86	[0.72,1.02]
Mass media access (Yes)				1.15	[0.97,1.38]	1.16	[0.97,1.38]
Child gender (Male)				0.99	[0.85,1.16]	0.99	[0.85,1.16]
Birth size							
Small				0.88	[0.73,1.07]	0.88	[0.73,1.06]
Average				1	[1.00,1.00]	1	[1.00,1.00]
Large				0.93	[0.75,1.16]	0.94	[0.76,1.17]
Highest education level							
No education				1	[1.00,1.00]	1	[1.00,1.00]
Primary				1.11	[0.88,1.40]	1.80	[0.98,3.30]
Secondary				1.06	[0.78,1.45]	2.57	[0.96,6.91]
Higher				1.06	[0.63,1.79]	10.05	[0.98,102.7]
Age at 1st birth (Woman)				1.04**	[1.02,1.07]	1.04**	[1.02,1.07]
Marital Status							
Single/Never married				0.90	[0.64,1.27]	0.89	[0.63,1.25]
Married				1	[1.00,1.00]	1	[1.00,1.00]

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CHAPTER FOUR: MANUSCRIPT 2 OF 3

Title: The influence of ANC quality on Appropriate diarrhea prevention practices in three East African countries: A multilevel Analysis

Abstract

Background

Despite diarrhea being preventable and treatable, the deaths associated with the condition remain high in many low- and middle-income countries. While the direct and central factor for diarrhea is hygiene and sanitation, the literature varies regarding population characteristics and behavioral practice towards the prevention. Programs such as Antenatal care can be hypothesized as a link between communities and the health care providers where a variety of health information is shared. This paper, therefore, examines the extent to which quality of Antenatal care influences maternal/women's actions towards preventing diarrhea among young children.

Methods

Data for this study was obtained from the demographic and health surveys (DHS)(22) collected in Kenya (2014), Uganda (2016) and Tanzania (2015-2016). The main independent variable, ANC quality, was assessed using two measures a) ANC utilization, and b) essential ANC health promotion care practices (ANC HPCPs). The binary outcome measure was “appropriate diarrhea prevention practices (1=a range of practices vs 0=none). We analyzed descriptive, bivariate, and multilevel logistic regression models for each country as well as pooled data to measure the effect of ANC quality on diarrhea prevention practices, while controlling for other covariates.

Results

Overall, the proportion of women practicing appropriate diarrhea prevention practices incrementally increased with the level of ANC utilization i.e., from poor, intermediate, to adequate ANC utilization, with a range of poor to adequate of 77.3% - 84.4% in Kenya, 81% - 83% in Uganda, and 74.1% - 82.2 % in Tanzania. In Kenya, the adjusted odds of appropriate diarrhea practices were 65% higher [AOR: 1.65; 98% CI: (1.19,2.29)] and twice [AOR: 2.13; 95% CI: (1.24,3.65)] higher among the women with intermediate and adequate ANC utilization, respectively. However, this comparison was not statistically significant in both Uganda and Tanzania. Moreover, The odds of the outcome increased by 13% for every additional number of essential ANC HPCPs in Kenya, [AOR: 1.13; 95% CI: 1.03,1.23], 17% in Uganda [AOR: 1.17; 95% CI: (1.11,1.23)], and 15% in Tanzania [AOR: 1.15; 95% CI: (1.10,1.21)]. In the pooled analysis, intermediate ANC utilization [AOR:1.31; 95% CI: (1.18,1.46)], and adequate ANC utilization, [AOR: 1.41; 95% CI: (1.23,1.63)], were associated with higher odds of diarrhea prev. practices. In addition, for every encounter in ANC HPCPs, the odds of women's diarrhea prevention practices increased by 16% [AOR:1.16; 95% CI: (1.13,1.20)]. We also adjusted for other covariates as discussed in the paper.

Conclusion

The results largely supported our hypothesis that higher levels of ANC utilization (adequate and intermediate), compared to poor ANC utilization, as well as increased encounter for ANC HPCPs, were associated with higher odds of exercising appropriate diarrhea prevention practices. This is a justification that access and familiarity with the health care system such as during ANC, may induce a mother to engage in the appropriate care for safeguarding the health of her child against diarrhea outcomes, using affordable options at home. The findings provide a solid foundation for policy formulation and the need to introduce diarrhea prevention information during ANC visits to reach out to a wider network of women and discuss the prevention measures way before the child is born.

4.1 INTRODUCTION

Diarrhea, according to the World Health Organization (WHO), involves the passage of three or more loose stools in a day, in a frequency that is not normal for the individual frequency(1, 2). It is usually a symptom of gastrointestinal infection, which can be caused by a variety of bacterial, viral, and parasitic organisms(2, 3). The infection is spread through contaminated food or drinking water, or from person to person because of poor hygiene(2). Although the global mortality from diarrhea has declined over the last 2 decades(1), the morbidity of childhood diarrhea continues to be a major cause of child mortality in the developing world (1,2). About 80% of global under 5 mortality from diarrhea occur in Africa and Asia(4, 5). Beyond the 2015 Millennium Development Goals era, there have been renewed global partnership initiatives aimed at ending preventable child and maternal deaths, with diarrhea being a top priority(6). These initiatives contained in the UNICEF report, “A Promise Renewed”, target in lowering the mortality to 20 or fewer under-5 deaths per 1,000 live births by the year 2035 in all countries(6). At the country and population level, strategies for localizing these policies are needed given that children continue to suffer and die from this preventable cause.

Children aged 5 years and younger in Sub-Saharan Africa (SSA) experience an average of 5 diarrhea episodes per year, with the highest incidence occurring in children aged 6 months to 2 years(7-9). The East African countries are among the worst hit countries in SSA. Key studies and country reports indicate an average prevalence of 15% for under-5 diarrheal diseases in Kenya (9-11). Similarly, the prevalence of diarrhea among children aged under 5 is 20% in Uganda, with the problem varying based on region and season of the year(12, 13). In Tanzania,

the current statistics on national burden of diarrhea stand at 12%, according to recent studies and population-based demographic and health survey reports(14, 15). However, the mortality from diarrhea remains high as it remains among the leading causes of child mortality in SSA.

Severity of diarrheal illness

Despite childhood diarrhea being preventable, it can have grave consequences if proper remedial actions are not, timely, taken to address the problem. Among the most common complications include dehydration(16-19). The increased vulnerability of children to dehydration is explained by the fact that water makes a higher proportion of children's body weight as compared to adults. (15). The body loses water and electrolytes through liquid stools, vomiting, sweating, or urinating(29). When these losses occur with a high frequency; as it is with the case for diarrhea, and are not adequately replaced, dehydration occurs(30). The dehydration therefore interferes with normal metabolic function of the body(17,29). Children also use more water per day than adults due to their higher metabolic rates. A child with diarrhea can therefore lose body fluids 3 times as much as the circulating blood volume(30). Without effective intervention, the dehydration, inadequate nutrient absorption, and loss of appetite may lead to death, regardless of the causative agent (1,15). While short term effects from sporadic episodes of diarrhea include dehydration and electrolyte imbalance (29) , persistent diarrhea may lead to nutritional deficiencies and other long-term consequences such as stunted growth and impaired cognitive development(15,17)-

Most studies examining the severity of deaths from diarrhea focus on the condition as the primary cause. There are, however, unexplored avenues where diarrhea functions as a secondary cause of death through other comorbidities such as malaria, HIV, among others(20-22). In

addition to the direct health burden of these illnesses, longer-term effects of diarrhea include secondary malnutrition and impaired cognitive development(23). A few studies have explored the relationship between diarrhea and acute respiratory infection(24-27), including reports from the World Health Organization-WHO(26). Chopra et al(25) highlighted the possibility of diarrhea episodes being associated with illnesses such as acute respiratory infection, which is often a sign of pneumonia. However, this is an area that requires further exploration due to the paucity of studies. A study by Schilling et al (27) found that children aged less than 5 years had increased risk of pneumonia, especially after suffering from severe episodes of diarrhea. Moreover studies conducted in Tanzania(15, 28) and other countries in East Africa(14) recommended the need for further research in exploring the association between diarrhea and other childhood infections.

On the other hand, the opportunistic childhood infections associated with diarrhea are believed to be catalyzed by low immunity due to depletion of nutrients and poor feeding associated with diarrhea(1, 3, 9). This explains why diarrhea is highly identified as a major cause of malnutrition. Malnourished children are also highly susceptible to diarrheal diseases because of low immunity(29, 30). This bidirectional association ultimately affects the optimal growth trajectory of the affected children due to lack of proper nutrients to build up immunity against disease causing pathogens(1,3). The benefits of breastfeeding and vitamin A supplementation have been discussed in many studies as highly critical in providing required nourishment for children(2,7). On the other hand, persistent cases of diarrhea are associated with underweight and other impaired growth patterns(27). As a result of diarrhea, inadequate nutrients are absorbed potentially leading to nutrition deficiency conditions(27,28).

The depletion of micronutrients and dehydration can be mitigated by administering safe and effective Oral Rehydration salts (ORS)(4, 16). Since the 1970's the WHO has continuously

recommended use of oral rehydration therapy to curb dehydration(31). Case studies in multiple countries have demonstrated the effectiveness of this intervention in saving the lives of children(9, 18, 31, 32). However, the use of ORS is not ubiquitous in all areas where diarrhea is prevalent. Several studies estimate that approximately a third of childhood diarrhea episodes in SSA are appropriately managed with ORS(4, 19, 20). Some of the factors identified as common determinants for inadequate usage of ORS include insufficient knowledge of ORS or its usage, (31) negative perceptions against modern drugs including use of ORS, belief in other traditional remedies as more effective in treating diarrhea than ORS, and inadequate distribution or unavailability of ORS in the facilities. A study by Lam (5) in Uganda found ORS use was highly reported among households that were in proximity with clinics stocked with the rehydration therapy. Other maternal factors such as higher education level, higher maternal age, and socioeconomic status have been identified as protective towards the usage of ORS in Uganda and Kenya. (5,32). In the absence of ORS, a solution of clean water, sugar and salt can be prepared at home to ease the condition(32) .

Sociodemographic and environmental determinants of diarrhea

The literature portrays mixed findings on the influence of individual characteristics on diarrheal incidences. In some studies, parental characteristics such as higher education level, employment, and number of children attenuated the effect of unhygienic environment in causing diarrhea (7,8). This was, however, not the case in other studies showing no significant modification effects of socioeconomic factors and diarrhea prevention(3, 29). Children between 6–24 months have commonly been identified as highly susceptible to diarrheal outbreaks in several studies(29, 30, 33, 34). The age between 6-24 months is critical because i) it is the common point of introduction to complementary feeding, increasing susceptibility to diarrhea

due to possible contamination, and ii) babies begin to crawl and can pick dirt from uncleaned surfaces(30, 34). The introduction of other liquids and foods at the time of weaning has been associated with increased spread of microbes that cause disease(9). Specific unhygienic practices increasing the susceptibility of diarrhea in children include poor body hygiene by the lactating mother (2,7), bottle feeding & shared baby utensils (7,10), and poor food hygiene (7). Proper hand washing with soap before handling the baby has been shown to reduce approximately 30% of diarrhea cases among children in low-income countries(11).

Moreover, several studies have shown high correlation between inadequate breastfeeding(35-37) and nutritional deficiency(37-40) and increased diarrhea incidence. Exclusive breastfeeding is known to safeguard the immunity of the newborn and shield them against illnesses including diarrhea. The maternal antibodies provide a natural immunological defense against pathogens(41, 42). Breastfeeding also reduces the exposure of the child to contaminated surfaces such as utensils, or food and drinks that may expose the child to diarrhea causing pathogens(3, 16, 17, 43). Breastmilk also promotes the growth of beneficial bacteria such as *Lactobacillus*(44). Early weaning deprives the child of these essential microorganisms and increase the susceptibility of the intestinal environment to infection(29, 45).

Most studies have concentrated in examining the importance of exclusive breastfeeding within the first 6 months of child's life while few have explored the impact of continued breastfeeding beyond six months on diarrhea episodes. This literature review explored some studies focusing on diarrhea-rated benefits for the continued breastfeeding past six months. A meta-analysis by Akombi et al (29) reported that the incidence of diarrhea decreased with increase on overall maternal health literacy, breastfeeding, immunization, and vitamin A

supplementation, among children aged 12-59 months(29). Other studies have highlighted the protective effect of breastfeeding among children aged less than 5 years(41, 46-48).

Closely related to nutrition is the effect of other diseases linked to diarrhea as a major symptom. Diarrhea has been linked to health conditions such as HIV and malaria in children aged <5 years(11, 49). HIV is assumed to cause changes in the intestinal immune system leading to higher susceptibility to enteric infections that lead to diarrhea(12). In a study conducted in Kenya, Deichsel (21)explains that children with HIV are mostly from low-income households and are susceptible to acute weight loss due to both nutrient and weight loss. Use of antibiotics, antimalarial, and other antiretroviral drugs may also contribute to diarrhea among the children with compromised immunity(11, 21, 49).

Risk factors vary geographically, with studies exploring the significant determinants of diarrhea between urban and rural areas. For urban residence, unsanitary environment and sewerage disposal were highly cited (1,14-16). Among the rural residents, inadequate sources of water(2, 50, 51), other diseases (3, 29), and knowledge of ORS(4, 16, 18) were commonly identified as key predictor factors. Many communities use surface water supplies that may harbor infectious agents, and unsafe for use without purification(38, 52). Moreover, low latrine coverage(7, 29), open defecation practices(10, 18, 51) and unsanitary disposal of children feces(3) have been identified as key contaminants of surface water sources. In addition, while latrine ownership is a great step towards household improvement of sanitary conditions, it has minimal contribution to community benefits if open defecation is common among other households in the area(3) .

Diarrhea prevention practices

Overall, undisputed diarrhea prevention measures as per the literature include access to, and use of, safe drinking-water (2,3), use of improved sanitation, hand washing with soap, exclusive breastfeeding for the first six months of life (9,19), good personal and food hygiene (20), health education about how infections spread, rotavirus vaccination (21), as well as zinc and vitamin A supplementation. Despite these workable interventions, diarrhea remains a leading killer of children under 5 years in SSA. As the literature shows, the cases from diarrhea remain unacceptably high despite the overall reduction in morbidity and mortality over time.

Research gap and focus of current study

As described above, childhood diarrhea is treatable, and deaths associated with diarrhea are preventable. While the direct and central factor for diarrhea is hygiene and sanitation, the literature varies regarding population characteristics and behavioral practice towards the prevention. There are a myriad of underlying factors that drive behavioral practices towards diarrhea prevention. Programs such as Antenatal care can be hypothesized as a link between communities and the health care providers where a variety of health information is shared, and the individual is exposed to skilled care and information sharing about health promotive practices.

From the literature review, many studies have focused on the association between various individual and other sociodemographic factors that determine the prevalence of diarrhea. However, examining the influence of the interaction with the health system through ANC utilization on individual health promotive practices towards preventing diarrhea in children has rarely been studied. This paper, therefore, examines the extent to which quality of Antenatal care

influences maternal/women's actions towards preventing diarrhea among young children. The study is based on a social cognitive theoretical model to explain how interaction with the source of care through ANC likely enhances individual knowledge and practice of health promotion practices towards preventing diarrhea in children. Based on the SCT model, the study also has a secondary objective of examining the socio-demographic and environmental determinants of the recommended diarrhea prevention practices.

This study is important, in that it contributes to the literature by providing evidence on factors that could counter the detrimental effects of diarrheal illnesses in SSA. The study will have policy implications by demonstrating the significant influence of ANC on diarrheal prevention practices and possibly provide evidence and justification for introducing reforms in the health sector about patient-provider communication on health promotive practices, as well as review the interactions and quality of information provided during ANC visits. The study will be based on the following hypothesis.

- 1. The odds of appropriate diarrhea prevention practices varied by **level of ANC utilization** such that women with intermediate and adequate ANC utilization had significantly greater odds of having appropriate diarrhea prevention practices as compared to those who had poor ANC utilization.*
- 2. Women who had higher scores on the **essential ANC health promotion care practices (ANC HPCPs)** were more likely to have appropriate diarrhea prevention practice(s), as compared to women with lower scores on essential ANC HPCPs.*

4.2 METHODS

Data Source

Data for this study was obtained from the demographic and health surveys (DHS)(22) collected in Kenya (2014), Uganda (2016) and Tanzania (2015-2016). The DHS program, mainly funded by the USAID, provides technical assistance for the collection of nationally representative data mostly in low- and middle-income countries, hence advancing global understanding of the current and emerging health issues in the developing world(23). The target population for DHS may vary from country to country or from survey to another, but it is generally defined as all women of reproductive age (15-49 years old) and their young children under five years of age living in ordinary residential households, as well as men (most surveys) aged 15-59 years(22).

Sampling design

The DHS surveys use a two-stage cluster sampling procedure (24); a primary sampling unit (PSU) at the cluster level followed by a secondary sampling unit at the household level (SSU)(24). Households were randomly selected with equal probability from a household list in each cluster. The interviewers visited only the preselected households, and no replacement of the preselected households was allowed during data collection period. A total of 12,563 households in Tanzania, 19,588 in Uganda, and 36,812 in Kenya were occupied at the time of the interview. Among these households, the number of eligible women varied from 13,634 (Tanzania), 19,088 (Uganda), and 15,317 (Kenya). The surveys yielded high response rates of 97% in Tanzania(N=13,266), 97% in Uganda (N=18,506) and 96% in Kenya (N=14,741). The final

sample selected for this study included n=13446 in Kenya, n=9196 in Uganda, and n=6380 in Tanzania, totaling to pooled weighted sample of n=29,022.

Data extraction

Permission to access the DHS dataset was obtained by registering with Measure DHS website; https://preview.dhsprogram.com/data/dataset_admin/login_main.cfm. The data is already de-identified and strict ethical and confidentiality measures are followed by the survey implementation agencies during the data collection and data processing. As a result, no IRB requirement was needed to access and use the secondary data, which was available to the public after registration. The public use dataset was downloaded in STATA files to access the variables of interest for final analysis.

Study Measures

Outcome Variable

There outcome variable was “***Appropriate Diarrhea Prevention Practices***”. This variable was a measure of the number of known diarrhea prevention practices undertaken to promote the health of the baby against diarrhea. These health promotive practices investigated included postnatal checkup of the child, vitamin A and Zinc supplementation, deworming, knowledge of ORS, and safe methods of disposing of the child’s stools. The binary outcome measure was coded as “0” for those without any of the practices and “1” to indicate a range of 1-5 of the practices (whether the respondent followed at least one of the five practices).

Main independent Variable

The main independent variable, ANC quality, was assessed using two measures a) ANC utilization, and b) essential ANC health promotion care practices.

a. ANC Utilization

ANC utilization as a measure of quality was operationalized as a composite measure consisting of 1) *timely initiation of ANC*, 2) *type of provider for ANC*, and 3) *number of ANC visits*. The WHO recommends that pregnant women should initiate contact with healthcare provider at the earliest time possible in their pregnancy-during their first trimester, seek service from a skilled healthcare provider in a government or registered/authorized private facility, and make at least 8 contacts with a healthcare provider during their pregnancy period. However, during the period of data collection for the 3 countries, the WHO recommended a minimum of 4 ANC visits as the optimal effective visits for pregnancy monitoring; hence applied in this study to assess utilization level. In this study, the ANC variable was categorized into either *poor*, *intermediate*, or *adequate* ANC utilization based on the women's experience in their last pregnancy. **Poor ANC utilization** meant the woman did not achieve either of the 3 measures. i.e., did not initiate ANC during their first trimester, did not seek services from a skilled provider, and attended less than 4 visits during their entire pregnancy period. **Intermediate ANC utilization** was indicative of achieving either one or a combination of two of the measures, while **adequate ANC utilization** signified that the woman attained all the 3 measures i.e., initiated ANC during their first trimester, saw a skilled provider, and attended at least 4 visits. For the analysis, Poor ANC utilization is coded as 1, Intermediate ANC utilization is coded as 2, and Adequate ANC utilization was coded 3.

b. Essential ANC health promotion care practices (ANC HPCPs)

The essential components of ANC involve the content of information shared, or service administered through the interaction with healthcare provider during the ANC visit. This measure was a continuous score of whether the essential ANC HPCPs were covered during ANC

visit, as stipulated in the WHO guidelines (ref). The six essential components were blood pressure measurement, blood test, urine test, whether the woman received information on nutrition, whether she was informed of possible complications during pregnancy, and finally whether she was given advice on a birth preparedness plan. Each of these questions had a binary response of (Yes=1, and No=0). A continuous variable was created to measure the individual attainment of these measures with a scoring of 0 to 6. For the narration of the analytical procedures, interpretation of the results and discussion of the findings, the essential ANC health promotion care practices will otherwise be referred to as “ANC HPCPs”.

The overall ANC Quality measures are illustrated in the **TABLE 5a**.

Other Sociodemographic and Environmental Exposure Variables

Other explanatory variables were selected based on the literature review, and their theoretical justification of their association with the outcome. These measures included **sanitation** factors namely household water source (Safe=1, Unsafe=2) and type of toilet facility (Flush toilet=1, Pit Latrine=2, No facility/bush/field=3) as well as **health access** relating to childbirth and development, including place of delivery (*Skilled=1, Non-skilled=0*) and post-natal health visit (*Yes=1, No=0*), and insurance coverage (*Yes=1, No=0*). **Sociodemographic factors** such as maternal, child and household characteristics were also controlled for. These included child factors: age (*age in months*), gender (*Male=0, Female=1*), and birth size (*Small=1, Average=2, Large=3*); maternal factors: education (*No education=0, Primary=1, Secondary=2, Higher=3*), maternal age (years), marital status (*Single/Never married=1, Married=2, Divorced/Separated/Widowed=3*), pregnancy intention (*Yes=1, No=0*) and employment status (*Yes=1, No=0*), as well as household wealth index (*Poorest=1, Poorer=2,*

Rich=3, Richer=4, Richest=5). In addition to the individual and household characteristics, the place of residence (*Urban=0, Rural=1*), region and country of residence were also measured. The variables are summarized in Appendix 1.

Data Analysis

Levels of Analysis

The analysis involves data from 3 countries: Kenya, Uganda, and Tanzania. Descriptive and regression analyses were conducted separately for each country. The data from each of the countries was then appended to estimate a pooled analysis for a combined adjusted effect of ANC quality on diarrhea prevention measures in the East Africa region.

a) Descriptive Statistics and bivariate analysis

Descriptive characteristics of the subjects were presented as frequencies and percentages to summarize the distribution of selected background characteristics of the sample population. This was followed by bivariate logistic regression comparing each of the explanatory variables with the outcome variable. The results were presented as unadjusted odds ratios (OR) and confidence intervals (95% CI) at the 0.05 alpha level. All variables with a p value < 0.05 at bi-variate logistic regression, or theoretically important based on the previous literature, were entered into the multilevel logistic regression models.

b) Multilevel Logistic regression

The surveys were collected by stratified cluster sampling resulting in hierarchical data where respondents were nested within clusters. Respondents within the same cluster are likely to be more similar to each other. Running an ordinary logistic regression would therefore ignore the independence between clusters by assuming an equal population. This leads to having small

standard errors. For this reason, and to test the research hypothesis, two stage multivariable multilevel logistic regression models were used to identify the extent to which ANC quality influences diarrhea health promotion practices while controlling for other sociodemographic, sanitation and community variables. The models were run separately for each country, followed by a pooled analysis involving appended data for all countries. While we analyzed descriptive, bivariate, and multilevel regression for each country, we utilized the pooled data for the multilevel regression only.

Model Specification

We ran a null model (**model 0**) without any explanatory variable to assess the variation of women diarrhea prevention practices due to cluster differences, hence a justification for the multilevel analysis. This was estimated using the Intraclass Correlation Coefficient (ICC). Accordingly, about 10% (ICC=0.10), 15% (ICC=0.15) and 12 % (ICC=0.12) of the total variation in the odds of Appropriate diarrhea practices in Kenya, Uganda and Tanzania, respectively, was due to cluster difference. **Model 1** contained only the main predictor i.e., ANC Quality (includes ANC utilization and ANC HPCPs). We consequently adjusted for maternal, child and household characteristics, Sanitation and health access factors, and community factors in the full model (**Model 2**). The final model (**Model 3**) contained the components for model 2 plus interaction effects, whenever applicable. The rationale for testing for interaction was because the number of ANC visits may influence or increase opportunities more HPCPs among pregnant women. Moreover, we examined for other potential interactions because the overall quality of ANC may vary by different levels of some of the other explanatory factors such as

maternal education, residence, among others. We began by running models for each country (all three countries), followed by a pooled analysis.

The fixed and cluster variation random effects were performed based on the following equation:

$$\text{Logit}[P(Y_{ij} = 1)] = \gamma_{00} + \gamma_{10}X_p + \gamma_{01}Z_q + U_{0j}$$

In the equation, subscripts *i* and *j* represent the individual *i* from group(cluster) *j*. *Y_{ij}* denotes the dichotomous outcome variable for level-one-unit *i* in level 2-unit (cluster) *j*. That is, diarrhea prevention measures by *ith* woman in the *jth* group(cluster). *γ₀₀* is the grand average intercept; that is the log odds of practicing diarrhea prevention measures in the absence of explanatory variables. The terms *X_p* and *Z_q* are individual (fixed effects) and group (cluster) measures, respectively. *γ₁₀* is the regression coefficient of the individual level variable *X_p* and finally, *γ₀₁* is the regression coefficient of the group(cluster) level variables *Z_q*. The term *U_{0j}* is the cluster level residuals.

Moreover, model comparison was done using Bayesian information criteria (BIC) and Akaike's information criterion (AIC). The model with minimum BIC and AIC value was considered as a better fit. The results of the regression analysis were presented as adjusted odds ratios (AORs) with 95% percentage confidence intervals (CIs). The statistical significance was set at a *P* value ≤ 0.05 (25,26)

4.3 RESULTS

4.3.1 Characteristics of study population

Table 1 summarizes the ANC quality measures in addition to sociodemographic characteristics, sanitation and health access factors and community factors in relation to practice of diarrhea prevention measures among the women. The sample ranged from 6380 (Tanzania), 9196 (Uganda), to 13446 (Kenya). Overall, diarrhea prevention practices increased with the ANC utilization levels with a range of low to high of 77.3% - 84.4% in Kenya, 81% - 83% in Uganda, and 74.1% - 82.2 % in Tanzania. Across all the three countries, a larger proportion of women who had visited a health facility within the past 6 months, had skilled delivery, were covered by insurance, had a secured source of water, and used a flush toilet system, were more likely to practice appropriate diarrhea prevention measures. Majority of the women had a normal size baby at birth in all the three countries. A greater proportion of the women in Kenya and Uganda did not have access to mass media. Across all the three countries, a larger proportion of the women had completed a primary school as the highest-level education achieved and were married.

4.3.2 Proportion of diarrhea prevention practices against population characteristics

The column percentages in table 1 compare the prevalence of practicing at least 1 diarrhea prevention practice against each of the predictors. Majority of the women had intermediate utilization of ANC in both Kenya and Uganda (41.7% and 83.1%, respectively), while over two thirds in Tanzania (74.4%) had poor ANC utilization. Across the three countries, over 60% of the women had had visited a health facility over the last 6 months as well as had skilled delivery during their last birth. Regarding sanitation measures, majority of the women did

not have a safe water source, and over two thirds used a pit latrine. Moreover, a larger proportion of the women were married, employed, and resided in the rural areas.

4.3.2 Bivariate Analysis Results

Table 2 summarizes the results of the bivariate analysis comparing the unadjusted odds ratios and confidence intervals among the three countries. In Kenya, women who had a high level of ANC utilization had increased odds of having one or more diarrhea prevention practices, compared to women with poor ANC utilization [OR:1.58;95% CI: (1.32,1.89)]. A similar trend was reported in Tanzania [OR:1.62; 95% CI: (1.02,2.57)]. In Uganda, those with intermediate ANC utilization significantly had increased odds of having at least one diarrhea prevention measure compared to those with poor ANC utilization [OR:1.15; 95% CI:(1.00,1.32)]. With every increase in the number of ANC HPCPs, the Odds of practicing diarrhea prevention measures were 26% higher in Kenya [OR:1.26;95% CI: (1.09,1.25)], 17% higher for Uganda [OR:1.17;95% CI: (1.12,1.22)], and 16% higher for Tanzania [OR:1.11;95% CI:(1.11,1.21)].

Other significantly greater odds of practicing diarrhea prevention measures in Kenya included having skilled delivery [OR:1.29; 95% CI: (1.17,1.43)], insurance [OR: 1.58; 95% CI: (1.06,2.34)], increasing child age [OR: 1.01; 95% CI: 1.08,1.14]. In Uganda and Tanzania visiting a health facility in the last 6 months was significantly associated with higher odds of the outcome [OR:1.63; 95%CI: (1.39,1.91)] and [OR:1.54; 95% CI:(1.31,1.81)], respectively. The odds of the outcome also significantly increased with every increase in both child and maternal age in both Kenya and Uganda. The relationship of child age and the outcome opposite in Tanzania with the odds decreasing by 2% with every additional age in months.

For sanitation measures, availability of a flush toilet system was significantly associated with greater odds of the outcome in all the three countries compared to using a pit latrine; [OR:1.29;95% CI:(1.05,1.58)], [OR:1.87;95% CI: (1.23,2.86)], and [OR:1.81;95%CI: (1.44,2.28)], respectively for Kenya, Uganda and Tanzania. There results demonstrate a declining trend in the odds of practicing diarrhea prevention from the richest to the poorest in both Kenya and Tanzania. Compared to the women in the richest wealth quintile in Kenya, the odds of the outcome were lower by a range of approximately 19% [OR:0.81;98% CI: (0.66,0.98)] for those in the richer wealth quintile(richer) to 36% [OR:0.64;98% CI: (0.53,0.77)] among those in the poorest wealth quintile. Similarly compared to those in the richest wealth quintile, the odds of the outcome were significantly lower by a range of 21% [OR:0.79;98% CI: (0.63,0.99)] among those in the richer wealth quintile to 48% [OR:0.54; 98% CI: (0.43,0.68)] among those in the poorest wealth quintile. Being employed in Uganda was significantly associated with greater odds of the outcome [OR:1.18;95%CI: (1.01,1.41)].

4.3.3 Multilevel logistic regression (Country specific)

Table 3a,3b, and 3c compares the separate multilevel regression analysis for Kenya, Uganda, and Tanzania, respectively. The tables 3c and 3d include Model 0(unconditional), Model 1 (ANC Quality measures only), and model 2(fully adjusted). Table 3a (for Kenya) includes Model 0-2 plus additional interaction model (Model 3). Similar interaction measures were tested for Uganda and Tanzania, but the results were non-significant.

The empty models (Model 0) for all countries indicate significant cluster differences signifying between cluster variation. Model 1 is the unadjusted model for containing the level of ANC utilization and essential ANC HPCPs. While the odds of diarrhea practices in both Uganda and Tanzania were higher for intermediate and adequate utilization, compared to poor, the

relationship was not statistically significant. In Kenya, the odds of diarrhea practices were 65% higher [AOR: 1.65; 98% CI: (1.19,2.29)] and twice [AOR: 2.13; 95% CI: (1.24,3.65)] higher among the women with intermediate and adequate ANC utilization, respectively, as compared to those with poor ANC utilization. The odds of the outcome increased by 13% for every additional number of essential ANC HPCPs in Kenya, [AOR: 1.13; 95% CI: 1.03,1.23], 17% in Uganda [AOR: 1.17; 95% CI: (1.11,1.23)], and 15% in Tanzania [AOR: 1.15; 95% CI: (1.10,1.21)]

Model 2 included the ANC quality measures adjusted for other sociodemographic, sanitation, health access, residence, and region factors. In Kenya, the adjusted odds of diarrhea measures were 46% higher [AOR: 1.46; 95% CI:(1.03,2.07)] and 29% [AOR: 2.291; 95% CI:(1.328,3.952)] higher for intermediate and adequate ANC utilization, respectively as compared to poor ANC utilization. This significant association was similarly recorded for Tanzania comparing low and adequate ANC utilization where the odds of the outcomes were 75% higher among those with adequate ANC utilization [AOR: 1.75; 95% CI: (1.06,2.88)]. While the influence of ANC utilization on diarrhea prevention was not statistically significant in Uganda, the findings for Kenya and Tanzania support our first hypothesis(hypothesis#1) where we had predicted that that women with intermediate and adequate ANC utilization would significantly have greater odds of having appropriate diarrhea prevention practices as compared to those who had poor ANC utilization. Moreover, for every additional ANC care practice, the adjusted odds of the outcome were approximately 15% greater in both Kenya and Uganda [AOR: 1.15; 95% CI:(1.04,1.27)] and [AOR:1.14; 95% CI: (1.08,1.21)], respectively, and 12% greater in Tanzania [AOR: 1.12; 95% CI:(1.07,1.18)]. This significant association aligns with our second hypothesis (hypothesis #2) where we had predicted that the odds of appropriate diarrhea prevention measures would significantly increase with every unit increase on the ANC HPCPs.

Having visited a health facility in the last month and skilled delivery in the last birth were associated with increased odds of diarrhea prevention measures among women in Kenya and Tanzania. The results were however opposite in Uganda with the odds being 17% lower for the women with skilled delivery in their birth, [AOR:0.83; 95% CI: (0.70,0.98)]. In all countries, having no facility or a toilet with a flush system was associated with higher odds of diarrhea prevention measures as compared to those who used latrine. These results were significant in Kenya and Tanzania. The odds of the outcome increased with increasing child age in Kenya [AOR: 1.04; 95% CI: (1.03,1.05)] and Uganda [AOR: 1.02; 95% CI: (1.03,1.06)].

We tested the possible interaction between the level of ANC utilization and ANC HPCPs across all the three countries. There was no significant interaction in both Tanzania and Uganda; therefore, we did not present the interaction model for these two countries. In Kenya (Model 3), the results show that, with every additional unit of ANC care practice, women with adequate ANC utilization had almost 2 times [AOR: 1.74; 95% CI: (1.26,2.40)] greater odds of having adequate diarrhea prevention measures compared to the women with poor ANC utilization.

4.3.4 Multilevel logistic regression (Pooled analysis)

Table 3d summarizes the results of the pooled multilevel logistic regression analysis of the association between ANC quality and diarrhea prevention practices among women in Kenya, Uganda, Tanzania. As shown in model 1, the odds of diarrhea practices among women were significantly higher among women with intermediate ANC utilization [AOR:1.31; 95% CI: (1.18,1.46)], and adequate ANC utilization, [AOR: 1.41; 95% CI: (1.23,1.63)], as compared to poor ANC utilization. Indeed, the results show that the odds of women's diarrhea prevention practices increased with the level of ANC utilization (poor to adequate). In addition, for every

encounter in ANC HPCPs, the odds of women's diarrhea prevention practices increased by 16% [AOR:1.16; 95% CI: (1.13,1.20)].

Model 2 was adjusted for other sociodemographic and household characteristics, sanitation, and health access factors, as well as place and country of residence. This attenuated the significant effect of the ANC utilization factors, hence hypothesis #1 was not supported by the findings. However, the odds increased by 15% with every ANC HPCPs [AOR:1.15; 95% CI: (1.10,1.18)]. These results were in line with our hypothesis # 2 that predicted that the odds of the diarrhea prevention measures would significantly increase with every unit increase on the number of essential ANC HPCPs. Compared to those using a latrine, the odds of diarrhea prevention measures were 2 times higher for those without any toilet facility (field/open), [AOR: 2.10; 95% CI: (1.63,2.60)] and 49% higher for those with a flush system [AOR:1.49; 95% CI: (1.15,1.93)].

Other factors, significantly, associated with increased odds of diarrhea practices included small birth size [AOR:1.14; 95% CI: (1.02,1.28)], increasing child age [AOR: 1.02; 95% CI: (1.01,1.02)], and living in a rural area [AOR:1.19; 95% CI: (1.02,1.40)], compared to urban residence. The odds of the outcome were higher and increased with every level of education completed. Compared to those with no education, the odds were 1.11, 1.37, and 1.43 times higher for those who had completed primary, secondary, and higher education, respectively. At the country level, women from Uganda and Tanzania had significantly lower odds (73% and 82% lower, respectively) of diarrhea practices compared to those from Kenya.

We also tested the possible interaction between the ANC quality measures and other independent variables and found a significant interaction between the level of ANC utilization and country of birth (Model 3). For the key predictors, who had adequate ANC utilization had

more than twice the odds of appropriate diarrhea prevention practices [AOR: 2.28; 95% CI:(1.40,3.73)] as compared to the women with poor ANC utilization. Similarly, women who had intermediate ANC utilization had 43% higher odds of appropriate diarrhea prevention practices as compared to those with poor ANC utilization [AOR:1.43;95%CI:(1.03,1.97)]. For the women in Kenya, the odds of full vaccination increased by 15% for every increase in the score for ANC HPCPs. We found an interaction between adequate ANC utilization and country of birth, whereby compared to women with poor ANC utilization, women with adequate ANC utilization, who lived in Uganda, had 57% lower odds [AOR 0.43; 95% CI:(0.26,0.72)] of having appropriate diarrhea prevention practices.

4.4 DISCUSSION

The **primary objective** of this study was to measure the extent to which ANC quality; operationalized as the level of ANC utilization during pregnancy and the number of essential ANC HPCPs i.e., service administered, or information shared, across the pregnancy period, were associated with women's diarrhea prevention practices towards preventing child diarrhea. While the level of ANC utilization focused on the extent to which the women engaged with the healthcare system (skilled care), the essential ANC HPCPs provided an understanding of the magnitude and quality of care received. For the level of ANC utilization, the bivariate(unadjusted) models showed greater odds of diarrhea prevention practices among women who had adequate ANC utilization compared to those with poor ANC utilization. This association increased with each level of utilization across the 3 countries, an indication that the more the engagement with skilled care the higher the likelihood to be exposed to, and ultimately practice, health information. This effect was mirrored by the association between ANC HPCPs and diarrhea practices. For all the countries, the odds of diarrhea prevention measures increased

with every additional encounter for ANC HPCPs. Our findings therefore indicate that the nature of ANC quality has a viable impact on appropriate care for children with diarrhea.

Country-Level regression output (Adjusted models)

The effect of the ANC quality measures was attenuated in the adjusted multilevel models but remained significant with varying results across the countries. In our first hypothesis (hypothesis #1), we predicted that the odds of appropriate diarrhea prevention practices would vary by level of ANC utilization such that women with intermediate and/or adequate ANC utilization had significantly greater odds of having appropriate diarrhea prevention practices as compared to those who had poor ANC utilization. This research hypothesis was supported by the findings in Kenya and Tanzania (See model 2 for both countries). In Kenya, both the level of ANC utilization and ANC HPCPs were associated with increased odds of diarrhea prevention measures, after controlling for other factors. Compared to women with poor ANC utilization, women with intermediate and adequate levels of ANC utilization had 46% and more than double greater odds, respectively, of applying the appropriate diarrhea prevention practices. The results for Kenya also supported the second hypotheses (hypothesis #2) that Women who had higher scores on the ANC HPCPs were more likely to have appropriate diarrhea prevention practice(s), as compared to women with lower scores on essential ANC HPCPs. However, in the interaction model, women with adequate ANC utilization appeared to have 82% lower odds of exercising appropriate diarrhea prevention practices. This can be explained by the significant interaction of ANC HPCPs on the association between adequate ANC utilization and the outcome such that the effect of adequate ANC quality in Kenya increased by 73% with every unit increase in the ANC HPCPs. In Tanzania, there was a significant association between adequate level of ANC utilization with almost double the odds of diarrhea prevention as compared to poor utilization, as

well as increased odds of the outcome with every unit increase in the ANC HPCPs. These findings for Tanzania therefore supported both the hypothesis #1 and #2. In Uganda, while the level of ANC utilization was not significantly associated with the outcome after controlling for other predictors, there was a significant association between the ANC HPCPs and diarrhea prevention practices. i.e., the odds of diarrhea prevention practices increased with each additional count of ANC care practice. The findings in Uganda, therefore, did not support hypothesis #1 but were in line with hypothesis #2.

From the wide search of the literature search, we could hardly find studies that directly explore the influence of ANC quality on diarrhea prevention measures or specifically on other water sanitation and hygiene (WASH) activities. Other closely related studies provide conflicting results concerning the effect of ANC on neonatal and child mortality in SSA, (82,104,122,126-128) , Nevertheless, our findings are supported by previous studies have demonstrated that prior interaction with a primary care provider is a significant predictor of appropriate care for diarrhea episodes such as administering ORS at home(4, 13, 18, 45). Another study by Lam et al, demonstrated that access to oral therapies from community health workers was associated with an increase in appropriate care for children with diarrhea(17).

Pooled regression analysis

The analysis with the combined data provided a stronger comparison which showed a similar pattern to the multilevel regression results from the individual countries. Compared to women with poor ANC utilization, the odds of appropriate diarrhea prevention were significantly higher for both the women with intermediate and adequate ANC utilization. This association remained significant even after adjusting for other covariates. Similarly, the odds of the appropriate diarrhea prevention measures increased with every unit increase in essential ANC

HPCPs. Other significant associations in the adjusted models include the presence and type of toilet facility in the household, small child at birth, child age in months, maternal education, and rural residence. The direction of influence (greater/lower odds) of these factors matched that of the individual countries, and the justification of their influence on the outcome (as discussed above) did not change with the pooled analysis.

Moreover, we observed that a strong relationship in each country translated to similar significant results in the pooled analysis even if the association wasn't strong, and possibly not significant, in the other countries. This is a limitation of pooled analysis where authors can make erroneous conclusion by generalizing the results when some of the effects are highly country specific, and don't necessarily represent the situation in a neighboring country. We were able to counter this problem in our analytical approach by comparing each country separately in addition to the pooled analysis to identify some of the key differences between the countries that are likely to drive the nature of the results in the pooled analysis models. Therefore, by controlling for country of origin in the pooled analysis models, we found that women in Kenya had greater odds of appropriate diarrhea prevention measures followed by Uganda and Tanzania. According to the literature review, several factors such as national GDP, health infrastructure and communication systems place Kenya at an advantage in overall population outcomes compared to her immediate neighbors.

The **secondary objective** of this study was to examine the socio-demographic and environmental determinants of the appropriate diarrhea prevention measures, while factoring the influence of ANC quality. We adjusted for several predictor variables based on the results from the bivariate analysis as well as their theoretical association with the outcome as per the previous literature. Among the significant covariates across all the three countries included visiting health

facility in the last 6 months, maternal education level, and region of residence. In Kenya and Uganda, the age of the child was a significant predictor. Type of toilet facility in the household and place of delivery during the last pregnancy were significant predictors for Uganda and Tanzania and not in Kenya. Finally, the size at birth for the child and marital status were significantly associated with the outcomes in Uganda and Tanzania, respectively. Notwithstanding the varying levels of significance, the direction of the association (either greater or lower odds) between most control variables in the models and the outcome was similar across countries.

Visiting a health facility within the last 6 months was associated with approximately 1.5 times the odds of the outcome in each of the 3 countries. Similarly, having a skilled delivery for the last delivery was also associated with increased odds of the outcome in Uganda and Tanzania. It has been observed that increasing access to skilled health professionals has a close linkage to positive health behaviors(53-55). Previous or recent health visits has, specifically, been associated with reduction in diarrhea incidence, skilled delivery, better child nutrition and malaria incidence(54, 55). A visit to the health facility could mean acquiring or maintaining health literacy on various health promotive practices(56). This positive association is in line with our overall prediction in this paper that utilization of care (though ANC) bridges the gap between the providers and users of care, creates familiarity and acceptability of health services, and promotes maternal knowledge on the appropriate health promotion practices against children's ailments.

The influence of education on diarrhea prevention practices varied across the countries. Consisted with previous studies, the odds of the outcome increased with every level of maternal education completed for women in Uganda and Tanzania. Although some of the levels of

education completed were not significantly associated with the outcome, the odds of diarrhea prevention practices incrementally increased from lower to highest education level. The possible reason might be because education is expected to improve household health care and hygiene practices. The results conform with previous studies that explain the effect of education on diarrhea prevention(14, 19, 26). Singh et al demonstrated that highly educated caregivers had a higher odd of utilizing healthcare facilities for managing childhood diarrhea (34). In addition, the decision of the educated caregivers to use home treatment, have been attributed to their ability to utilize health information wisely (35). The results were different for Kenya where, compared to women with no education, those with primary, secondary, or higher education had lower odds of practicing diarrhea prevention measures. This finding is inconsistent with previous studies and the results were not statistically significant except for primary education.

Our findings show that adequate diarrhea prevention increased with every additional age (in months) of the child in Kenya and Uganda. Loosely explained, these findings could mean older children are keenly taken care of as compared to younger children. This, however, might not be the case and especially in relation to diarrhea prevention. These findings may relate in part to breastfeeding practices, and an increased concern for the health of growing children past the weaning period, where they are introduced to new and potentially contaminated foods as well as begin crawling, exposing them to germs, among others. Exclusive breastfed infants have fewer morbidities, such as diarrhea, however, shortly after weaning, the risk of diarrhea and the associated consequence of dehydration increases, in addition to other physical risks as the baby continuously becomes mobile(57, 58). These facts therefore are potential explanations of the increased care against diarrhea as the child becomes older and prone to multiple risks. There are

fewer previous studies assessing this association and this is an area requiring further exploration in future studies.

Compared to the single/never-married women in Tanzania, married and divorced/widowed/separated women had a higher likelihood of practicing diarrhea prevention. Studies in both the developed and developing world have shown the protective effect of marriage on health access, utilization, and practice. In the US, Medicare costs among the married beneficiaries are approximately half than those not married(59). Unmarried individuals have reduced access to resources such as insurance and disposable income(59). With the all-round socio-economic support, being married is therefore associated with overall better access to health information, and utilization of health services(29, 60). These advantages of being married over single/never married are relatable across geographic boundaries and have been shown in many studies showing better health outcomes among the married compared to single/never married(ref). Never married women are less likely to share resources (e.g., health insurance benefits or finances) and compare information on health actions. Closely related to support through marriage is partner's education which has been associated with utilization of health facilities to treat diarrhea episodes (33,34). This affirms the protective role of partners (36), as an additional reinforcement factor for mother's decision to seek appropriate care when managing childhood illness (33,36).

The main sanitation related control factors were source of water (within the home or away) and type of toilet facility (flush system, pit latrine, or open/field/no latrine. With a pit latrine being the reference for the type of toilet facility, using a toilet with a flush system as well as having no toilet facility was associated with greater odds of diarrhea prevention measures in all the three countries. These results agree with previous studies (35,37,40) that have found

consistence of association between having modern systems such as ventilated improved pit (VIP) latrine or flush toilet with improved diarrhea management as compared to having the ordinary latrine. It is important to note that majority of women used pit latrine. People using flush system toilet are most likely to be in urban areas, or still rural with higher income, with access to reliable water sources and information as well as more conducive health infrastructure for accessing and utilizing appropriate diarrhea prevention measures. Having a toilet facility has been found to be beneficial towards prevention of diarrhea episodes (37). However, diarrhea episode/or risk was not the direct outcome of this study, and the increased odds of appropriate diarrhea practices among those with no toilet facility can be as a result of being more cautious in preventing disease, either because they have already suffered due to increased risk, hence more ideas on how to prevent future events, or generally acting out of caution to minimize the risk on themselves and their children. This therefore explains why the two extremes of sanitation system measures i.e., flush system vs open defecation/not toilet were significantly associated with higher odds of appropriate diarrhea prevention measures compared to having a latrine.

Proper hygiene and sanitation practice are key prevention measures for infections through the fecal-oral route. (18) Studies have identified contaminated water sources and inappropriate solid and liquid waste disposal as key risk factors for increased diarrhea in the East African region. (5,39,40). Practices such as open defecation, and unsafe disposal of children's faeces are top contaminants of the environment and surface water systems. (37) A study by Kwiringira et al (12) in Uganda highlighted the belief that children faeces are less harmful as compared to adult faeces, hence okay to throw them in the open air. Another RCT study by Waiswa et al (61) explained the dangers of open defecation showing that individual latrine ownership had less community health benefit in areas where open defecation was common.

Geographical region was a significant factor with women living in the regions with bigger cities more likely to practice diarrhea prevention. The results for each of the countries, as well as the pooled analysis showed that rural residents had increased odds of diarrhea prevention measures compared to urban residents. However, this association was only significant in the pooled analysis. According to the literature, urban and rural areas have distinctive health problems, which require consideration. Several studies have examined the determinants of diarrhea based on urban/rural residence. (8,11,43) Commonly perceived determinants for both urban and rural residents include contaminated drinking water, inadequate latrine coverage and unsanitary environments. (8,43) According to Tambe et al (8), magnitude and settings of health problems among communities differ between the rural and urban settlements. The literature is inconclusive regarding the risk level of diarrhea between rural and urban residence. A recent study in Kenya by Akech et al (62) looking at patterns for hospitalized care among children with diarrhea found a higher prevalence among rural residents. A closely related study Kwiringira et al (12) discussed the vulnerability of living in urban slums, or general urban residence with poor water supply as unique risk factors for diarrheal diseases in urban areas. Comparative studies on rural and urban sociocultural determinants of diarrhea in SSA are inadequate and require consideration. Even though the health infrastructure and community settings differ, the focus on social contexts and cultural practices is useful in guiding effective control of diarrheal diseases.

Strengths and Limitations

There are several limitations that need to be factored in the interpretation of the study findings. Among the downside of this study is the fact that it's based on the analysis of secondary data. As such, the variables were restricted to the pre-determined questions and responses in the survey questionnaire. Therefore, despite the DHS surveys being extensive in the number of questions

asked, we were not able to fully investigate the questions in the best way possible because the questions were not drafted with this study in mind. Moreover, with the study being cross-sectional we are not able to assess causation or make temporal conclusions on the association between the predictors and the outcome. Additionally, this study is prone to recall bias as it was conducted through survey interviews on previous experiences. It is therefore possible that respondents might have forgotten, responded incorrectly, or given socially desirable answers to the questions. For example, there is a possibility of mothers reporting that they sought appropriate care against diarrhea when they did not, to avoid being socially judged with negligence to their children.

Despite the above limitations, the study also carried great strengths that help in validating the results. The study uses nationally representative data which is also comparable across countries and therefore the findings can be used to inform public health policies and program actions at the national level. Another strength is the use of multilevel modelling to account for the nested nature of the dataset which leads to more reliable estimates.

Conclusion & Study implications

The outcome for this study, appropriate care for children's diarrhea prevention, is slightly different from other measures addressing health care utilization such as vaccination because some of the recommended actions occur at home and do not necessarily require the mother to access the formal healthcare system. The results however, strongly supported our hypothesis that higher levels of ANC utilization (adequate and intermediate), compared to poor ANC utilization, as well as increased encounter for ANC HPCPs, were associated with higher odds exercising appropriate diarrhea prevention practices. This is a justification that access and familiarity with the health care system such as during ANC, may induce a mother to engage in the appropriate

care for safeguarding the health of her child against diarrhea outcomes, using affordable options at home. This is possibly through a decision to accept and apply information from the formal health care system, and its recommended processes.

Our study is among the few papers highlighting 1) new measures of defining and operationalizing ANC Quality, and 2) examining the direct relationship between ANC Quality and maternal health promotion practices, specifically diarrhea prevention measures, beyond the pregnancy period. The findings portray not only the importance of incorporating health promotion and child survival measures during ANC visits (reviewing the current ANC HPCPs to address maternal and child health promotion strategies), but also the benefits of ensuring adequate ANC utilization to bridge the gap between the community and the health care system. We highlighted some gaps and inconsistencies in the literature with previous studies providing conflicting results concerning the effect of ANC on outcomes such as neonatal and child mortality in SSA, (82,104,122,126-128). The literature is also sparse regarding infant outcomes after deliveries by mothers without prenatal care, particularly regarding the women's behavior, and abilities, towards disease preventive measures such as immunization, breastfeeding, and sanitation. (126) This study there narrows the gap in the literature by not only focusing on a less explored association, but also providing a solid justification of the importance of antenatal care not only on a safe pregnancy outcome but also health promotive practices such as diarrhea prevention.

The study also creates a reference baseline for measuring both ANC quality and diarrhea prevention practices. While we came up with the best combination of measures for preventing the risk of diarrhea based on the questions from the DHS survey, some of the measures could equally be applied to measure the risk of other health conditions. Therefore, the women might

have undertaken some practices not necessarily with the aim to reduce the risk of diarrhea on their children but also other health precautions. Future studies can apply a more robust measure to strictly incorporate diarrhea prevention practices, for more precise measurement of the outcome.

4.5 Tables and Figures

4.5.1 Table 5a: A summary of the ANC Quality measures.

1. ANC Utilization	Number of ANC Visits		Skilled ANC Provider		Early ANC Initiation
• Adequate ANC utilization	4 or more visits	“and”	YES	“and”	First Trimester
• Intermediate ANC utilization	4 or more visits	“or”	YES	“or”	First Trimester
• Poor ANC utilization	3 or less visits	“and”	NO	“and”	Second/third trimester or never
2. Essential ANC health promotion care practices (“ANC HPCPs”)	Continuous score of the following components: ✓ Blood pressure measurement ✓ Blood test done ✓ Urine test ✓ Nutrition information ✓ Information on Pregnancy complications ✓ Discussion on birth preparedness				

2.5.2 Table 1: Descriptive summary of determinants of diarrhea prevention practices

	KENYA					UGANDA					TANZANIA			
Variables		Appropriate diarrhea Prevention Measures (Yes)					Appropriate diarrhea Prevention Measures (Yes)					Appropriate diarrhea Prevention Measures (Yes)		
	N	n	Row %	Col %		N	n	Row %	Col %		N	n	Row %	Col %
ANC Utilization														
1 Poor	5502	4254	77	39		3214	2602	81	35		4823	3574	74	74
2 Intermediate	5491	4518	82	42		3795	3152	83	83		1392	1093	79	23
3 Adequate	2453	2070	84	19		2187	1816	83	24		165.4	136	82	3
ANC HPCPs: N (mean, SD)	8614(4.5,1.4)					13604(4.3,1.3)					8860(4.2,1.6)			
Health Visit														
0 No	2063	1905	92	24		2743	2076	76	19		1983	1299	66	20
1 Yes	6548	6147	93	76		10861	9077	84	81		6875	5126	75	80
Skilled delivery														
0 No	6950	5349	77	37		3642	2954	81	26		3393	2290	68	36
1 Yes	10988	8927	81	63		9963	8199	82	82		5466	4137	76	64
Insurance														
0 No	7251	6753	93	84		10935	8505	78	99		8196	5894	72	92
1 Yes	1367	1306	96	16		186.1	164.7	88	17		664	532.8	80	8
Water Source														
0 Safe	12405	9821	79	69		11505	9445	82	84		6925	4906	71	76
1 unsafe	5510	4430	80	31		2100	1709	81	16		1935	1521	79	24
Toilet Facility														
1 Flush toilet	2614	2178	83	15		346.6	308.5	89	3		1126	905.5	80	14

2 Pit Latrine	12325	9789	79	68		12148	9862	81	88		6515	4519	69	70
3 No facility/bush/field	3034	2334	77	16		1110	982.9	89	9		1219	1002	82	16
Sex of child														
1 Male	9136	7275	80	51		6783	5556	82	50		4490	3272	73	51
2 Female	8841	7029	80	49		6821	5597	82	50		4369	3154	72	49
Birth size														
1 Small	2193	2047	93	26		3598	3020	84	28		1667	1253	75	20
2 Normal	5062	4747	94	60		7150	5788	81	53		6275	4528	72	71
3 Large	1250	1164	93	15		2626	2164	82	20		844.7	607.8	72	10
Mass Media														
0	10959	8605	79	65		9073	7354	81	68		3577	2535	71	41
1	5780	4640	80	35		4074	3393	83	32		4920	3610	73	59
Maternal Education														
0 No Education	2159	1599	74	11		1499	1228	82	11		1903	1291	68	20
1 Primary	10069	8009	80	56		8331	6751	81	61		5726	4135	72	64
2 Secondary	4258	3483	82	24		2889	2410	83	22		1145	928.2	81	14
3 Higher	1490	1214	82	8		884.9	764.3	86	7		84.17	72.47	86	1
Marital Status														
1 Single Never Married	1254	1001	80	7		567.3	440.4	78	4		479.9	343.5	72	5
2 Married	12049	8942	74	84		11588	9553	82	86		7439	5404	73	84
3 Divorced /Separated	1564	1252	80	9		1449	1160	80	10		940.4	679.4	72	11
Wealth Index														
1 Poorest	4342	3287	76	23		3102	2557	84	23		2195	1476	67	23
2 Poorer	3680	2913	79	20		2866	2313	81	21		1900	1345	71	21

3 Rich	3230	2573	80	18		2611	2134	82	19		1703	1251	74	19
4 Richer	3128	2553	82	18		2411	2003	83	18		1621	1217	75	19
5 Richest	3596	2979	83	21		2614	2146	82	19		1441	1138	79	18
Employment status														
0 No	3092	2871	93	36		2890	2309	80	21		1880	1400	75	22
1 Yes	5516	5178	94	64		10714	8844	83	79		6980	5027	72	78
Place of residence														
1 Urban	6369	5204	82	36		2894	2362	82	21		2345	1787	76	28
2 Rural	11607	9100	78	64		10710	8791	82	79		6515	4640	71	72

4.5.3 Table 2: Bivariate association between the explanatory factors and Diarrhea prevention practices

	Kenya				Uganda				Tanzania			
	Odds ratio	P>t	[95% CI]		Odds Ratio	P>t	[95% CI]		Odds Ratio	P>t	[95% CI]	
ANC Utilization												
1 Poor (Ref)	1.00				1.00				1.00			
2 Intermediate	1.36	0.0000	1.21	1.53	1.15	0.0480	1.00	1.32	1.28	0.0090	1.06	1.53
3 Adequate	1.58	0.0000	1.32	1.89	1.15	0.0830	0.98	1.35	1.62	0.0410	1.02	2.57
Essential ANC HPCPs	1.17	0.0000	1.09	1.25	1.17	0.0000	1.12	1.23	1.16	0.0000	1.11	1.21
Health Visit (Yes)	1.27	0.1110	0.95	1.70	1.64	0.0000	1.40	1.92	1.54	0.0000	1.31	1.81
Skilled delivery (Yes)	1.30	0.0000	1.17	1.44	1.08	0.2110	0.96	1.22	1.50	0.0000	1.31	1.72
Insurance (Yes)	1.58	0.0220	1.07	2.34	1.70	0.0810	0.94	3.10	1.59	0.0010	1.21	2.08
Water Source(safe)	1.08	0.2240	0.95	1.22	0.95	0.6510	0.77	1.17	1.52	0.0000	1.27	1.80
Toilet Facility (type)												
1 Flush toilet	1.29	0.0140	1.05	1.59	1.88	0.0030	1.23	2.86	1.81	0.0000	1.44	2.28
2 Pit Latrine	1.00				1.00				1.00			
3 No facility/bush/field	0.86	0.0290	0.76	0.99	1.79	0.0010	1.28	2.52	2.04	0.0000	1.65	2.52
Gender (Female)	1.01	0.8790	0.92	1.11	0.99	0.8450	0.89	1.10	1.03	0.5580	0.92	1.16
Birth size												
1 Small	0.93	0.6390	0.70	1.25	1.23	0.0030	1.07	1.41	1.17	0.0460	1.00	1.36
2 Normal	1.00				1.00				1.00			
3 Large	0.89	0.4140	0.68	1.17	1.10	0.2040	0.95	1.28	0.99	0.9140	0.82	1.19
Child Age (Continuous)	1.01	0.0000	1.01	1.01	1.01	0.0000	1.00	1.01	0.99	0.0000	0.99	0.99

Mass Media Access (Yes)	1.11	0.0790	0.99	1.25	1.17	0.0250	1.02	1.33	1.13	0.0710	0.99	1.30
Maternal Education												
0 No Education (Ref)	1.00				1.00				1.00			
1 Primary	1.36	0.0000	1.18	1.57	0.95	0.5870	0.78	1.15	1.23	0.0140	1.04	1.46
2 Secondary	1.57	0.0000	1.32	1.88	1.11	0.3930	0.87	1.42	2.03	0.0000	1.59	2.58
3 Higher	1.54	0.0000	1.21	1.95	1.40	0.0470	1.00	1.96	2.94	0.0050	1.39	6.22
Maternal Age	1.02	0.0000	1.01	1.02	1.01	0.0020	1.01	1.02	0.99	0.2620	0.98	1.00
Marital Status												
1 Single Never Married (Ref)	1.00				1.00				1.00			
2 Married	0.98	0.8530	0.80	1.20	1.35	0.0220	1.04	1.75	1.05	0.6980	0.80	1.38
3 Divorced /Separated	1.01	0.9170	0.79	1.30	1.16	0.3660	0.84	1.58	1.03	0.8220	0.77	1.38
Wealth Index												
1 Poorest	0.65	0.0000	0.54	0.78	1.02	0.8530	0.81	1.29	0.55	0.0000	0.43	0.68
2 Poorer	0.79	0.0130	0.65	0.95	0.91	0.4010	0.73	1.13	0.64	0.0000	0.51	0.80
3 Rich	0.81	0.0390	0.66	0.99	0.97	0.8090	0.79	1.21	0.74	0.0110	0.58	0.93
4 Richer	0.92	0.4210	0.75	1.13	1.07	0.5400	0.86	1.33	0.80	0.0490	0.64	1.00
5 Richest (Ref)												
Employment status (Yes)	1.18	0.1550	0.94	1.48	1.19	0.0430	1.01	1.41	0.88	0.1540	0.74	1.05
Place of residence (Urban)	0.81	0.0020	0.72	0.92	1.03	0.7210	0.87	1.23	0.77	0.0020	0.66	0.91

4.5.4 Table 3a: Multilevel regression of Diarrhea prevention practices (Kenya)

	Model 0	Model I		Model 2		Model 3	
		AOR	[95% CI]	AOR	[95% CI]	AOR	[95% CI]
ANC Utilization							
1 Poor (Ref)		1	[1.00,1.00]	1	[1.00,1.00]	1	[1.00,1.00]
2 Intermediate		1.65**	[1.19,2.29]	1.46*	[1.03,2.07]	1.38	[0.34,5.61]
3 Adequate		2.13**	[1.24,3.65]	2.29**	[1.33,3.95]	0.18*	[0.04,0.85]
Essential ANC_HPCP		1.13*	[1.03,1.23]	1.15**	[1.03,1.27]	1.104	[0.99,1.234]
Health Visit (Yes)				1.54*	[1.08,2.21]	1.51*	[1.05,2.17]
Skilled delivery (Yes)				1.12	[0.78,1.61]	1.15	[0.78,1.60]
Insurance (Yes)				1.17	[0.72,1.91]	1.16	[0.71,1.89]
Water Source				0.89	[0.62,1.28]	0.90	[0.63,1.29]
Toilet Facility (type)							
1 Flush toilet				1.17	[0.58,2.38]	1.18	[0.58,2.39]
2 Pit Latrine				1	[1.00,1.00]	1	[1.00,1.00]
3 No facility/bush				1.71	[0.85,3.43]	1.73	[0.86,3.48]
Gender (Female)				1.08	[0.80,1.44]	1.06	[0.79,1.43]
Birth size							
1 Small				0.88	[0.61,1.27]	0.88	[0.61,1.27]
2 Normal				1	[1.00,1.00]	1	[1.00,1.00]
3 Large				0.81	[0.54,1.19]	0.80	[0.54,1.18]
Child Age				1.04***	[1.03,1.05]	1.04***	[1.03,1.05]
Mass Media Access (Yes)				1.31	[0.95,1.81]	1.32	[0.96,1.82]
Maternal Education							
0 No Education				1	[1.00,1.00]	1	[1.00,1.00]
1 Primary				0.49*	[0.23,0.97]	0.49*	[0.25,0.98]
2 Secondary				0.57	[0.27,1.22]	0.57	[0.27,1.22]
3 Higher				0.42	[0.14,1.25]	0.41	[0.14,1.21]

Maternal Age				0.99	[0.97,1.01]	0.99	[0.96,1.01]
Marital Status							
1 Single Never Married				1	[1.00,1.00]	1	[1.00,1.00]
2 Married				0.75	[0.41,1.37]	0.74	[0.40,1.36]
3 Divorced /Separated				0.61	[0.27,1.37]	0.59	[0.26,1.35]
Wealth Index							
1 Poorest				1.22	[0.61,2.45]	1.27	[0.63,2.54]
2 Poorer				0.99	[0.51,1.93]	1.02	[0.53,1.98]
3 Rich				0.91	[0.48,1.72]	0.93	[0.49,1.75]
4 Richer				1.36	[0.74,2.50]	1.41	[0.77,2.58]
5 Richest (Ref)				1	[1.00,1.00]	1	[1.00,1.00]
Employment status (Yes)				1.30	[0.94,1.81]	1.32	[0.95,1.84]
Place of residence (Urban)				1.39	[0.97,2.01]	1.39	[0.97,2.00]
Interaction							
Poor* ANC_HPCP						1	[1.00,1.00]
Intermediate* ANC_HPCP						1.02	[0.76,1.38]
Adequate* ANC_HPCP						1.74***	[1.26,2.40]
Variance	1.48***	2.22***	[1.50,3.29]	1.76**	[1.19,2.61]	1.77**	[1.19,2.64]
ICC (%)	10	19		15		14	
Model fit statistics							
AIC	19702.76	2768.35		2453.22		2433.24	
BIC	19710.62	2795.60		2754.56		2675.58	

Abbreviations: ICC, intra-class correlation, AIC, Akaike's information criterion; BIC, Bayesian information criteria.

Model 0 (Empty model) was fitted without predictor variables.

Model 1 includes ANC quality measures only

Model 2 is ANC quality measures adjusted for other covariates.

Model 3 is the full model testing for interaction.

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.5.5 Table 3b: Multilevel regression of Diarrhea prevention practices (Uganda)

	Model 0	Model I		Model 2	
		AOR	[95% CI]	AOR	[95% CI]
ANC Utilization					
1 Poor (Ref)		1	[1.00,1.00]	1	[1.00,1.00]
2 Intermediate		1.05	[0.90,1.22]	1.01	[0.87,1.18]
3 Adequate		1.01	[0.85,1.20]	0.99	[0.83,1.19]
Essential ANC_HPCP		1.17***	[1.11,1.23]	1.14***	[1.08,1.21]
Health Visit (Yes)				1.42***	[1.18,1.70]
Skilled delivery (Yes)				0.83*	[0.70,0.98]
Insurance (Yes)				0.87	[0.44,1.73]
Water Source (safe)				1.05	[0.81,1.35]
Toilet Facility (type)					
1 Flush toilet				1.91*	[1.07,3.41]
2 Pit Latrine				1	[1.00,1.00]
3 No facility/bush/field				1.73*	[1.05,2.86]
Gender (Female)				1.03	[0.90,1.18]
Birth size					
1 Small				1.20*	[1.02,1.42]
2 Normal				1	[1.00,1.00]
3 Large				1.024	[0.85,1.24]
Child Age				1.02***	[1.02,1.03]
Mass Media Access (Yes)				1.13	[0.96,1.33]
Maternal Education					
0 No Education				1	[1.00,1.00]
1 Primary				1.26	[1.00,1.59]
2 Secondary				1.55**	[1.17,2.05]
3 Higher				1.79**	[1.17,2.74]

Maternal Age				1.01	[1.00,1.07]
Marital Status					
1 Single Never Married				1	[1.00,1.00]
2 Married				1.21	[0.91,1.60]
3 Divorced /Separated				1.03	[0.74,1.44]
Wealth Index					
1 Poorest				1.15	[0.83,1.60]
2 Poorer				1.07	[0.79,1.44]
3 Rich				1.14	[0.88,1.49]
4 Richer				1.27	[0.97,1.66]
5 Richest (Ref)				1	[1.00,1.00]
Employment status (Yes)				1.06	[0.88,1.28]
Place of residence (Urban)				1.18	[0.92,1.52]
/					
Variance	1.75***	1.49***	[1.34,1.66]	1.32***	[1.20,1.46]
ICC (%)	15	11		7	
Model fit Statistics					
<i>AIC</i>	12953.51	8593.43		6427.71	
<i>BIC</i>	12961.04	8621.98		6662.39	

Abbreviations: ICC, intra-class correlation, AIC, Akaike's information criterion; BIC, Bayesian information criteria.

Model 0 (Empty model) was fitted without predictor variables.

Model 1 includes ANC quality measures only

Model 2 is ANC quality measures adjusted for other covariates.

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.5.6 Table 3c: Multilevel regression of Diarrhea prevention practices (Tanzania)

	Model 0	Model I		Model 2	
		AOR	[95% CI]	AOR	[95% CI]
ANC Utilization					
1 Poor (Ref)		1	[1.00,1.00]	1	[1.00,1.00]
2 Intermediate		1.15	[0.95,1.40]	1.13	[0.92,1.38]
3 Adequate		1.51	[0.93,2.45]	1.75*	[1.06,2.88]
Essential ANC_HPCP		1.15***	[1.10,1.21]	1.12***	[1.07,1.18]
Health Visit (Yes)				1.45***	[1.20,1.75]
Skilled delivery (Yes)				1.22*	[1.02,1.46]
Insurance (Yes)				1.35	[1.00,1.88]
Water Source(safe)				1.11	[0.87,1.41]
Toilet Facility (type)					
1 Flush toilet				1.33	[0.93,1.89]
2 Pit Latrine				1	[1.00,1.00]
3 No facility/bush/field				2.17***	[1.65,2.84]
Gender (Female)				1.04	[0.90,1.21]
Birth size					
1 Small				1.10	[0.91,1.32]
2 Normal				1	[1.00,1.00]
3 Large				1.06	[0.84,1.35]
Child Age (Continuous)				1.00	[0.99,1.00]
Mass Media Access (Yes)				1.02	[0.88,1.19]
Maternal Education					
0 No Education				1	[1.00,1.00]
1 Primary				1.14	[0.93,1.40]
2 Secondary				1.51*	[1.10,2.08]
3 Higher				1.85	[0.52,6.63]
Maternal Age				1.00	[0.99,1.01]

Marital Status					
1 Single Never Married				1	[1.00,1.00]
2 Married				1.51**	[1.10,2.06]
3 Divorced /Separated				1.49*	[1.06,2.09]
Wealth Index					
1 Poorest				1.10	[0.73,1.65]
2 Poorer				1.44	[0.95,2.18]
3 Rich				1.47	[0.98,2.20]
4 Richer				1.41	[0.99,2.01]
5 Richest (Ref)				1	[1.00,1.00]
Employment status (Yes)				1.01	[0.81,1.22]
Place of residence (Urban)				1.08	[0.83,1.41]
Variance	1.53***	1.34***	[1.19,1.52]	1.26***	[1.13,1.42]
ICC (%)	12	8		7	
Model fit Statistics					
<i>AIC</i>	10462.52	6971.77		6427.71	
<i>BIC</i>	10469.62	6998.79		6662.39	

Abbreviations: ICC, intra-class correlation, AIC, Akaike's information criterion; BIC, Bayesian information criteria.

Model 0 (Empty model) was fitted without predictor variables.

Model 1 includes ANC quality measures only

Model 2 is ANC quality measures adjusted for other covariates.

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.5.7 Table 3d: Multilevel regression of Diarrhea prevention practices (Pooled data)

	Model 0	Model 1		Model 2		Model 3	
		AOR	[95% CI]	AOR	[95% CI]	AOR	[95% CI]
ANC Utilization							
1 Poor (Ref)		1	[1.00,1.00]	1	[1.00,1.00]	1	[1.00,1.00]
2 Intermediate		1.31***	[1.18,1.46]	1.10	[0.98,1.24]	1.43*	[1.03,1.97]
3 Adequate		1.41***	[1.23,1.62]	1.16	[1.00,1.35]	2.28**	[1.40,3.73]
Essential ANC_HPCP		1.16***	[1.13,1.20]	1.14***	[1.10,1.19]	1.15***	[1.11,1.19]
Health Visit (Yes)				1.47***	[1.31,1.66]	1.47***	[1.31,1.66]
Skilled delivery (Yes)				1.02	[0.91,1.14]	1.02	[0.91,1.14]
Insurance (Yes)				1.24	[0.96,1.60]	1.22	[0.94,1.58]
Water Source(safe)				1.07	[0.92,1.25]	1.07	[0.92,1.25]
Toilet Facility (type)							
1 Flush toilet				1.49**	[1.15,1.93]	1.47**	[1.14,1.91]
2 Pit Latrine				1	[1.00,1.00]	1	[1.00,1.00]
3 No facility/bush/field				2.06***	[1.63,2.60]	2.07***	[1.64,2.62]
Gender (Female)				1.05	[0.96,1.15]	1.05	[0.96,1.16]
Birth size							
1 Small				1.14*	[1.02,1.28]	1.14*	[1.02,1.28]
2 Normal				1	[1.00,1.00]	1	[1.00,1.00]
3 Large				1.01	[0.88,1.16]	1.01	[0.88,1.16]
Child Age (Continuous)				1.01***	[1.01,1.02]	1.01***	[1.01,1.02]
Mass Media Access (Yes)				1.10	[1.00,1.22]	1.10	[1.00,1.23]
Maternal Education							
0 No Education				1	[1.00,1.00]	1	[1.00,1.00]
1 Primary				1.12	[0.97,1.30]	1.12	[0.96,1.29]
2 Secondary				1.38***	[1.14,1.67]	1.38***	[1.14,1.67]
3 Higher				1.43*	[1.01,2.01]	1.43*	[1.01,2.02]
Maternal Age				1.01	[0.99,1.01]	1.01	[0.99,1.01]
Marital Status							
1 Single Never Married				1	[1.00,1.00]	1	[1.00,1.00]
2 Married				1.20	[0.99,1.45]	1.20	[0.99,1.45]

3 Divorced /Separated				1.08	[0.86,1.35]	1.08	[0.86,1.35]
Wealth Index							
1 Poorest				1.07	[0.85,1.34]	1.08	[0.86,1.35]
2 Poorer				1.17	[0.94,1.45]	1.17	[0.94,1.46]
3 Rich				1.20	[0.98,1.48]	1.21	[0.98,1.48]
4 Richer				1.30**	[1.07,1.59]	1.31**	[1.08,1.60]
5 Richest (Ref)				1	[1.00,1.00]	1	[1.00,1.00]
Employment status (Yes)				1.05	[0.93,1.18]	1.05	[0.93,1.19]
Place of residence (Urban)				1.19*	[1.02,1.40]	1.20*	[1.02,1.41]
Country							
Kenya				1	[1.00,1.00]	1	[1.00,1.00]
Uganda				0.28***	[0.23,0.33]	0.35***	[0.28,0.45]
Tanzania				0.18***	[0.15,0.22]	0.22***	[0.17,0.27]
Interaction							
Poor ANC*Kenya						1	[1,1]
Poor ANC*Uganda						1	[1,1]
Poor ANC*Tanzania						1	[1,1]
Intermediate*Kenya						1	[1,1]
Intermediate*Uganda						0.70	[0.494,1.00]
Intermediate*Tanzania						0.79	[0.539,1.14]
Adequate*Kenya						1	[1,1]
Adequate*Uganda						0.43**	[0.26,0.72]
Adequate*Tanzania						0.76	[0.38,1.53]
Variance	1.65***	1.87***	[1.68,2.07]	1.40***	[1.29,1.52]	1.40***	[1.29,1.52]
ICC (%)	13	16		10		9	
Model fit statistics							
AIC	43375.82	19299.58		17544.31		17343.17	
BIC	43384.47	19331.64		17090.74		17080.60	

Abbreviations: ICC, intra-class correlation, AIC, Akaike's information criterion; BIC, Bayesian information criteria.

Model 0 (Empty model) was fitted without predictor variables.

Model 1 includes ANC quality measures only

Model 2 is ANC quality measures adjusted for other covariates.

Model 3 is the full model testing for interaction.

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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CHAPTER FIVE: MANUSCRIPT 3 OF 3

Title: Association of ANC Quality with Breastfeeding in three East African countries: A multilevel Analysis.

Abstract

Introduction

Among the WHO targets is to increase the rate of exclusive breastfeeding to at least 50% between 2012-2025. However, the rates of breastfeeding remain lower than expected in many low- and middle-income countries, including SSA. While the information about breastfeeding and other support services can be shared during ANC visits, it is not clear to what extent it can be impactful through actual breastfeeding behavior after birth. This study therefore examines the influence of ANC quality on 3 separate breastfeeding outcomes, namely, early initiation of breastfeeding (EIBF), exclusive breastfeeding (EBF), and continued breastfeeding (CBF).

Methods

The study applies pooled data from the latest demographic and health surveys for Kenya, Uganda, and Tanzania, including $n=17106$ for EIBF outcome, $n=11326$ for the EBF outcome and $n=12934$ for the CBF outcome. The study population was women aged 15-49 years who were currently breastfeeding during the survey and the baby was alive and present in the household the night before the survey. The main independent variable, ANC quality, was assessed using two measures a) ANC utilization, and b) essential ANC health promotion care practices (ANC HPCPs). The analysis included descriptive statistics, bivariate analysis, and binary logistic regression, while accounting for the clustering nature of the survey data. We also tested for interaction effects between the main predictors as well as between the main predictor(s) and other covariates.

Results

Across all breastfeeding outcomes, majority of women had poor ANC utilization while the least had adequate ANC utilization. Adequate ANC utilization was significantly associated with 18% greater odds of EIBF compared poor ANC utilization [AOR:1.19; 95% CI (1.02,1.39)]. Women with Intermediate level of ANC utilization had significantly lower (crude) odds of EBF compared to those with poor ANC utilization. This effect was attenuated in the fully adjusted EBF model. Compared to women with poor ANC utilization, women with intermediate [AOR: 1.74; 95% CI (1.07,2.85)] and adequate [AOR: 2.39; 95% CI (1.18,4.81)] ANC utilization had 74% and more than twice greater odds of CBF past 6 months. Control factors significantly associated with higher odds of all breastfeeding outcomes included delivery in a skilled care setting, increasing maternal age at first birth, and currently married. In addition, increasing child age, low birth size, and currently working were associated with lower odds of both EBF and CBF. Birth by c-section was associated with lower odds of EIBF.

Conclusion

This study demonstrates that optimal levels of ANC utilization increase the likelihood of recommended breastfeeding practices as shown by the increased likelihood of breastfeeding practices among the women with either intermediate or adequate ANC utilization levels as compared to the women with poor ANC utilization. Our findings are critical in policy formulations as they provide a justification of incorporating targeted breastfeeding education in the ANC program, as well as initiating strategies to scale up the level of ANC utilization among pregnant women. Through the estimation of other covariates adjusted for in the models, the study also highlights how the triad between personal as well as social and health access factors and behavior are interconnected to predict individuals' informed decisions about breastfeeding behavior.

5.1 INTRODUCTION

The growth period from the inception of pregnancy through to the child's second birthday, approximately 1000 days, is usually referred to as the "critical window" of proper nutrition and breastmilk is the best food during this critical time(1, 2). It is currently recommended that starting within one hour of birth, infants should be exclusively breastfed for the first six months of life(3-5), and that breastfeeding should continue up to 2 years of age or beyond(5, 6).

Exclusive breastfeeding (EBF), involves feeding children (0-6 months) on breast milk without the supplementation of any other food or drink, not even water except for oral rehydration salt (ORS), vitamins, minerals, and medications(7). From the age of 6 months, it's recommended that children be introduced to safe and balanced complimentary feeding while continuing with breastfeeding for up to 2 years or beyond(8, 9). Breast milk aids with the stimulation of the infant immune system, maintenance of gastrointestinal pH balance and microbial changes, as well as stimulation of the epigenetic programming of the infant(10). Indeed nutrition experts analogize breastfeeding to babies' first immunization and the most effective and inexpensive lifesaver against childhood communicable diseases and other infections(10-12). It is approximated that adequate breastfeeding, alone, can save up to 1.5 million babies globally from immature deaths(13).

Among the WHO targets is to increase the rate of exclusive breastfeeding to at least 50% between 2012-2025(9). Adherence to these guidelines varies globally, with only 37% of infants in low- and middle-income countries (LMICs) being exclusively breastfed for the first 6 months of their life, and about 58% older than 6 months benefiting from continued breastfeeding(1). Previous research has also shown that children who are adequately breastfed become less

susceptible to infectious diseases such as diarrhea and pneumonia and their survival rate is 14 times higher compared to those who are not breastfed(14). In addition, early initiation of breastfeeding within the 1st hour as well as optimal breastfeeding have the potential to prevent 20% of neonatal deaths, and 12% of under 5 deaths, respectively, in LMICs (1, 9). Other benefits of breastfeeding cited in previous studies include reducing the risk of infectious diseases e.g., diarrhea(15), and under 5 mortality(15, 16), adequate brain development, hence higher intelligence for the child(5, 13), as well as improvement in family planning and child spacing(5). Inadequate breastfeeding has potential long-term effects in the growth trajectory of the child including poor school performance, impaired intellectual development, and poor socioeconomic outcomes later in life(17, 18). However, despite the undisputed benefits of breastfeeding, and the associated risks of early weaning, the rates of breastfeeding remain lower than expected in many low and middle income countries (LMICs)(2). While high income countries have on average shorter durations of breastfeeding as compared to low-and middle-income countries (LMICs), the associated risks are more pronounced in the LMICs(2).

The literature highlights various pathways through which demographic, social and health system factors affect women's breastfeeding behavior. First time mothers constitute a greater percentage of all pregnancies in many countries of SSA(19-21), and they tend to be young and psychologically unprepared for parenthood(19). Enthusiasm about breastfeeding is also associated with mother's perception about the impact of the practice on her own physical appearance(22-24). This behavior has also been referred to as breastfeeding self-efficacy (22). Nankumbi et al (23) study in Uganda noted physical appearance as important predictor of breastfeeding with about 30% of mothers believing that exclusive breastfeeding contributed to thinner body and likeliness of sagging breasts(23). Factors such as maternal age, economic

status, method of delivery, health of the baby, family and hospital support have been found to be crucial in determining the level of self-awareness associated with breastfeeding(23, 25). Being an employed mother has also been found as a barrier to both exclusive and optimal duration of breastfeeding for 24 months(26) due to divided time between work and childcare. Denial, or short maternity leave allowance may not fit well with the recommended six months of exclusive breastfeeding(26). The breastfeeding experience has also been tied to marital relationships and partner support(16). Verbal persuasions from significant others, family members as well as health care professionals have been found to encourage mothers to continue breastfeeding their infants despite the many social challenges(26, 27).

The social organization in many African communities explains why women increasingly receive advice on breastfeeding information from family members and neighbors(4). Grandmothers and other elders in the family play an influential role in supporting the young women (their daughters and daughters-in-law) during pregnancy, childbirth, and throughout the care of the newborn(28). However, these elders sometimes endorse harmful practices which might adversely affect the decision of the mother on breastfeeding and other health promotion practices(29). Cultural factors can often override the knowledge received from health professionals, especially in regions where the majority of mothers opt for home delivery assisted by grandmothers or traditional birth attendants. For example, studies in Nigeria(15), Tanzania(16) and Uganda(30) highlight the common belief among many communities that breastmilk is not adequate to quench baby's thirst and therefore water should be supplemented to not only quench thirst but also dilute the colostrum. This belief is countered by the scientific evidence of breast milk being is easily digestible complete food containing all the required

nutrients for the first six months' life of the infants and completely satisfies an infant's nutritional and water needs(30, 31).

There is evidence of a gap in information sharing between mothers and health care providers(4). This is especially common in the rural and urban low-income settlements(31). Factors such as the framing of the health information(32), the literacy level of the mother or the capacity to understand the information shared(33, 34) or the confidence to engage the providers and ask the right questions(23, 25) are key determinants of the nature and quality of provider-client interaction. It is important to note that mothers may not feel comfortable raising any non-health related concerns with healthcare workers(35). Problems with breastfeeding may be assumed as of less priority to share with the mother during their ANC visit; with the main focus being the mother's health and the unborn baby, while breastfeeding can be shared in the postnatal period(36). Health care providers cite several issues affecting breastfeeding. Firstly, are the knowledge gaps among mothers who never seek care during their pregnancy(37, 38), as well as inaccurate information provided by non-skilled providers such as the traditional birth attendants(38). Problem with position and attaching the baby to the breast has also been identified as a common issue(22), hence affecting the feeding habits of the baby. Other issues include poor nutrition of the mother which affects the quantity of the milk(39).

Previous studies have found substantial heterogeneity between and within countries on the national prevalence estimates of breastfeeding in the African region(2, 40). Even though the disparities within countries are common, they are also often masked by national estimates or less methodical subnational comparisons(1).

As a result of the continued malnutrition risk, the global agencies, including WHO and UNICEF, recommend the incorporation of nutrition and breastfeeding counselling messages

during ANC visits as this period marks most women's initial contact with the healthcare system in many parts of the developing world(7, 39). Early health information sharing and sensitization about breastfeeding can therefore be useful towards women's internalization of benefits to both the mother and the baby through immediate initiation of breastfeeding after birth, exclusive breastfeeding for the first six months, and continuing breastfeeding towards 2 years and beyond(41). Evidence-based guides also recommend that mother-support programs during ANC visits and maternal and child health check-ups should incorporate breastfeeding support. (7, 13). While the information about breastfeeding and other support services can be shared during ANC visits, it is not clear to what extent it can be impactful through actual breastfeeding behavior after birth. There are also fewer studies looking at the influence of ANC beyond the pregnancy period. To further explore this association and narrow the gap in the literature, this study examines the extent to which ANC quality influences early initiation of breastfeeding, exclusive breastfeeding, and continued breastfeeding up to 2 years or beyond. As such, this study examined the following research hypotheses based on the outcomes,

Early Initiation of Breastfeeding (EIBF)

1. *The odds of early initiation of breastfeeding (EIBF) varied by **level of ANC utilization** such that women with intermediate and adequate ANC utilization had significantly greater odds of EIBF as compared to those who had poor ANC utilization.*
2. *Women who had higher scores on the **essential ANC health promotion care practices** were more likely to initiate breastfeeding early, as compared to women with lower scores.*

Exclusive Breastfeeding (EBF)

3. *The odds of exclusive breastfeeding (EBF) varied by **level of ANC utilization** such that women with intermediate and adequate ANC utilization had significantly greater odds of EBF as compared to those who had poor ANC utilization.*
4. *Women who had higher scores on the **essential ANC health promotion care practices** were more likely to exclusively breastfeed their children, as compared to women with lower scores on essential ANC health promotion care practices.*

Continued Breastfeeding (CBF)

5. *The odds of continued breastfeeding (CBF) beyond six months varied by **level of ANC utilization** such that women with intermediate and adequate ANC utilization had significantly greater odds of CBF as compared to the women who had poor ANC utilization.*
6. *Women who had higher scores on the **essential ANC health promotion care practices** were more likely to continue breastfeeding beyond six months, as compared to women with lower scores on essential ANC health promotion care practices.*

The study also has a secondary objective of examining other sociodemographic and health related factors associated with breastfeeding practices.

5.2 METHODS

Data Source

Data for this study was obtained from the Demographic and Health Surveys (DHS)(40) collected in Kenya (2014), Uganda (2016) and Tanzania (2015-2016). The target population for DHS may vary from country to country or from survey to another, but it is defined as all women of reproductive age (15-49 years old) and their young children under five years of age living in ordinary residential households, as well as men (most surveys) aged 15-59 years(40). Details about the two-stage cluster sampling design and the surveys are extensively reported elsewhere(42). We obtained data for both women aged (15-49 years) as well as youngest children under 2 years who were living with their mother at the time of the survey. The pooled analysis sample was obtained by appending data for the 3 countries. The pooled data was weighted based on the countries latest census to ensure equal representation and prevent overrepresentation of one country in the pooled sample.

Data Access and Ethical approval

Permission to use the DHS data in this study was obtained from the DHS program. All the data was de-identified before publishing for use on the DHS website. The DHS program follows strict IRB and ethical protocols while planning and collecting the data. Therefore, no further protocols are required from the final users of the de-identified data, except the written request to gain access to the data storage website.

Study Measures

Outcome Variables

The breastfeeding status was measured using three outcomes, namely a) ***Early initiation of breastfeeding (EBF)*** within the first hour, b) ***Exclusive breastfeeding (EBF)*** from birth to 6 months, and c) ***Continued breastfeeding (CBF)*** past six months up to 2 years. The early initiation of breastfeeding (EIBF) was a binary measure of whether the child was breastfed immediately (within 1 hour) after birth (coded 1) or afterwards (coded 0). Exclusive breastfeeding (EBF) outcome was categorized as 1 if a mother did not feed the baby anything else apart from breast milk, except syrups and medicines, during the first 6 months after birth and 0 otherwise. According to the definition by the World Health Organization (WHO), EBF entails feeding the infant only breast milk, excluding any other liquids or solids, not even water, except for oral rehydration solution, or drops/syrups of vitamins, minerals, or medicines(43). The variable was measured using a 24-hour recall among mothers with infants under 6 months of age. The third outcome involved continued breastfeeding (CBF) past 6 months coded as zero (0) for those who stopped breastfeeding before six months and 1 to represent continued breastfeeding for children aged 6-24 months. These questions targeted mothers who were currently

breastfeeding during the survey and the baby was alive and was present in the household the night before the survey.

Main independent Variable

The main independent variable, ANC quality, was assessed using two measures a) ANC utilization, and b) essential ANC health promotion care practices (ANC HPCPs).

a. ANC Utilization

ANC utilization as a measure of quality was operationalized as a composite measure consisting of 1) *timely initiation of ANC*, 2) *type of provider for ANC*, and 3) *number of ANC visits*. The WHO recommends that pregnant women should initiate contact with healthcare provider at the earliest time possible in their pregnancy-during their first trimester, seek service from a skilled healthcare provider in a government or registered/authorized private facility, and make at least 8 contacts with a healthcare provider during their pregnancy period. However, during the period of data collection for the 3 countries, the WHO recommended a minimum of 4 ANC visits as the optimal effective visits for pregnancy monitoring; hence applied in this study to assess utilization level. In this study, the ANC variable was categorized into either *poor*, *intermediate*, or *adequate* ANC utilization based on the women's experience in their last pregnancy. **Poor ANC utilization** meant the woman did not achieve either of the 3 measures. i.e., did not initiate ANC during their first trimester, did not seek services from a skilled provider, and attended less than 4 visits during their entire pregnancy period. **Intermediate ANC utilization** was indicative of achieving either one or a combination of two of the measures, while **adequate ANC utilization** signified that the woman attained all the 3 measures i.e., initiated ANC during their first trimester, saw a skilled provider, and attended at least 4 visits. For the

analysis, Poor ANC utilization is coded as 1, Intermediate ANC utilization is coded as 2, and Adequate ANC utilization was coded 3.

b. Essential ANC health promotion care practices (ANC HPCPs)

The essential components of ANC involve the content of information shared, or service administered through the interaction with healthcare provider during the ANC visit. This measure was a continuous score of whether the essential ANC HPCPs were covered during ANC visit, as stipulated in the WHO guidelines (ref). The six essential components were blood pressure measurement, blood test, urine test, whether the woman received information on nutrition, whether she was informed of possible complications during pregnancy, and finally whether she was given advice on a birth preparedness plan. Each of these questions had a binary response of (Yes=1, and No=0). A continuous variable was created to measure the individual attainment of these measures with a scoring of 0 to 6. The ANC quality measures are summarized in **TABLE A**.

Other explanatory variables

We grouped the other explanatory variables into two main categories namely, sociodemographic factors and health related factors that are likely to affect breastfeeding. The maternal sociodemographic factors included mothers' age at first birth (continuous measure of age in years), highest level of maternal education, grouped into 0=no education, 1=primary education, 2=secondary education, and 3=higher, employment status (0=Not employed, 1=employed), marital status (1=Single/never married), 2=married, and 3=divorced/separated/widowed). The child sociodemographic factors included birth size (1=small, 2=average, 3=large), child age (in months), and gender(1=male,2=female). There were

also household level sociodemographic factors including measurement of wealth index based on 5 wealth quintiles (1=poorest, 2=poor, 3=rich, 4=richer, and 5=richest), and mass media access to examine the level of access/exposure to information (TV; 0=No, 1=Yes, Radio; 0=No, 1=Yes, Newspaper; 0=No, 1=Yes).

Health related factors measured whether mother wanted the last pregnancy (0=No, 1=Yes), delivered in a skilled care setting (0=No, 1=Yes), gave birth through c-section (0=No, 1=Yes), baby was placed on a skin-to-skin contact after birth (0=No, 1=Yes), whether mother went for postnatal checkup within six months after birth (0=No, 1=Yes), mother was currently pregnant as at the time of the survey (0=No, 1=Yes), and finally whether mother used tobacco products (0=No, 1=Yes). Given that we only used the pooled data for the analysis, we included a contextual measure of country of residence (1=Kenya, 2=Uganda, 3=Uganda), to compare any significant differences on the outcome based on the country of residence. The details of the variables, questions and response categories used in the analysis are summarized in Appendix 1.

Data analysis

Prior to the commencement of the analysis, data cleaning, labelling, and recoding was done for the variables using SAS statistical software; SAS 9.4. Categorizing variables was done using information from the country reports for easier reference, representativeness, and accuracy of the categorization. The sociodemographic characteristics and general information were presented by frequency and percentage for categorical variables as well as mean and standard deviation was used to report continuous explanatory variables. In addition, we performed cross tabulation to explore the proportion of different categories of each of the predictor variables against each of the three binary breastfeeding outcomes.

Bivariate analysis was performed to determine the unadjusted associations (odds ratios) of the predictors and the outcome. Variables deemed to be significant (p-value 0.05) or influential based on the review of the literature, were carried over for the multivariate multilevel regression analysis. STATA 16 software was used in the bivariate and regression analyses.

Model specification in the regression analysis

The surveys were collected by stratified cluster sampling resulting in hierarchical data where respondents were nested within clusters. Respondents within the same cluster are likely to be more similar to each other. Running an ordinary logistic regression would therefore ignore the independence between clusters by assuming an equal population. This leads to having small standard errors. For this reason, we applied binary logistic multilevel analysis techniques to account for the clustering nature of the data as well as the binary response of each of the breastfeeding outcome measures. We also tested for the interaction effect between the main predictors and other variables of interest.

Four models were considered in the multilevel multivariate analysis to determine the model that best fits the data; **Model 0** (empty model) was measured without explanatory variables to evaluate the cluster level difference in each of the breastfeeding outcomes i.e., the total variance in early initiation, exclusive or continued breastfeeding between clusters. **Model 1** included only the ANC Quality measures i.e., level of ANC utilization and number of essential ANC HPCPs. **Model 2** adjusted for sociodemographic and health related factors and country of residence. We also tested for interaction within the main predictors and between the main predictors and other covariates. The rationale for testing for interaction was because the number

of ANC visits may influence or increase opportunities more HPCPs among pregnant women. Moreover, we examined for other potential interactions because the overall quality of ANC may vary by different levels of some of the other explanatory factors such as maternal education, residence, among others. In the presence of interaction, **Model 3**, therefore included the fully adjusted interaction model.

The models are based on the following equations:

a) Early initiation of breastfeeding (EIBF)

This outcome was binary coded as whether the mother breastfed the child within 1 hour after birth (coded as 1), or later (coded as 0). The multilevel regression models were based on the following equation.

$$\text{Logit}[P(Y_{ij} = 1)] = \gamma_{00} + \gamma_{10}X_p + \gamma_{01}Z_q + \cup_{0j}$$

In the equation, subscripts **i** and **j** represent for the individual **i** from group/cluster **j**. **Y_{ij}** denotes the dichotomous outcome variable for level-one-unit **i** in level 2-unit (cluster) **j**. That is, timely initiation of breastfeeding for **ith** woman in the **jth** group. **γ_{00}** is the grand average intercept; that is the log odds of EIBF in the absence of explanatory variables (This is what is measured by Model 0). The terms **X_p** and **Z_q** are individual (level 1) and cluster (level 2) explanatory variables, respectively. **γ_{10}** is the regression coefficient of the individual level variable **X_p** (fixed effects). **γ_{01}** is the regression coefficient of the community/cluster level variables **Z_q** (random effects). Finally, the term **$\cup_{0j}$** is the community/cluster level residuals.

b) Exclusive breastfeeding

This outcome was binary coded with a code of 1 indicating that the mother exclusively breastfed the child i.e., fed the child (0-6 months) on breast milk without the supplementation of any other food or drink, not even water except for oral rehydration salt (ORS), vitamins, minerals, and medications. within 1 hour after birth (coded as 1), or later (coded as 0). A code of 0 implied that the mother did not exclusively breastfeed. The binary multilevel logistic regression models were based on the following equation.

$$\text{Logit}[P(Y_{ij} = 1)] = \gamma_{00} + \gamma_{10}X_p + \gamma_{01}Z_q + U_{0j}$$

In the equation, subscripts ***i*** and ***j*** represent for the individual *i* from group/cluster *j*. ***Y_{ij}*** denotes the dichotomous outcome variable for level-one-unit ***i*** in level 2-unit (cluster) ***j***. That is, exclusive breastfeeding practice of ***ith*** woman in the ***jth*** group. ***γ₀₀*** is the grand average intercept; that is the log odds of EBF in the absence of explanatory variables (This is what Is measured by Model 0). The terms ***X_p*** and ***Z_q*** are individual (level 1) and cluster (level 2) explanatory variables, respectively. ***γ₁₀*** is the regression coefficient of the individual level variable ***X_p*** (fixed effects). ***γ₀₁*** is the regression coefficient of the community/cluster level variables ***Z_q*** (random effects). Finally, the term ***U_{0j}*** is the community/cluster level residuals.

c) Continued breastfeeding

Past the age of months, breastfeeding is highly recommended, with supplemental feeding, up to 2 years or beyond. The outcome of continued breastfeeding was binary coded to measure whether mother continued to breastfeed past 6 months (coded as 1) or not (coded as 0). The multilevel regression models were based on the following equation.

$$\text{Logit}[P(Y_{ij} = 1)] = \gamma_{00} + \gamma_{10}X_p + \gamma_{01}Z_q + U_{0j}$$

In the equation, subscripts **i** and **j** represent for the individual **i** from group/cluster **j**. **Y_{ij}** denotes the dichotomous outcome variable for level-one-unit **i** in level 2-unit (cluster) **j**. That is, CBF practice of **ith** woman in the **jth** group. **γ₀₀** is the grand average intercept; that is the log odds of continued breastfeeding in the absence of explanatory variables (This is what Is measured by Model 0). The terms **X_p** and **Z_q** are individual (level 1) and cluster (level 2) explanatory variables, respectively. **γ₁₀** is the regression coefficient of the individual level variable **X_p** (fixed effects). **γ₀₁** is the regression coefficient of the community/cluster level variables **Z_q** (random effects). Finally, the term **U_{0j}** is the community/cluster level residuals.

Measures of Association & Variation

The results of fixed effects were presented as adjusted odds ratios (AORs) with 95% percentage confidence intervals (CIs). The statistical significance was set at a *P* value ≤ 0.05 (25,26) The measures of variation were reported using Intra-cluster correlation (ICC). The ICC shows the variation in each of the breastfeeding outcome due to community/cluster differences. The higher the ICC (higher than 5%) the more relevant is the cluster differences in explaining the individual variation in each of the breastfeeding outcomes.

The ICC was calculated as follows: $ICC = \frac{\delta^2 u}{\delta^2 u + \delta^2 e}$, where **δ²u** =between group variation, and **δ²e**= within group variation. The STATA software command “estat icc” was used to generate the ICC values for each model. While this analysis focused on the fixed effects (only individual variables), the ICC values for the empty model were important because they helped in determining whether there was any difference in the variation between clusters which would then justify for a multilevel model as opposed to an ordinary logistic regression. Accordingly, about

24%, 5% and 25% of the total variation in the odds of EIBF, EBF and CBF, respectively, was due to cluster differences. The ICC values and significant community variance ($P < 0.05$) therefore justify the application of the multilevel model in our analysis.

Finally, model comparison for goodness of fit was done using Bayesian information criteria (BIC) and Akaike's information criterion (AIC). The model with minimum BIC and AIC value is considered as a better fit. The subsequent decrease in the values of AIC on each model indicates that model II, *AIC (16426.2)* for EIBF, model III, *AIC (5424.8)* for EBF, and model III, *AIC (6073.1)* for CBF, were chosen as the models that explain the best fit of the data.

5.3 RESULTS

Overall, a total of 17,106 women in the pooled data nested within 185 clusters were included in the sample for the EIBF outcome; 11,326 women nested within 185 clusters in the sample for EBF outcome; and 12,934 women nested within 185 cluster included in the sample for the CBF outcome.

Population Characteristics

Table 1 compares the distribution of ANC quality measures and other population characteristics based on the 3 different breastfeeding outcomes. Across all breastfeeding outcomes, majority of women had poor ANC utilization while the least had adequate ANC utilization. More than two thirds (67%) of women who had initiated breastfeeding early had skin-to-skin contact with their baby after birth; similar to 60% among those who exclusive breastfed and 58% among those who continued breastfeeding beyond 6 months. Also, considering all breastfeeding outcomes, less than 10% of the women had C-section in their last birth, used tobacco products, or were currently pregnant.

Close to 60% of women, across all outcomes, had intended to get pregnant in their last birth, over 70% were currently employed, and over 60% had no postnatal check-up within six months after delivery. Children were equally represented based on gender, and the majority were of average size at birth. A substantial proportion of the women had primary education, were married, had no access to TV or magazine, and lived in the rural areas. Country representation in the sample varied by outcome. However, women from Uganda had the greatest representation among those who initiated breastfeeding early (47%), exclusively breastfed (48%) and continued breastfeeding beyond six months (41%).

Bivariate analysis

Table 2 summarizes the pooled bivariate analysis (crude/unadjusted odds ratios) between ANC quality measures, and other covariates, against each of the breastfeeding outcomes.

a) Determinants of Early initiation of breastfeeding (EIBF)

Although not statistically significant, the odds of EIBF were greater among women with intermediate and adequate ANC utilization compared to those with poor ANC utilization. The odds of timely initiation also increased by 5% with every unit increase in essential ANC component [COR: 1.05; 95% CI (1.01,1.09)]. Among the maternal sociodemographic factors, secondary and higher levels in maternal education and being currently employed were associated with lower odds of timely-initiating breastfeeding. Moreover, being married was associated with significantly higher odds of timely-initiating breastfeeding. Among the health-related factors, being a current smoker, giving birth by c-section, and having no post-natal check-up were significantly associated with lower unadjusted odds of timely-initiating breastfeeding. On the other hand, women who wanted their pregnancy [COR:1.18; 95% CI (1.07,1.30)] and gave birth

in a skilled-care facility [COR:1.43; 95% CI (1.30,1.58)] had 18% and 43%, respectively, higher unadjusted odds of initiating breastfeeding. At the contextual level, living in urban areas [COR:1.18; 95% CI (1.04,1.33)] was associated with 18% greater odds of timely breastfeeding. Moreover, women living in both Uganda and Tanzania had greater odds of timely initiating breastfeeding compared to women living in Kenya.

b) Determinants of Exclusive Breastfeeding (EBF)

Women with intermediate level of ANC utilization had significantly lower odds of exclusive breastfeeding compared to the women with poor ANC utilization. Moreover, exclusive breastfeeding reduced by 5% for every unit increase on the number of essential ANC HPCPs [COR: 0.95; 95% CI (0.91,0.99)]. Other factors associated with significant lower odds of exclusive breastfeeding included having a postnatal check-up [COR:0.66; 95% CI (0.58,0.75)], being currently employed [COR:0.74; (95% CI (0.65,0.85))] and increasing child age [COR:0.53; 95% CI (0.51,0.56)]. Comparing country of residence, women in Uganda had significantly 34% higher likelihood of exclusively breastfeeding compared to women in Kenya [COR: 1.34; 95% CI (1.14,1.56)].

c) Determinants of Continued Breastfeeding (CBF)

The women with intermediate level of ANC utilization had approximately 20% lower odds of continued breastfeeding beyond six months as compared to those with poor level of ANC utilization. Among the health-related control measures, women who used tobacco products [COR:0.24; 95% CI (0.12,0.47)] and those currently pregnant [COR:0.04;95% CI (0.03,0.05)] had significantly lower odds of continued breastfeeding. The odds of continued breastfeeding also reduced by 15% with every unit increase in child's age [COR: 0.86; 95% CI (0.85,0.87)]. Regarding maternal education, the odds of continued breastfeeding significantly reduced with

every higher level of education completed. This ranged from 30% among those with primary education [COR: 0.70; 95% CI (0.59,0.82)] to 55% among those with higher than secondary education [COR:0.45: 95% CI (0.33,0.59)], compared to the women with no education. For country comparisons, women from Uganda and Tanzania were more than 5 times more likely to continue breastfeeding compared to the women in Kenya.

MULTILEVEL REGRESSION MODELS

Outcome: Early initiation of breastfeeding (EIBF)

Table 3a summarizes the results of the pooled multilevel logistic regression analysis of the association between ANC quality measures and early initiation of breastfeeding, within the first hour after birth, among three countries in East Africa. In the model with only ANC quality measures (Model 1), adequate ANC utilization appeared was significantly associated with 18% greater odds of timely initiation of breastfeeding compared poor ANC utilization [AOR:1.19; 95% CI (1.02,1.39)]. There were also greater odds of timely breastfeeding among women with intermediate ANC utilization compared to those with poor utilization. However, this was not statistically significant. On the other hand, the odds of the full vaccination increased by 4% [AOR 1.04; 95% CI (1.00,1.08)]with every unit increase in essential ANC HPCPs but were not statistically significant.

Model 2 was adjusted for other sociodemographic and household characteristics, health related factors, as well as place and country of residence. The effect of the ANC utilization on the outcome was attenuated after adjusting for other covariates and was no longer statistically significant. However, effect of the essential ANC HPCPs remained not statistically significant but unchanged with the odds of timely breastfeeding initiation increasing by approximately 4%

with every unit increase on the number of essential ANC HPCPs [AOR: 1.04; 95% CI (1.00,1.09)]. Factors significantly associated with lower odds of timely breastfeeding initiation included increasing maternal education level, small and large birth size among children. Having a child with small birth size [AOR 0.85; 95% CI (0.75,0.97)] or large birth size [AOR 0.71; 95% CI (0.62,0.82)] was associated with approximately 15% and 30% lower odds of timely breastfeeding, respectively. Compared to women with no education, the odds of timely breastfeeding initiation were 20% lower among women with primary education [AOR 0.80; 95% CI (0.68,0.94)], 28% lower among women with secondary education [AOR 0.72; 95% CI (0.59,0.89)] and 35% lower among women with education level higher than secondary [AOR 0.65; 95% CI (0.47,0.89)].

Among the health-related factors, delivery in a skilled care setting was associated with 70% adjusted greater odds of timely breastfeeding initiation [AOR: 1.70, 95% CI (1.50,1.92)]. Similarly, women who had full intention to get pregnant in their last pregnancy had 20% greater odds of timely breastfeeding initiation [AOR: 1.20; 95% CI (1.09,1.33)]. On the other hand, giving birth through caesarean section [AOR: 0.14; 95% CI (0.11,0.17)], and being currently employed [AOR: 0.86; 95% CI (0.76,0.98)] were all significantly associated with lower odds of timely breastfeeding initiation. Comparing country of residence, women from Uganda had 20% greater odds of timely breastfeeding initiation compared to women from Kenya. On the contrary, the women from Tanzania had 45% lower odds of early initiation of breastfeeding compared to those from Kenya.

Outcome: Exclusive Breastfeeding (EBF)

Table 3b summarizes the results of the pooled multilevel logistic regression analysis of the association between ANC quality measures and exclusive breastfeeding, adjusting for other

covariates. In the model with only ANC quality measures (Model 1), intermediate level of ANC utilization was significantly associated with lower odds of exclusive breastfeeding compared to poor ANC utilization. This effect was however attenuated in the subsequent models with (model 3) and without (model 2) interaction.

Model 2 was adjusted for other sociodemographic and household characteristics, health access and utilization factors, as well as place and country of residence. A few factors were significantly associated with the outcome including increasing child age and small birth size. The results show that the odds of exclusive breastfeeding significantly reduced by more than half with every additional month in the age of the child [AOR: 0.53; 95% CI (0.50,0.56)]. Compared to mothers of children born with average birth size, mothers of children born with small size were less likely to exclusively breastfeed their children [AOR: 0.75; 95% CI (0.60,0.93)]. Women who had given birth through c-section were 40% less likely to exclusively breastfeed compared to those who had given birth by natural means. Moreover, the odds of exclusive breastfeeding significantly increased by 5% with every additional year on maternal age at birth [AOR: 1.06; 95% CI (1.03,1.09)]. Similar to timely initiation of breastfeeding, women in Tanzania had significantly lesser odds of exclusive breastfeeding compared to women in Kenya. Even though not statistically significant, women from Uganda had greater odds of exclusive breastfeeding compared to Kenya.

The significant effects of the predictors remained fairly the same in the final interaction model (Model 3), with none of the ANC quality measures significantly being associated with exclusive breastfeeding. We, however, found a significant interaction effect of higher level of education on the association between both intermediate and adequate ANC utilization on exclusive breastfeeding. Having higher education was associated with lower odds of exclusive

breastfeeding among women with adequate and intermediate ANC utilization compared to those with poor ANC utilization. i.e., the odds of exclusive breastfeeding among women with intermediate [AOR: 0.18; 95% CI (0.06,0.52)] and adequate [AOR: 0.28; 95% CI (0.09,0.84)] level of ANC utilization, respectively, were 82% and 72% lower if they also had higher level of education.

Outcome: Continued Breastfeeding (CBF)

Table 3c summarizes the results of the pooled multilevel logistic regression analysis of the association between ANC quality measures and exclusive breastfeeding, including adjusting for other covariates. The model with only ANC quality measures (Model 1), shows that both ANC utilization and essential ANC HPCPs were not significantly associated with continued breastfeeding for the past six months. The results remained non-significant in the adjusted model (Model 2). As shown in Model 2, maternal factors significant associated with higher odds of continued breastfeeding were maternal age at birth, being currently employed, and marital status. With every additional unit in maternal age, the odds of continued breastfeeding increased by 4%. [AOR: 1.04; 95% CI (1.02,1.07)]. In addition, compared to women who were single/never married, the married women had almost three-quarter greater odds of continued breastfeeding, [AOR: 1.74; 95% CI (1.31,2.31)]. Women who were employed also had over 20% greater odds of continued breastfeeding compared to those who were not working.

Other demographic factors associated with lower odds of continued breastfeeding included being currently pregnant, increasing level of education, and increasing child age. Pregnant women at interview time had over 90% lower odds of continued breastfeeding [AOR: 0.04; 95% CI (0.03,0.05)]. With every additional month in the age of the child, the odds of continued breastfeeding reduced by almost a quarter [AOR: 0.75; 95% CI (0.73,0.76)].

Regarding the level of education attained, there was a consistent decline in the odds of continued breastfeeding with every higher level of education attained. Compared to women with no education, the adjusted lower odds of the outcome ranged from 25% for the women with primary education [AOR: 0.75; 95% CI (0.58,0.97)] to 60% for those with higher than secondary education [AOR: 0.40; 95% CI (0.24,0.68)]. Women in the rural areas were 57% more likely to continue breastfeeding as compared to those residing in the urban areas [AOR: 1.57; 95% CI (1.24,1.99)]

The significant association between the predictors and the outcome in model 2 were replicated in model 3. In addition, ANC utilization became significantly associated with continued breastfeeding in the interaction model (Model 3). The interaction results show that, compared to women with poor ANC utilization, the odds of continued breastfeeding among women with intermediate level of ANC utilization were approximately 42% lower if they had primary education [AOR: 0.58; 95% CI (0.34,0.98)] and more than half lower if the women had completed secondary level of education [AOR: 0.49; 95% CI (0.27,0.89)]. Similarly, the odds of continued breastfeeding among women with adequate level of ANC utilization were lower by approximately 62% if the women also had secondary education [AOR: 0.38; 95% CI (0.18,0.79)], and lower by 3 quarters if the women also had higher than secondary education [AOR: 0.25; 95% CI (0.11,0.59)], compared to women with poor ANC utilization.

5.4 DISCUSSION

The **primary objective** of this study was to measure the extent to which ANC quality; operationalized as the level of ANC utilization during pregnancy and the number of essential ANC HPCPs, were associated with breastfeeding outcomes i.e., early initiation of breastfeeding (EIBF), exclusive breastfeeding (EBF), and continued breastfeeding (CBF) past 6 months. Our research hypothesis (**#1**) posited that the odds of EIBF would be significantly higher among the women with either intermediate or adequate levels of ANC utilization as compared to those with poor ANC utilization after controlling for other covariates. While our findings in the crude(unadjusted) model showed an increasing gradient of odds of EIBF based on the level of ANC utilization, from poor to adequate breastfeeding, the results were however not significant in the fully adjusted model. Nevertheless, majority of previous studies have showed significant positive association between predictors such as optimal ANC visits and skilled provider during ANC period to be associated with EIBF(44-46). This is likely because women who receive ANC are exposed to counselling sessions on the benefits of EIBF hence more likely to be inclined towards timely breastfeeding initiation(44). According to Ogbo et al(44), women who get counseling from nurses or physicians on breastmilk and breastfeeding are more likely to initiate and continue breastfeeding their children for a more extended amount of time compared to those who did not receive counseling sessions on the importance of breastfeeding.

While we could hardly find a study operationalizing ANC quality similar to our current study, our findings of non-significant association in the fully adjusted model were noted in other studies conducted in Tanzania(47) and Ethiopia(48), examining the effects of ANC visits, as a single measure of ANC utilization, on EIBF. Kiwango et al(47) noted that given breastfeeding is a natural process, women will likely practice it whether they attended ANC or not and this,

according to the authors, is what makes the process unique, compared to other health promotion practices(47). However, it would still be expected that women who have access to ANC will be exposed to information on breastfeeding counselling and guidelines, hence increased their likelihood of having EIBF compared to those with no exposure to such messages(49, 50). Further research is therefore needed especially mixed methods analysis to further examine women's perception about EIBF.

In our second hypothesis (#2), we predicted that odds of EIBF increased with every unit increase in the score on essential ANC HPCPs. Indeed, the odds of EIBF increased by 4% with every unit increase on the essential ANC HPCPs. Our results are similar to other study findings that have found targeted essential ANC HPCPs such as not being cancelled about EIBF during ANC care(25, 51) and inadequate knowledge about benefits of colostrum(51), to be negatively associated with EIBF. This illustrates how health information as a component of essential care practices during pregnancy can be critical in molding positive breastfeeding behavior.

Exclusive Breastfeeding (EBF)

Regarding exclusive breastfeeding, we hypothesized (#3) that the odds of EBF would be significantly greater among the women with either intermediate or adequate levels of ANC utilization as compared to those with poor ANC utilization, after controlling for other covariates. Even though not statistically significant, the results show that the odds of exclusive breastfeeding increased with every upper level of ANC utilization after controlling for other covariates. On the other hand, and opposite to our expectation, the odds of the EBF reduced with every score in essential ANC HPCPs; hence failing to reject the *null* hypothesis (#4) that the odds of EBF would not increase with every unit increase in the score for the essential ANC HPCPs. The literature highlights some knowledge and perception factors surrounding EBF that could not be

measured by our study but could explain why the results did not meet our prediction as per the hypothesis. According to Sutherland(24), a plausible explanation for not exclusively breastfeeding the child could be because of the mothers' conception that breast milk alone cannot satisfy their newborns' needs for nourishment and hydration as they get older. Additionally, another cause could have to do with mothers' perceptions that their ability to produce enough breast milk to support their child's growth has deteriorated with time and it can be connected to mothers' inadequate understanding of the value of exclusive breastfeeding and the negative effects of starting supplemental feeding before six months of age(52).

According to a qualitative study by Dhingra et al(28), a problem with breastfeeding could be emanating from how the information about the benefits is shared and subsequently internalized by the recipients (mothers)(28). The study revealed sentiments illustrating how despite women seeing the importance of exclusive breastfeeding, they did not understand why other foods should not be given within the first six months(28). This highlights how women had learnt the public health message, but not fully understood the reasoning behind the message. These phenomena are explained in other related studies(53-55). Guttersrud et al(56) states that lack of internalized knowledge could be related to weaknesses in communication by the health care providers. This could also be caused by misinterpretation or lack of knowledge among the healthcare providers(55). A qualitative study in Uganda found peer counselling to be more effective as compared to knowledge shared by government workers(30). Counselling and decision support during pregnancy and postpartum may also increase uptake of effective breastfeeding practices(57).

The literature is also contradictory on the influence of different forms of ANC on EBF and this appears to vary based on studies conducted in the developed countries versus LMICs.

Majority of studies conducted in the African region including Kenya(5, 32), Ethiopia(58), Nigeria(15) and Tanzania(16) have associated various components of ANC, such as ANC visits and seeing a skilled ANC provider, with higher rate of exclusive breastfeeding. On the contrary, a study by Costanian(59), using a national survey of women in Canada found no significant association between adequate ANC initiation or service use and any form of breastfeeding practice. However, the breastfeeding practices significantly varied by the type of provider. Similarly, a randomized controlled intervention trial in the US by Kellams et al(60) investigated whether use of a breastfeeding education video in the ANC setting would impact rates of EIBF and EBF among low-income women. The study found that breastfeeding video alone was ineffective in improving breastfeeding practices and suggested a multipronged effort beginning early in pregnancy. Indeed, the results from another US study based on one of the international breastfeeding initiatives; the Baby-friendly Hospital Initiative (BFHI), supported that a collection of maternity care practices were able to explain the variability of EBF(61). The BFHI includes a set of 10 evidenced-based maternity practices that when used together have been shown to improve breastfeeding outcomes(61-63). The BFHI was also found to be effective in promoting EBF from a study conducted in Kenya especially if combined with community and mother support groups(62).

We found a significant interaction of education on the association between both intermediate and adequate level of ANC utilization and exclusive breastfeeding such that the odds of EBF among the women with intermediate and adequate level of ANC utilization significantly reduced by 82% and 72%, respectively, if they had higher than secondary education. Studies conducted in the developed world have shown lower odds of EBF among highly educated women which can be attributed to their busy schedule due to work(59, 64, 65).

The trend is becoming a norm in many LMICs where women are getting more educated and their roles shifting from “housewives” due to opportunities associated with higher education such as employment and busy lifestyles which interfere with their EBF plans(66). A key question that would be important but has not been covered by this study is examining the reason(s) for non-exclusive breastfeeding. A study by Kazaura(67) suggests that most women cited insufficient milk as the primary reason for not exclusively breastfeeding their children, a factor that has been mentioned in other studies.

Continued Breastfeeding (CBF)

Compared to women with poor ANC utilization, women with intermediate and adequate ANC utilization were, respectively, 1.7 and 2.4 times more likely to continue breastfeeding. This shows an increasing gradient in the odds of continued breastfeeding from poor to intermediate and adequate level of ANC utilization. The findings therefore support our hypothesis (#5) that the odds of CBF would be significantly higher among the women with either intermediate or adequate levels of ANC utilization as compared to those with poor ANC utilization after controlling for other covariates. Our findings are similar with other closely related previous studies conducted in Ghana(66), and Kenya(68, 69). The literature shows that EIBF and EBF are positive precursors of CBF as suggested in multiple studies(2, 14, 24). This can be explained by the fact that women who already understand the benefits (and practice) by either initiating breastfeeding early or exclusively breastfeeding are more likely to continue breastfeeding beyond six months.

The findings did not support our last hypothesis (#6) where we had posited that women who had higher scores on the essential ANC HPCPs were more likely to continue breastfeeding beyond six months, as compared to women with lower scores on essential ANC HPCPs. While

the odds ratios show a positive association between the essential ANC HPCPs and CBF, the results were not statistically significant. The interaction results, however, show that the odds of continued breastfeeding among women with adequate level of ANC utilization were significantly lower if they had primary or secondary education. Education is a measure of social economic status and the reduction in the odds of continued breastfeeding among the women with adequate ANC utilization could mean there are other social factors hindering them from prolonged breastfeeding despite being exposed to breastfeeding and other health information from adequate ANC utilization. This also explains why the odds of continued breastfeeding are lower among women who are currently working.

Other Covariates

Other significant health related factors controlled for in the models included delivery in a skilled care setting and giving birth by c-section. Sociodemographic factors significantly associated with either of the outcomes included child characteristics such as age and size at birth, and maternal characteristics namely, age at first birth, pregnancy status, pregnancy intention, currently working and marital status.

According to Tewabe(70), early initiation of breastfeeding is considerably linked with the mode of delivery. In this study, the findings reveal that women who gave birth in a skilled care setting had 70% adjusted greater odds of EIBF. A possible reason for this is the encouragement by gynecologist and other nursing staff to initiate early breastfeeding and by educating the moms about the significance of early initiation of breastfeeding. The findings echo similar results from earlier studies conducted in Kenya(71), Uganda(29, 72) and Nigeria(15) that found a positive association between hospital delivery and timely initiation of breastfeeding. Mothers who give birth outside the health facilities may lack the necessary informed support (during delivery and

postnatal period) on how to handle the newborn and rely on family and friends who may unwillingly provide misinformation on the best care practices for the mother and the baby. There is growing evidence of first-time mothers in SSA mostly receiving advice from family members and neighbors on matters such as breastfeeding(4, 56). Common among these advice is the nutrition and feeding practices of the baby(4). Issues such as crying of the baby after birth brings up concerns of insufficient colostrum, hence starving of the newborn, leading to pre-lacteal feeding(6, 16). This problem could be emanating from less experience and emphasis of frequent breastfeeding, correcting positioning, and physical and emotional attachment of the mother to the baby, to increase the supply of milk(16). Indeed, baby positioning during breastfeeding has been identified as a common problem among new mothers in studies in Kenya(5, 73), Uganda(51) and Tanzania(22). Fears of suffocating the baby with the breast blocking the baby's nose if held too close during breastfeeding had also been noted in a recent study by Talbert et al in Kenya(5). Failure to latch onto the breast adequately can result in slow milk flow, with rapid sucking and increased effort from the baby(24), yet mothers may be unaware of this potential cause and attribute their perceived insufficient milk to poor diet(22). As the baby grows older, crying after feeds and appearing to be hungry have been stated as the main reasons for giving additional fluids and food(5, 25). A major gap discussed in several studies is the need for an in-depth understanding of caregivers' perception of, and responses to, infant negative emotional states and hunger cues that mostly contribute to supplementing breastmilk with other fluids of foods to calm babies from crying.

It has been noted that postoperative treatment might occasionally take longer, prohibiting the woman from seeing her child during the postpartum period, which delays early initiation breastfeeding(70). This fact aligns with our finding that having a caesarean section was

substantially linked to reduced likelihood of both EIBF and EBF. This can emanate from the delayed anesthetic and physical recovery before the mother can initiate or breastfeed comfortably. It can also be as a result postpartum care procedures that that don't effectively factor the importance of infant feeding and immediate bonding with the mother(14). Ndiragu, et al(74) adds that during cesarean birth, the woman might receive more attention while the child's feeding may be overlooked. As a result of the painful procedures women may struggle finding a suitable nursing position to hold the baby which also leads to delayed start in breastfeeding(14). Additionally, according to Liben and Yesuf,(75), babies delivered by cesarean section may also have respiratory difficulties and are more likely to be physically separated from their mother and transferred to a neonatal critical care unit hence delaying timely initiation of breastfeeding. C-section also prevents skin-to-skin contact which is the initial connection between the mother and the child and has been shown to stimulate flow of breastmilk(76).

Several studies have revealed that early initiation of breastfeeding was higher among mothers who had big children at birth(10, 17, 77). In contrast our study findings indicate that that the odds of EIBF were significantly lower among babies with both small and large birth size, while the odds of EBF were lower among babies with small birth size; all compared to babies born with normal birth size. Because small and large newborns frequently exhibit weak nursing responses such as poor coordination, and trouble swallowing; the observed results could have happened because health professional may have focused more on stabilizing the infant than on making breastfeeding easier to start(78). Babies born small than average size are also likely to continue exhibiting feeding problems which forces the mother to introduce other feeding alternatives(79). Bigger babies are also more likely to be born via C-section which also delays EIBF as the mother recovers from the operative procedures(2, 79).

Additionally, the results show that the odds of both EBF and CBF significantly reduced by with every additional month in the child's age. This result was consistent with other previous studies (67, 79, 80). The women's notion that breast milk alone cannot satisfy their newborns' needs for nourishment and hydration as they age may be the plausible explanation for giving them more food as they age(8). Another cause could be mothers' perceptions that their ability to produce enough breast milk to support their child's development has deteriorated with time(8, 14). Additionally, it can be connected to mothers' inadequate understanding of the value of exclusive breastfeeding and the negative effects of starting supplemental feeding before six months of age(52, 67).

Increasing maternal age at first birth was associated with greater odds of both EBF and CBF. This finding is consisted with previous studies that revealed that younger women are at a greater risk of prematurely ceasing to exclusively breastfeed(23, 24, 73). Researchers argue that young women, who are first time mothers, tend to be immature or psychologically unprepared for parenthood(19, 21, 81). Issues such as baby positioning during breastfeeding has been identified as a common problem among new mothers in studies in Kenya(73), Uganda(51) and Tanzania(82). Young inexperienced mothers may also associate the crying of the baby with insufficient milk, leading to pre-lacteal feeding(6, 16). Younger mothers may also be more susceptible to the persuasive power of the breastmilk replacement business. There has been a correlation between an increase in breastmilk substitutes and a decrease in breastfeeding among young and first-time mothers (113). Therefore, transition to parenthood among young or teenage mothers is a major milestone that requires adaption and support among closer social networks in enduring social experiences and health related decisions(19, 21).On the contrary, some studies have attributed the aggregate increase in the level of education among younger women to

increased rates of breastfeeding due to exposure to more information and self-reliance(6).

Kimani-Murage et al(6) highlight how social change and information access has contributed to a shift in younger cohorts of mothers having better outcomes in breastfeeding as compared to similar age groups in previous years.

Over the last few decades, there has also been an overall gradual increase in the proportion of employed women in many countries in SSA due to increased urbanization, higher education attainment for women, and gender equity campaigns(83). Whether in the formal or informal sector, however, employed mothers experience challenges combining work and caring for their babies(23, 26, 32). Our findings show that currently employed women had lower odds of both EIBF and EBF. The findings are similar to previous studies that have demonstrated how being an employed mother also creates a barrier to both exclusive and optimal duration of breastfeeding for 24 months(23, 26). Denial, or short maternity leave allowance may not fit well with the recommended six months of exclusive breastfeeding(26). The short maternity leave period drives mothers towards not breastfeeding at all or weaning earlier than the recommended duration(23).Furthermore, many workplaces lack established breastfeeding friendly environment where mothers could take their infants to the workplace or express milk for later feeding of the infant(26, 84). On the contrary, some studies have found no significant grounds for associating mothers employed with lack of breastfeeding(85, 86). This can be explained by instances where breastfeeding is the only option for mothers with minimal income, who might not afford to buy supplemental foods for their babies, hence appear to breastfeed more(85).

The period following birth in many African communities is often marked by cultural practices(34). Some of these cultural practices hinder the health and survival of the newborn, and young first-time mothers are often most likely to follow these practices(32, 87). The influence of

other community gatekeepers such as local leaders and traditional birth attendants, and their potential for channeling information and swaying behavior, offer both opportunities and challenges(29). It is common to find cultural factors overriding the knowledge received from health professionals especially in regions where majority of mothers opt for home delivery assisted by grandmothers or traditional birth attendants(29). Among the factors include the spacing between pregnancies(32) There is an increased chance of weaning among mothers who become pregnant while breastfeeding. Our study shows that being pregnant was associated with lower odds of CBF. According to a qualitative study by Mohamed et al(26) in Kenya, Somali women indicated that their culture does not allow a mother to breastfeed while pregnant(26). They are therefore forced to immediately stop breastfeeding the moment the notice or suspect they are pregnant with another child(26). Many of these cultural barriers are propagated by traditional birth attendants, grandmothers, and other influential elders in the community(28, 29, 34).

The breastfeeding experience can also be influenced by marital relationships(23). Our findings show that unlike women who were not in a partnership either by being single, separated or widowed, women who were currently married had increased odds of both EIBF and CBF. Verbal persuasions from significant others, family members as well as health care professionals have been found to encourage mothers to continue breastfeeding their infants despite the many social challenges(22, 23). Other studies have however demonstrated limited support from men (husbands and/or male adults) in the family towards helping with household chores and other domestic responsibilities(27, 72, 82). This leads to exhaustion, as the sole responsibility of the child is left to the mother(72). Surprisingly, a previous study conducted in Kenya(34) and Nigeria(33) indicated time wasting and negative effect on marital relationship, respectively, as

some of the reasons for avoiding exclusive and prolonged breastfeeding among married women. There is, however, limited literature on men's views in helping with childcare, especially in the rural areas, hence making it difficult to understand their perceptions about breastfeeding. A recommendation for future studies is to target men's perceptions and barriers to their involvement in infant care.

The study's findings also show that urban women were more likely to start breastfeeding early and also exclusively breastfeed compared to the women in the rural areas. With regard to continued breastfeeding, however, the odds were significantly higher for rural residents. The former can be explained by moms residing in metropolitan regions having greater exposure to better health care and breastfeeding counselling than their rural counterparts(2, 14, 23, 87). Women who live in urban areas may also have easier access to information, which might result in higher likelihood of early breastfeeding initiation as indicated by Mbada et al(33). The increased odds of continued breastfeeding among rural residents can be attributed to poverty or food scarcity where breastfeeding remains the only viable option to feed the baby(88). Most of the women in rural areas are less likely to be employed and therefore have more time to breastfeed their children for a longer period of time compared to the urban-employed residents.

Strengths and weaknesses

This study has several limitations that should be factored while exploring the impact of the findings. First, the study used cross-sectional data which is great in providing a snapshot of the population outcomes at a given point or period in time but may not be used to draw a true conclusion about causality. Other studies using the DHS surveys have analyzed the data longitudinally using subsequent surveys across years to measure any difference on specific population attributes across years. Second, some responses are subsequent to recall bias

especially on the ANC quality measures and the experience during the ANC visits. Finally, as noted in the earlier discussion some important measures of knowledge, attitude and perceptions about breastfeeding were not included in the survey and could not be factored in our analysis. However, despite these limitations this study has great strengths. The study uses nationally representative data which is also comparable across countries and therefore the findings can be used to inform public health policies and program actions at the national level. To the best of our knowledge, this is among the few studies that have analyzed ANC quality as a composite measure to incorporate both the nature and level of women's utilization of ANC services as well as the care practices experienced during the visit, and how these impact maternal health promotion practices. The study therefore provides a baseline and reference for future work on improving maternal and childcare guidelines before, during, and after pregnancy period.

Conclusion and recommendations

This study demonstrates that higher levels of ANC utilization are strongly related to higher chances of breastfeeding practices as shown by the increased likelihood of breastfeeding practices among the women with either intermediate or adequate ANC utilization levels as compared to the women with poor ANC utilization. The findings add to the justification of availing access to information on optimal breastfeeding practices at the points of care and encouraging mothers to breastfeed their children exclusively with the option of complimenting with other foods past six months. By discussing other covariates adjusted for in the models, the study highlights how the triad between personal as well as social and health access factors and behavior are interconnected to predict individuals' informed decisions about breastfeeding behavior. This demonstrates that breastfeeding is influenced by multiple factors and while breastfeeding counselling and other forms of health education are critical, it is important to

understand other social and environmental factors that promote or hinder optimal breastfeeding practices at different stages in the child's breastfeeding period. The findings also highlight gaps in which nursing personnel and healthcare professionals must be educated about the barriers to early breastfeeding start, get training on the various breastfeeding positions, and practice breast-crawling after cesarean sections. We strongly advocate for qualitative research in these areas to build a practical and evidence-based intervention for women and better understand the various factors that impact the choice to breastfeed effectively.

The study has several implications for policy and future research. Breastfeeding is widely considered among the most effective behaviors in improving the quality of life of infants and young children and a key indicator in the WHO's action plan for the prevention and control of pneumonia and diarrhea, which are leading preventable causes of death among children in LMICs, and especially in SSA. The study findings highlight the importance of continued promotion of breastfeeding behaviors not only during ANC visits but also postnatal follow -ups and child-wellness clinics. The findings especially support our research hypothesis on the significant association between ANC quality and both EIBF and CBF. Interventions programs aimed at reducing neonatal and infant deaths should lay more emphasis on the informational or behavioral gaps on breastfeeding uptake, especially in SSA where despite having higher optimal breastfeeding rates as compared to high income countries, the neonatal and infant mortality are still higher.

Community based breastfeeding support programs in SSA should remain a priority with clear emphasis on the benefits and support for EBF. This follows the findings from the previous studies demonstrating that other social and environmental determinants could potentially influence EBF irrespective of the level of ANC quality experience; a possible explanation why

our research hypothesis (#3 & #4), ANC quality is positively associated with EBF, was not supported by this study. These programs should target some of the key factors hindering especially EIBF and EBF such as negative cultural practices, nutrition support for lactating mothers, policies for including breastfeeding spaces at work locations, and mandating paid maternity (and paternal) leave for women after birth. In conclusion, our study revealed that a larger proportion of the women in the pooled sample of East Africa have poor ANC utilization. Key stakeholders in these countries should invest in interventions to improve the level of ANC utilization. Going by our results, this improvement in ANC quality will likely translate to increasing better breastfeeding practices and ultimately contributing to lowering overall infant and child mortality as breastfeeding is attached to a myriad of other health benefits to the young children.

5.5 Tables and Figures

5.5.0 Table a: A summary of the ANC Quality measures.

3. ANC Utilization	Number of ANC Visits		Skilled ANC Provider		Early ANC Initiation
• Adequate ANC utilization	4 or more visits	“and”	YES	“and”	First Trimester
• Intermediate ANC utilization	4 or more visits	“or”	YES	“or”	First Trimester
• Poor ANC utilization	3 or less visits	“and”	NO	“and”	Second/third trimester or never
4. Essential ANC health promotion care practices	Continuous score of the following components: ✓ Blood pressure measurement ✓ Blood test done ✓ Urine test ✓ Nutrition information ✓ Information on Pregnancy complications ✓ Discussion on birth preparedness				

5.5.1 Table 1: Distribution of population characteristics and breastfeeding outcomes

	Timely Initiation of breastfeeding		Exclusive Breastfeeding		Continued Breastfeeding	
VARIABLES	N (%)	Yes (Col %)	N (%)	Yes (Col %)	N (%)	Yes (Col %)
ANC utilization						
1 Poor	7998(49)	3709(48)	5534(51)	1168(53)	5848(47)	3847(49)
2 Intermediate	5752(35)	2761(35)	3674(34)	695(32)	4500(36)	2755(35)
3 Adequate	2591(16)	1327(17)	1676(15)	337(15)	2017(16)	1230(16)
ANC HPCPs: N (mean, SD)	12750(4.4,1.4)		10907(4.4,1.4)		9643(4.4,1.4)	
Skin to Skin conduct						
0 No	3733(41)	1868(33)	3182(41)	631(39)	2841(41)	2313(42)
1 Yes	5399(59)	3777(67)	4578(59)	1000(61)	4032(59)	3234(58)
Tobacco Use						
0 No	181(1)	121(2)	163(2)	34(2)	132(1)	114(1)
1 Yes	16207(99)	7700(98)	10743(98)	2166(98)	12270(99)	7734(99)
Skilled Delivery						
0 No	5098(31)	2088(27)	3371(31)	644(29)	3899(31)	2467(31)
1 Yes	11283(69)	5732(73)	7534(69)	1557(71)	8498(69)	5381(69)
C-Section						
0 No	15099(92)	7530(96)	10095(93)	2053(94)	11466(93)	7280(93)
1 Yes	1267(8)	279(4)	790(7)	139(6)	923(7)	557(7)
Pregnancy Intention						
0 No	5248(41)	3091(40)	4511(41)	939(43)	3904(40)	3193(41)
1 Yes	7503(59)	4730(60)	6396(59)	1261(57)	5739(60)	4656(59)
Post Natal check-up						
0 No	7926(62)	4968(64)	6740(62)	1520(69)	5864(61)	4714(60)
1 Yes	4796(38)	2840(36)	4141(38)	672(31)	3761(39)	3119(40)
Respondent Working						
0 No	3681(29)	2430(31)	3138(29)	733(33)	2641(27)	2117(27)

1 Yes	9068(71)	5390(69)	7768(71)	1468(67)	7000(73)	5731(73)
Currently Pregnant						
0 No	15614(95)	7455(95)	10793(99)	2200(100)	11629(94)	7736(99)
1 No	775(5)	366(5)	113(1)	0(0)	773(6)	113(1)
Sex of child						
1 Male	8333(51)	3969(51)	5500(50)	1101(50)	6314(51)	3948(50)
2 Female	8056(49)	3852(49)	5407(50)	1100(50)	6088(49)	3901(50)
Size of child at birth						
1 Small	3047(24)	1844(24)	2571(24)	486(22)	2317(24)	1848(24)
2 Average (Ref)	7470(59)	4692(61)	6401(59)	1332(61)	5632(59)	4599(59)
3 Large	2077(16)	1191(15)	1793(17)	355(16)	1572(17)	1294(17)
Highest education						
0 No education	2095(13)	1057(14)	1506(14)	296(13)	1599(13)	1117(14)
1 Primary	9644(59)	4601(59)	6591(60)	1355(62)	7245(58)	4685(60)
2 Secondary	3604(22)	1726(22)	2234(21)	431(20)	2776(22)	1649(21)
3 Higher	1046(6)	437(6)	575(5)	118(5)	783(6)	398(5)
Marriage						
1 Single	1273(8)	543(7)	813(8)	173(8)	922(7)	554(7)
2 Married	13750(84)	6623(85)	9189(84)	1862(85)	10393(84)	6614(84)
3 Divorced/Separate	1366(8)	655(8)	904(8)	165(7)	1087(9)	681(9)
Wealth Index						
1 Poorest	3964(24)	1779(23)	2719(25)	571(26)	2970(24)	1955(25)
2 Poorer	3388(21)	1581(20)	2283(21)	478(22)	2567(21)	1638(21)
3 Rich	3055(19)	1449(19)	2061(19)	404(18)	2313(19)	1478(19)
4 Richer	2903(18)	1507(19)	1968(18)	396(18)	2158(17)	1398(18)
5 Richest	3078(19)	1506(19)	1875(17)	351(16)	2394(19)	1379(18)
Frequency (Radio)						
0 No	3994(24)	1957(25)	2802(26)	582(26)	3040(25)	2050(26)
1 Yes	12392(76)	5864(75)	8105(74)	1619(74)	9362(75)	5799(74)
Frequency (TV)						
0 No	10328(63)	5043(64)	7111(65)	1477(67)	7761(63)	5085(65)
1 Yes	6055(37)	2778(36)	3795(35)	724(33)	4635(37)	2764(35)
Frequency (Magazine)						
0 No	11909(73)	5752(74)	8057(74)	1678(76)	8970(72)	5786(74)

1 Yes	4478(37)	2069(36)	2849(26)	522(24)	3431(27)	2062(26)
Place of Residence						
1 Urban	4675(29)	2140(27)	2764(25)	522(24)	3608(29)	2030(26)
2 Rural	11714(71)	5682(73)	8142(75)	1678(76)	8794(71)	5818(74)
Survey						
1 Kenya	7024(43)	2134(27)	2949(27)	539(25)	5352(43)	2159(28)
2 Uganda	5470(33)	3671(47)	4587(42)	1054(48)	4101(33)	3247(41)
3 Tanzania	3894(24)	2016(26)	3371(31)	607(28)	2949(24)	2443(31)

5.5.2 Table 2: Bivariate Analysis (Unadjusted odds ratios)

Variables	EIBF				EBF				CBF			
	COR	P>t	[95% CI]		COR	P>t	[95% CI]		COR	P>t	[95% CI]	
ANC utilization												
Poor	1.00				1.00				1.00			
Intermediate	1.02	0.6910	0.93	1.12	0.86	0.0150	0.76	0.97	0.84	0.0020	0.76	0.94
Adequate	1.09	0.1930	0.96	1.25	0.91	0.2720	0.78	1.07	0.83	0.0280	0.71	0.98
Essential health prom care practices	1.05	0.0100	1.01	1.09	0.95	0.0230	0.91	0.99	0.98	0.3030	0.93	1.02
tobacco Use (Ref=No)	0.45	0.0000	0.30	0.68	0.97	0.8930	0.66	1.45	0.24	0.0000	0.12	0.47
Skilled delivery (Ref: No)	1.43	0.0000	1.30	1.58	1.11	0.1240	0.97	1.27	0.96	0.4850	0.85	1.08
C-section (Ref: No)	0.19	0.0000	0.16	0.23	0.84	0.1790	0.65	1.08	0.89	0.2910	0.71	1.11
Wanted Pregnancy (Ref: No)	1.18	0.0010	1.07	1.30	0.93	0.2340	0.82	1.05	0.95	0.4800	0.84	1.09
Postnatal check (Ref: No)	0.84	0.0030	0.75	0.94	0.66	0.0000	0.58	0.75	1.19	0.0100	1.04	1.35
Employment (Ref: No)	0.82	0.0010	0.73	0.93	0.74	0.0000	0.65	0.85	1.12	0.1410	0.96	1.29
Age at First Birth (continuous)	0.97	0.0000	0.96	0.98	1.00	0.8920	0.99	1.02	0.99	0.1030	0.97	1.00
Currently Pregnant (Ref: No)	0.94	0.5280	0.77	1.14	N/A				0.04	0.0000	0.03	0.06
Child Age (continuous)	1.00	0.8300	0.99	1.01	0.53	0.0000	0.51	0.56	0.86	0.0000	0.85	0.88
Gender (Ref: Male)	1.01	0.9060	0.92	1.10	0.98	0.6660	0.87	1.09	0.93	0.2100	0.84	1.04
Birth Size												
Small	0.85	0.0160	0.75	0.97	0.88	0.0860	0.76	1.02	0.88	0.1140	0.76	1.03
Average (Ref)	1.00				1.00				1.00			
Large	0.74	0.0000	0.64	0.84	0.94	0.4370	0.80	1.10	1.04	0.6450	0.87	1.26
Maternal Education												
No education	1.00				1.00				1.00			
Primary	0.89	0.0730	0.78	1.01	1.05	0.5160	0.90	1.23	0.70	0.0000	0.59	0.82
Secondary	0.85	0.0490	0.73	1.00	0.98	0.8470	0.80	1.20	0.60	0.0000	0.50	0.73

Higher	0.66	0.0000	0.52	0.83	1.06	0.7080	0.77	1.48	0.45	0.0000	0.34	0.59
Marital Status												
Single never married	1.00				1.00				1.00			
Married	1.25	0.0110	1.05	1.48	0.92	0.4670	0.75	1.14	1.12	0.2540	0.92	1.36
Divorced/Separated	1.25	0.0430	1.01	1.54	0.80	0.1090	0.61	1.05	1.03	0.8520	0.79	1.34
Wealth Index												
Poorest	0.93	0.3910	0.80	1.09	1.14	0.2010	0.93	1.39	1.41	0.0000	1.18	1.68
Poorer	0.97	0.7540	0.83	1.15	1.12	0.2740	0.91	1.38	1.19	0.0560	1.00	1.43
Rich	0.95	0.5050	0.81	1.11	1.03	0.7630	0.83	1.28	1.24	0.0290	1.02	1.49
Richer	1.16	0.0890	0.98	1.37	1.07	0.5400	0.86	1.34	1.30	0.0110	1.06	1.59
Richest												
Mass media												
Radio (Ref: No)	0.96	0.0960	0.91	1.01	0.96	0.2810	0.90	1.03	0.85	0.0000	0.80	0.90
TV (Ref: No)	0.91	0.0010	0.86	0.96	0.94	0.1620	0.87	1.02	0.86	0.0000	0.80	0.92
Newspaper (Ref: No)	0.92	0.0370	0.86	1.00	0.89	0.0260	0.81	0.99	0.87	0.0020	0.80	0.95
Residence (Ref: Urban)	1.18	0.0090	1.04	1.33	1.11	0.1940	0.95	1.30	1.61	0.0000	1.41	1.84
Country												
Kenya	1.00				1.00							
Uganda	5.56	0.0000	4.96	6.23	1.34	0.0000	1.14	1.56	5.70	0.0000	5.08	6.41
Tanzania	2.89	0.0000	2.55	3.27	0.98	0.8010	0.82	1.16	7.27	0.0000	6.35	8.32

5.5.3 Table 3a: Binary logistic regression table summary (Early Initiation of Breastfeeding)

Variables	Model 0	Model 1		Model 2	
		AOR	[95% CI]	AOR	[95% CI]
Level of ANC utilization					
1 Poor		1	[1.00,1.00]	1	[1.00,1.00]
2 Intermediate		1.12	[1.00,1.25]	1.00	[0.88,1.12]
3 Adequate		1.19*	[1.02,1.39]	1.01	[0.85,1.20]
ANC HPCPs		1.04*	[1.00,1.08]	1.04*	[1.01,1.09]
Tobacco use (Yes)				0.95	[0.62,1.43]
Skilled care delivery (Yes)				1.70***	[1.50,1.92]
C-section (Yes)				0.14***	[0.11,0.17]
Pregnancy intention (Yes)				1.20***	[1.09,1.33]
Post Natal check (Yes)				0.88*	[0.78,0.99]
Currently working (Yes)				0.86*	[0.76,0.98]
Age at birth (continuous)				1.00	[0.99,1.02]
Pregnant (Yes)				0.86	[0.67,1.10]
Child age (continuous)				0.99	[0.99,1.07]
Gender					
1 Male				1.02	[0.92,1.13]
2 Female				1	[1.00,1.00]
Birth size					
1 Small				0.85*	[0.75,0.97]
2 Average				1	[1.00,1.00]
3 Large				0.71***	[0.62,0.82]
Highest education level					
0 No education				1	[1.00,1.00]
1 Primary				0.80**	[0.68,0.94]
2 Secondary				0.72**	[0.59,0.89]
3 Higher				0.65**	[0.47,0.89]
Marital Status					
1 Single/Never married				1	[1.00,1.00]
2 Married				1.27*	[1.03,1.55]

3 Divorced/Separated/widowed				1.23	[0.95,1.59]
Wealth Index					
1 Poorest				0.80	[0.62,1.03]
2 Poorer				0.84	[0.65,1.08]
3 Rich				0.84	[0.66,1.07]
4 Richer				0.98	[0.79,1.22]
5 Richest				1	[1.00,1.00]
Mass Media Access					
Radio (Ref No)				1.02	[0.95,1.09]
Television (Ref No)				0.97	[0.89,1.07]
Newspaper (Ref No)				1.04	[0.93,1.15]
Place of residence					
1 Urban				1	[1.00,1.00]
2 Rural				0.98	[0.82,1.17]
Country					
1 Kenya				1	[1.00,1.00]
2 Uganda				1.21*	[1.02,1.43]
3 Tanzania				0.55***	[0.47,0.66]
Variance	2.76***	2.18***	[1.90,2.50]	2.13***	[1.85,2.46]
ICC (%)	24	19		19	
Model fit statistics					
<i>AIC</i>	23684.10	17372.22		16194.84	
<i>BIC</i>	23691.81	17402.21		16426.24	

Outcome: Started breastfeeding within one hour of birth - last-born in the past 2 years

Abbreviations: ICC, intra-class correlation, AIC, Akaike's information criterion; BIC, Bayesian information criteria.

Model 0 (Empty model) was fitted without predictor variables.

Model 1 includes ANC quality measures only

Model 2 is ANC quality measures adjusted for other covariates.

Model 3 is the full model testing for interaction.

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.5.4 Table 3b: Binary logistic regression table summary (Exclusive Breastfeeding)

Variables	Model 0	Model 1	Model 2	Model 3		
		AOR	[95% CI]	AOR	[95% CI]	
Level of ANC utilization						
1 Poor		1	[1.00,1.00]	1	[1.00,1.00]	
2 Intermediate		0.88*	[0.78,0.99]	1.07	[0.88,1.31]	
3 Adequate		0.94	[0.80,1.11]	1.03	[0.79,1.33]	
ANC HPCPs		0.96	[0.92,1.00]	0.97	[0.91,1.04]	
Tobacco use (Yes)			1.29	[0.74,2.26]	1.30	[0.74,2.28]
Skilled care delivery (Yes)			1.16	[0.95,1.42]	1.14	[0.94,1.40]
C-section (Yes)			0.62*	[0.42,0.91]	0.63*	[0.43,0.92]
Pregnancy intention (Yes)			1.09	[0.91,1.30]	1.09	[0.91,1.30]
Post Natal check (Yes)			0.85	[0.70,1.02]	0.84	[0.70,1.02]
Currently working (Yes)			1.01	[0.84,1.23]	1.04	[0.82,1.23]
Age at birth (continuous)			1.06***	[1.03,1.09]	1.06***	[1.03,1.09]
Pregnant (Yes)			1	[1.00,1.00]	1	[1.00,1.00]
Child age (continuous)			0.53***	[0.50,0.56]	0.53***	[0.50,0.56]
Gender						
1 Male			0.89	[0.75,1.05]	0.90	[0.76,1.06]
2 Female			1	[1.00,1.00]	1	[1.00,1.00]
Birth size						
1 Small			0.75**	[0.60,0.93]	0.74**	[0.60,0.93]
2 Average			1	[1.00,1.00]	1	[1.00,1.00]
3 Large			0.80	[0.64,1.00]	0.81	[0.65,1.01]
Highest education level						
0 No education			1	[1.00,1.00]	1	[1.00,1.00]
1 Primary			0.90	[0.68,1.18]	1.03	[0.73,1.45]
2 Secondary			0.94	[0.66,1.32]	1.14	[0.73,1.76]
3 Higher			0.80	[0.46,1.38]	2.01	[0.88,4.58]
Marital Status						
1 Single/Never married			1	[1.00,1.00]	1	[1.00,1.00]
2 Married			1.14	[0.86,1.52]	1.16	[0.88,1.54]
3 Divorced/Separate/widow			1.31	[0.91,1.90]	1.34	[0.93,1.94]
Wealth Index						
1 Poorest			1.35	[0.92,1.99]	1.34	[0.91,1.96]
2 Poorer			1.34	[0.91,1.96]	1.33	[0.90,1.94]

3 Rich				1.20	[0.81,1.76]	1.17	[0.80,1.72]
4 Richer				1.19	[0.84,1.70]	1.20	[0.84,1.71]
5 Richest				1	[1.00,1.00]	1	[1.00,1.00]
Mass Media Access							
Radio (Ref No)				0.93	[0.84,1.034]	0.93	[0.84,1.04]
Television (Ref No)				1.05	[0.90,1.226]	1.05	[0.90,1.23]
Newspaper (Ref No)				0.86	[0.73,1.013]	0.87	[0.74,1.02]
Place of residence							
1 Urban				1	[1.00,1.00]	1	[1.00,1.00]
2 Rural				0.91	[0.69,1.18]	0.94	[0.72,1.22]
Country							
1 Kenya				1	[1.00,1.00]	1	[1.00,1.00]
2 Uganda				1.28	[0.98,1.65]	1.27	[0.98,1.64]
3 Tanzania				0.76*	[0.59,0.97]	0.76*	[0.59,0.98]
Interaction							
Poor ANC*No education						1	[1.00,1.00]
Poor ANC*Pri education						1	[1.00,1.00]
Poor ANC*Sec education						1	[1.00,1.00]
Poor ANC*Higher education						1	[1.00,1.00]
Intermediate*No education						1	[1.00,1.00]
Intermediate*Pri education						0.73	[0.40,1.34]
Intermediate*Sec education						0.71	[0.35,1.43]
Intermediate*Higher education						0.18**	[0.06,0.52]
Adequate*No education						1	[1.00,1.00]
Adequate*Pri education						0.59	[0.29,1.19]
Adequate*Sec education						0.46	[0.20,1.06]
Adequate*Higher education						0.28*	[0.09,0.84]
Variance	1.20***	1.20***	[1.09,1.32]	1.36**	[1.08,1.75]	1.37**	[1.08,1.74]
ICC (%)	5	5		3		9	
Model fit statistics							
AIC	11250.11	11231.31		5418.01		5424.82	
BIC	11257.40	11260.72		5637.10		5687.80	

Outcome variable: Exclusive breastfeeding

Abbreviations: ICC, intra-class correlation, AIC, Akaike's information criterion; BIC, Bayesian information criteria.

Model 0 (Empty model) was fitted without predictor variables.

Model 1 includes ANC quality measures only.

Model 2 is ANC quality measures adjusted for other covariates.

Model 3 is the full model testing for interaction.

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.5.5 Table 3c: Binary logistic regression table summary (Continued Breastfeeding)

Variable	Model 0	Model I		Model 2		Model 3	
		AOR	[95% CI]	AOR	[95% CI]	AOR	[95% CI]
Level of ANC utilization							
1 Poor		1	[1.00,1.00]	1	[1.00,1.00]	1	[1.00,1.00]
2 Intermediate		0.92	[0.80,1.05]	0.99	[0.83,1.20]	1.74*	[1.07,2.85]
3 Adequate		0.85	[0.71,1.01]	0.89	[0.69,1.15]	2.39*	[1.18,4.81]
ANC HCPs		0.99	[0.94,1.03]	1.04	[0.98,1.11]	1.04	[0.97,1.10]
Tobacco use (Yes)				0.74	[0.29,1.91]	0.77	[0.31,1.92]
Skilled care delivery (Yes)				0.81*	[0.66,0.99]	0.80*	[0.66,0.98]
C-section (Yes)				0.87	[0.62,1.23]	0.88	[0.63,1.25]
Pregnancy intention (Yes)				1.11	[0.93,1.31]	1.12	[0.95,1.33]
Post Natal check (Yes)				1.16	[0.96,1.39]	1.15	[0.96,1.38]
Currently working (Yes)				1.22*	[1.01,1.48]	1.23*	[1.01,1.50]
Age at birth (continuous)				1.04**	[1.02,1.07]	1.04**	[1.02,1.07]
Pregnant (Yes)				0.04***	[0.03,0.05]	0.04***	[0.03,0.05]
Child age (continuous)				0.75***	[0.73,0.76]	0.75***	[0.73,0.76]
Gender							
1 Male				0.91	[0.77,1.08]	0.91	[0.77,1.08]
2 Female				1	[1.00,1.00]	1	[1.00,1.00]
Birth size							
1 Small				0.95	[0.78,1.15]	0.94	[0.78,1.15]
2 Average				1	[1.00,1.00]	1	[1.00,1.00]
3 Large				1.04	[0.82,1.32]	1.06	[0.83,1.34]
Highest education level							
0 No education				1	[1.00,1.00]	1	[1.00,1.00]
1 Primary				0.75*	[0.58,0.97]	0.98	[0.70,1.37]
2 Secondary				0.53***	[0.38,0.74]	0.80	[0.52,1.25]
3 Higher				0.40***	[0.24,0.68]	0.60	[0.30,1.21]
Marital Status							
1 Single/Never married				1	[1.00,1.00]	1	[1.00,1.00]
2 Married				1.74***	[1.31,2.31]	1.77***	[1.33,2.36]
3 Divorced/Separate/widow				0.95	[0.66,1.37]	0.96	[0.67,1.39]
Wealth Index							
1 Poorest				1.75**	[1.18,2.60]	1.75**	[1.18,2.59]
2 Poorer				1.24	[0.86,1.81]	1.25	[0.86,1.81]

3 Rich				1.33	[0.94,1.89]	1.33	[0.94,1.88]
4 Richer				1.19	[0.86,1.64]	1.19	[0.87,1.64]
5 Richest				1	[1.00,1.00]	1	[1.00,1.00]
Mass Media Access							
Radio (Ref No)				1.02	[0.91,1.14]	1.010	[0.90,1.13]
Television (Ref No)				1.01	[0.87,1.15]	0.99	[0.87,1.15]
Newspaper (Ref No)				1.02	[0.88,1.17]	1.01	[0.87,1.16]
Place of residence							
1 Urban				1	[1.00,1.00]	1	[1.00,1.00]
2 Rural				1.57***	[1.24,1.99]	1.57***	[1.24,1.99]
Country							
1 Kenya				1	[1.00,1.00]	1	[1.00,1.00]
2 Uganda				0.82	[0.64,1.05]	0.82	[0.64,1.05]
3 Tanzania				0.94	[0.73,1.20]	0.95	[0.74,1.22]
Interaction							
Poor ANC*No education						1	[1.00,1.00]
Poor ANC*Pri education						1	[1.00,1.00]
Poor ANC*Sec education						1	[1.00,1.00]
Poor ANC*Higher education						1	[1.00,1.00]
Intermediate*No education						1	[1.00,1.00]
Intermediate*Pri education						0.58*	[0.34,0.98]
Intermediate*Sec education						0.49*	[0.27,0.89]
Intermediate*Higher education						0.43	[0.17,1.06]
Adequate*No education						1	[1.00,1.00]
Adequate*Pri education						0.38*	[0.177,0.79]
Adequate*Sec education						0.25**	[0.106,0.59]
Adequate*Higher education						0.37	[0.12,1.13]
Variance	2.96***	1.17**	[1.05,1.30]	1.18	[0.99,1.41]	1.18	[0.99,1.41]
ICC (%)	25	5		5		5	
Model fit statistics							
<i>AIC</i>	17033.31	9362.83		6075.11		6073.12	
<i>BIC</i>	17040.82	9391.63		6297.86		6339.03	

Abbreviations: ICC, intra-class correlation, AIC, Akaike's information criterion; BIC, Bayesian information criteria.

Model 0 (Empty model) was fitted without predictor variables.

Model 1 includes ANC quality measures only.

Model 2 is ANC quality measures adjusted for other covariates.

Model 3 is the full model testing for interaction.

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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CHAPTER SIX: OVERALL CONCLUSION, POLICY IMPLICATIONS AND FUTURE RESEARCH

General overview

Quality of care is an emerging concern across many low-and-middle-income countries as health systems work towards mitigating endemic and emerging conditions of public health importance(1). However, there is limited systematic and empirical guidance to measure quality in both care provision and utilization of health services by the end users. There is also a huge gap in the literature regarding quantitatively tested and comparative measures of quality of care, specifically ANC quality, that can be referenced to inform policies at the national level. This study is among the few that have attempted to operationalize ANC quality based on the essential components of care practices as contained in the WHO guidelines. In this study, the main independent variable, ANC quality, was assessed using two measures a) ANC utilization, and b) essential ANC health promotion care practices (ANC HPCPs). While the level of ANC utilization focused on the extent to which the women engaged with the healthcare system (skilled care), the essential ANC HPCPs focused on the nature of interaction with the care providers by examining the type and level of care receive across the pregnancy period. This operationalization of ANC quality is what makes this study unique as compared to other recent studies associating the quality of ANC and other sociodemographic factors.

The dissertation findings build upon prior literature in a number of ways. The inclusion of the composite measure of ANC quality; ranked from poor, intermediate, and adequate, as a key determinant of the various health promotion practices provides a solid foundation for policy debates on where to prioritize public health funds for the benefit of maternal and child health. Despite being unable to measure causality, the findings also justify the prediction that low

maternal health service utilization is an indication of poor future health seeking habits for children and other family members. This is unfortunate because women are the primary care givers in most homes, particularly, in SSA, and their health decisions directly affects all the people they take care of, including vulnerable children, as well as the social environment in which they interact. Behavioral practices are predominantly consistent and low users of health services are likely to remain low users, and vice versa. With the analysis showing cluster effect on the outcomes, it also justifies how and why individual decisions both affect and/or are affected by the social environment in which they live in, hence determining overall population outcome in a given area. This calls for both individual patient awareness as well as community-focused strategies to create awareness on health service utilization and mitigate against myths surrounding pregnancy, breastfeeding, or vaccine hesitancy.

Implication for policy and future research.

1. ANC Quality

The results of this study are important as they can help in addressing the trends towards achieving the sustainable development goals (SDGs) 2030, given that improving both maternal and child health are key international goals expressed through the United Nation's SDGs. The study demonstrated low ANC service utilization across all the countries. In the continuation of this study, future research should expand on our findings by analyzing the factors within ANC that affects improved care for children. For some women, the pregnancy period, through ANC visits, initiates their first contact with the maternal care facilities and navigating the health system. Researchers can aim to answer questions such as whether it's the mother's exposure to the health care system via ANC that creates familiarity with the health care system, hence she is comfortable to bring her child back for follow up services at a later date i.e., overall satisfaction

with the health care system., or is it something within ANC such as the information shared e.g. education on proper preventative and secondary services for the child received during ANC visits, mother support groups, that influences the mother's decision to seek care for her child? A mixed method approach would be necessary to achieve an all-round perspective especially in ethnically and geographically diverse communities in SSA by comparing health facility predictors of ANC quality (patient experiences) and the determinants of the utilization of ANC services from the point of end users.

There are a variety of studies that have analyzed quality of ANC in several African countries but using questions from different data sources as well as different ways of operationalizing ANC quality(1-7). This shows the necessity of standardized methods of assessing ANC quality not only from the researchers point but also for continuous improvement at the health facility level. There is also a need for more validation research to assess the tools for measuring quality of ANC. The Service provision Assessment (SPA) surveys from the DHS surveys are a great starting point as they follow a standardized questionnaire with minimal alterations to accommodate specific country needs. Applying standardized methods for measurements and analysis can allow comparisons of results across countries. Despite the variations in the operationalization of ANC quality across the studies, there were similarities in most of the care practices that were assessed to measure quality of ANC. Moreover, all the assessed studies generally reported low levels of ANC quality and utilization across the targeted countries; a finding that was replicated in the results for each of the dissertation papers. This affirms the continued need to address demand and supply needs in health service delivery in the three countries as well as other countries in SSA where the results are likely to be similar.

A recent service provision report in Uganda revealed that despite the new WHO guidelines recommending eight “contacts”; a shift from the previously recommended 4 or more visits as applied in the three studies, majority of the women did not achieve the latter(8). A similar case has been reported in Tanzania and Kenya(9, 10). This brings a question of whether limited resources should target ensuring the recommended 8 contacts to achieve the new ANC guideline, or whether to focus on the low utilization while addressing accessibility by women having less than 4 ANC visits or not receiving the services of a skilled provider. Moreover, studies have shown that higher rates in the number of contacts do not necessarily correspond to higher quality of care, and huge disparities in the receipt of essential ANC care components among women have been reported across populations in low-resource settings. For example, Kenya rolled out the 2014–2030 Health Policy Framework which included equitable distribution of health services and interventions in line with the SDGs(11). Among the applaudable outcomes of this policy is the provision of free basic maternal care in all public health institutions. This move has seen a considerable increase in the number of births assisted by skilled attendants as compared to previous years. However, the number of women missing out or having inadequate ANC during pregnancy remains high, closer to 40%(11).

The trend is similar in other African countries that despite removing user fees for ANC and delivery have reported a slow pace in the uptake of ANC and other maternal and childcare services(12-14). Possible reason for the continued low service utilization despite the governments’ effort in affordable care is the poor quality of services and disconnect in patient-provider interactions. Poor-quality in-service provision will likely translate to poor ANC quality for the users, as demonstrated in this paper. Policy makers should therefore balance in their

prioritization of limited financial and human resources to address both service provision and population needs and deterrents in accessing and utilization ANC services.

2. Measurement of outcomes

a) Vaccination

The vaccination study made the following overall conclusion regarding access and uptake of vaccination services: vaccination coverage in Kenya, Uganda, and Tanzania remains below the global estimates, ANC utilization and other forms of health facility access are associated with higher vaccination uptake, and vaccination cards are important reminders on vaccination dates. The findings demonstrated the potential for ANC as a period to lay strategies for higher vaccination rates, as shown by the association between intermediate and adequate ANC utilization with increased odds of vaccination. As such, health information surrounding the importance of vaccines should be introduced early in the ANC care period. Indeed, the vaccination shots provided to the mother during the pregnancy period are indirectly meant for the baby given that the health of the mother also affects the growth and development of the fetus. Explaining this linkage when administering the vaccines during the prenatal period could be an essential reminder of the importance of completing all the basic shots after the baby is born.

Vaccination requires the mother to visit the health facility and therefore it is expected that women will be convinced by the health care professionals about the need of vaccination. In this study, having a vaccination card was associated with increased likelihood of vaccination. The card serves as a reminder for the upcoming appointments for subsequent vaccination visits. With the high likeliness of losing the cards or damage, recent studies have tested the use of mobile phone technology in maintaining the connection between the clinics and the caregivers.

Appointment reminders through phone or email are common and effective in the western world and with the increasing mobile phone coverage and data technology in many parts of SSA, this is an area that has great potential in scaling up ANC and postnatal care clinics' visitations even in the most remote areas. Further research is needed on how mobile technology can possibly moderate the influence of ANC quality on maternal health promotive practices such as vaccination.

There have been several public health emergencies in the East Africa region including the threats of polio due to low immunization from neighboring countries in conflict, including, Somalia, Ethiopia, and Sudan(15, 16). However, none of these compare to the renewed vaccine hesitancy brought about by the global politics on Covid-19 pandemic, affecting immunization services and other public health interventions. Recent statistics from the WHO indicate reduced demand and low utilization of public health services in the WHO African region citing concerns of higher risks of exposure to COVID-19 in the clinical settings, stay at home orders, or general conspiracy theories surrounding the effectiveness and/or push on vaccination by the western nations(17, 18). The world is interconnected through social media and misinformation is widespread with a growing concern of the role of social media in amplifying the problem. Countries in SSA have an increased risk of the emergence of the already eradicated immunizable diseases due to the vulnerability of the structures and systems to reduce risk(18). Unfortunately, the challenge of communities distrusting modern vaccines will not recede with the pandemic. A significant step towards reducing the problem is restoring trust to health experts and maintaining and governments maintaining a stream of reliable and constant communication of COVID-19 spread and tying that to the significant impact of vaccination. There are also lessons learned from the COVID-19 mitigation that can be applied to improve the coverage of the other vaccines,

including community centered communication which involve localized approaches to community engagement to combat vaccine hesitancy. These strategies have been successful in Kenya and Malawi(19).

A combination of efforts are hereby recommended to scale up vaccination in the study countries, including: (a) harmonizing the political environment to create unity and uniformity of ideas on sustainable vaccine dissemination, b) inviting key stakeholders including religious leaders, influential non-governmental partners, and local community leaders, and health experts for a round-table discussion to abate vaccination rumors and misinformation, and c) tackling the web of social factors and media fraternity that is increasing becoming a modern threat in shaping perceptions and social acceptance of vaccines.

b) Diarrhea prevention

Prior research assessing the link between quality ANC and receipt of appropriate diarrhea prevention practices is largely non-existent. This study therefore provides a baseline for further exploration of this association especially given diarrhea is among the leading preventable causes of death among children in SSA. Unlike vaccination, some of the diarrhea prevention measures do not necessarily require interaction with the health facility and therefore target more on the knowledge and application of best mitigation measures at home. The support of our research hypothesis associating higher ANC utilization level with greater likelihood of applying diarrhea prevention measures justifies the possibility of acquired health literacy and reinforcement of individual's awareness and self-efficacy towards performing affordable and sustainable practices to safeguard children against diarrhea episodes.

The findings revealed that, in addition to ANC utilization, contact with the health system on other matters such as skilled delivery and postnatal check, were associated with higher odds of diarrhea prevention practices. This demonstrates great potential of seizing the opportunity by adding diarrhea sensitization and informational pamphlets as a routine in every maternal and child wellness visit. Tesema et al highlighted that while many hospitals in Kenya and Uganda have posters and charts demonstrating how to prevent diarrheal diseases, this information may have less impact if not discussed(20). Instituting policy strategies to discuss diarrheal prevention measures at the point of care and providing printed or video information to the population (patients) have been suggested as influential in increasing self-awareness and ability to act in preventing and/or managing diarrhea outbreaks.

Challenges persist in many SSA in creating policies to priority diarrhea prevention. Despite being among the top causes of child mortality, in comparison to HIV and malaria, diarrhea diseases receive minimal attention with very limited government and local media coverage(21). Except the rotavirus vaccination which have been adopted in most vaccine programs across many countries, the implementation of programs and policies surrounding diarrhea prevention are often scattered. Moreover, there is often a decentralized and fragmented organization with the responsibilities of vaccine, water, sanitation and hygiene, nutrition, and diarrhea treatment all falling across different government ministries, with none of the entities taking full responsibility of the diarrhea disease control. The case is different for programmes such as Malaria or HIV which have specific programs and structures to measure progress in managing the diseases in the countries. The findings from this study provide grounds for assessing social and structural gaps in policy related to diarrhea in each of the study countries. Overall, creating a political support to raise the profile of diarrheal disease as a top cause of

death in the targeted countries and SSA as a whole, better coordination of water sanitation and hygiene (WASH) activities, and population awareness about holistic approach to diarrhea disease are key towards saving children's lives.

c) Breastfeeding

The study results revealed that, across all the three countries, approximately 50% of women do not initiate breastfeeding within one hour after birth, only about 20% exclusively breastfeed and about two-thirds of the women continue to breastfeed beyond six months. The rate of continued breastfeeding is expected to drastically drop as the child becomes older. In an ideal situation, breastfeeding is generally an innate, physiological process that is expected to happen after giving birth. The process, however, doesn't happen smoothly for majority of women. Breastfeeding is a learned activity and new mothers have varying difficulties in adjusting to the practice. Consequently, the ultimate decision, especially to exclusively breastfeed or continue breastfeeding beyond six months can either be voluntary or involuntary due to difficulties associated with the process. This can explain the non-significant association between ANC quality measures and especially exclusive and continued breastfeeding outcomes, indicating underlying struggles that hinder breastfeeding irrespective of access to information, through ANC, on the benefits of breastfeeding.

The feeding challenges experienced at the initial days of baby's life are expected to continue if proper knowledge and support is not accorded. The results showed that younger mothers (majority of whom are first time mothers) or those who give birth by c-section struggle with breastfeeding if not well supported. With this context, this study recommends information dissemination strategies during the ANC period to discuss the challenges and appropriate feeding practices. The ANC period is also a great opportunity to discuss the caring of newborn with the

men, who in most African cultures, are rarely involved in delivery and care of newborn. Indeed, some of the adverse cultural practices affecting the feeding of the mother or breastfeeding of the child could be avoided if the husbands (or male partners) are well-informed, hence empowered to act on the interest of their spouse and newborn(s).

Interventions programs aimed at reducing neonatal and infant deaths should lay more emphasis on the informational or behavioral gaps on breastfeeding uptake, especially in SSA where despite having higher optimal breastfeeding rates as compared to high income countries, the neonatal and infant mortality are still higher. As a solution towards behavior change and strategies for mitigating less optimal breastfeeding practices at any given stage of the required breastfeeding period, this study recommends a multifaceted approach addressing various drivers to adequate breastfeeding practices, namely: a) mother's physical readiness and self-efficacy to breastfeed, b) social environment (home/work etc.), and c) institutional support (health system). The ANC period creates a great opportunity for maternal education on breastfeeding preparedness. While the WHO ANC guidelines include the incorporation of breastfeeding information as part of birth preparedness(22), there is a gap on the literature on effectiveness and extent to which this information is adapted and shared during the ANC visits in the research countries. Frequently ignored but important issues found to be significantly associated with breastfeeding in this study include immediate skin-to-skin-conduct after birth, correct baby positioning, anticipation of c-section and associated breastfeeding challenges, breastfeeding in case of c-section, techniques to stimulate milk flow, among others. The ANC period creates a great opportunity to share some of this information to the mother and her family as a form of orientation to the nursing of the newborn. In addition to dialogue, visual aids and videos that are

culturally appropriate to the local context and interpretable to low -literacy populations can be useful for easier understanding and recall of information shared.

Skilled delivery and utilization of post-natal care were associated with higher odds of breastfeeding in this study. This signifies the important opportunity of incorporating breastfeeding information in wellness checks for new mothers irrespective of what brought them for the visit. In the early postnatal period, especially, health workers should seize the opportunities for routine clinic visits, such as immunizations and mother's postnatal checks, to proactively ask about breastfeeding concerns with the mother and help demystify the medical benefits of breastfeeding to both the mother and the baby.

Aside from the individual interaction with the health system, the family roles in many African families are changing with the continued efforts and sensitization for girl-child education. Gender equity campaigns have also seen women taking up white-collar jobs and some becoming head of households(22). The study highlighted that women who are less educated and resided in the rural areas had increased odds of exclusive and continued breastfeeding. Working mothers struggle to sustain breastfeeding upon return to work after maternity leave or just balancing work and nursing a newborn. This study recommends workplace policies geared towards creating private spaces for nursing moms in the workplace. Among the three countries, Kenya has made some steps towards creating policies to support breastfeeding women at the workplace, through the recently enacted law, under the Health Act 2017, mandating employers to create safe spaces for breastfeeding women in the workplace, in line with the International Labor Organization Maternity Protection recommendation (N0.191). This is an area that warrants follow up studies to examine the feasibility, implementation, and outcomes of this policy, and comparing it with similar policy frameworks in other African countries.

Follow up research to this study could be a randomized controlled study evaluating the effectiveness of ANC breastfeeding education with both urban and rural clusters. The trial can test the effect of individual or group breastfeeding intervention against no breastfeeding education intervention. The group without education can be defined as receiving no formal or standardized information from a skilled provider during the ANC visits, excluding other informal sources such as mass media or peers. The outcomes can be the duration of exclusive breastfeeding, measured using survival analysis (duration up to the point of stopping exclusive breastfeeding), or binary logistic regression to examine the practice of exclusive breastfeeding at a given period vs not exclusively breastfeeding.

Tackling the complexity of health policies, social environment, and health behavior

The findings illuminate the benefit of quality ANC to not just the mother but also to the health and growth trajectory of the child, especially in estimating the early initiation and progress in breastfeeding, vaccination coverage, and practice of diarrhea prevention measures. However, a common question for sustainable behavior change pertains to how the public health system can be structured or positioned to improve health outcomes through the provision of services or health information dissemination that would increase the health literacy levels on various topics of public health importance, as well as which areas should be prioritized to see changes in the health outcomes. While many public health policy interventions target health behaviors with an aim to understand existing cultural and social norms to explain behavior in the social realm, others focus on the social and physical environment where individuals' behavior is somehow determined by the policies and resources within their surroundings. Because of the sporadic nature of many public health issues in SSA, majority of the interventions tend to be reactionary to solve the current problem with immediate attention. As a result, process improvement

strategies and mitigative measures for future preparedness are not thoroughly investigated. John Sterman (23), in his attempt to explain decision making in complex systems, explains how public health policy tends to focus on the short-term predictions of health outcomes and tends to ignore the complexity of the relationship between public health infrastructure, health policies and guidelines, as well as the dynamics within the population.

The social cognitive theory (SCT), which asserts that individual's behavior is learnt through interactions with the environment as well as observing others and reproduce the acts, is applicable in guiding the frameworks for linkage between health system and health promotion practices. Many theories in health promotion focus on behavior initiation with limited emphasis on habit maintenance and the aspect of self-efficacy which relates to control on one's behavior makes the SCT very relevant in guiding the overall recommendations for this study. In addition to the reciprocal determinism which explains the dynamic inter-relationship between an individual and their environment, key constructs of the SCT model such as the self-efficacy, behavioral capability and expectations are important in explaining behavior change. Specifically, considering a mother's decision on the health promotion practices, guided by the knowledge and skills to perform behavior (behavioral capability), the anticipated outcomes of better health for their children(expectations), or overall determination and cognitive ability to perform the behavior (self-efficacy), the behavioral choices are likely affected by other factors including the availability or absence of policies, or social environment. This complexity should therefore be considered while addressing the challenges in health outcomes especially in the targeted multicultural East African countries.

Indeed, beyond ANC, the studies highlighted how other social and environmental factors potentially influenced the childcare practices irrespective of individual cognitive awareness. The results reveal many areas in which to focus efforts towards enhancing improved care for women and children, such as, maternal education, focus of young and/or teenage mothers, support and information sharing on infant care after c-section, water sanitation and hygiene (WASH), vaccine hesitancy, among others. This information can be directly useful in designing campaigns to increase curative and preventative care for children under-five, not only in East Africa, but other regions in Sub-Saharan Africa, where child mortality remains high.

__The End__

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