Chapter 44

A Systems Dynamics Approach to Understanding the Determinants of Antenatal Care Utilization in Low-and Middle-Income Countries:
A Systematic Review

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ABSTRACT

There has been low adherence of antenatal care utilization (ANC) in low and middle-income countries (LMIC) despite its associated negative outcome on women and their unborn babies. Although several studies have examined ANC, the majority focus on isolated aspects and do not explore the holistic approach to understand its dynamics. The system dynamics approach provides a deeper understanding of the phenomenon by examining the underlying factors, causes, effects, feedback, and delays. This study aimed at understanding factors that influence ANC utilization using the system's dynamics approach. An interpretive systematic review to establish multifaceted and context-specific processes was done between May and November 2019. Data from 24 articles were synthesized and used to build causal loop diagrams, which were validated through focus group discussions and interviews with stakeholders. Results revealed human resource numbers and welfare, awareness campaigns, peer support groups, and community-based engagement as key leverage points towards ANC improvement.

INTRODUCTION

Unlike the developed world, maternal mortality is one of the greatest health and development concerns in the developing world (Paxton & Wardlaw, 2011). About 830 women die every day from pregnancy and childbirth-related complications and approximately 303,000 women died worldwide in 2015 during and following pregnancy and childbirth (WHO, 2018). Around 99% of maternal deaths occur in low-resource settings (WHO, 2014).

BACKGROUND

Antenatal care (ANC) reduces maternal and perinatal mortality and morbidity through detection and treatment of pregnancy-related complications, and the identification of women and girls at increased risk of developing complications during labor and delivery, thus ensuring referral to an appropriate level of care (Kuhnt and Vollmer, 2017; WHO, 2016). ANC is the care given by skilled healthcare providers to pregnant women and adolescent girls in order to ensure the best health conditions for both mother and baby during pregnancy (WHO, 2016). ANC includes risk identification; prevention and management of pregnancy-related or concurrent diseases; and health education and promotion (WHO, 2016). World-wide, approximately 64% of women had attended four or more ANC visits in 2016 (Ogbo *et al.,* 2019).

ANC services enable the identification of risk factors and early diagnosis of pregnancy complications such as preterm delivery, preeclampsia, anemia, neonatal tetanus, ectopic pregnancy, gestational diabetes, infections and birth defects (Perumal, Cole & Ouédraogo, 2013; Ali *et al.* 2018; WHO United Nations Children's Fund & United Nations Populations Fund, 2017). WHO envisions a world where "every pregnant woman and newborn receives quality care throughout the pregnancy, childbirth and postnatal period" (Tuncalp *et al.* 2015).

ANC services leads to the utilization of other maternal services like institutional delivery and seeking assistance for complications during delivery and postnatal period (Ali *et al.,* 2018; Namatovu, 2018). Good quality ANC services improve the survival and health of mothers and their unborn babies (Tekelab *et al.* 2019). The attainment of the recommended ANC visits varies between countries, tribe and culture, socio-demographic, geopolitical region, place of residence and socio-economic status. Since ANC is envisioned to improve pregnancy outcomes, it is prudent to understand the conditions that limit its adherence.

Motivation

Across the globe, different interventions for instance the provision of clean delivery kits; training of community health workers (CHW), skilled birth attendants and health care staff on birth preparedness through community mobilization and home visits have been employed to improve ANC attendance and utilization (Lassi *et al,* 2016). However, little progress has been registered in low and middle-income countries (Awasthi *et al.* 2018; Islam & Masud, 2018; WHO, 2016; Bloom, Lippeveld & Wypij 1999; Ram and Singh, 2006) with many not achieving the Ali2016). Although several studies have been conducted across the globe to understand the facilitators and barriers of ANC (Anastasi *et al.* 2015; Ghose *et*

al. 2017; Mugo, Dibley & Agho, 2015; Noh *et al.* 2019; Ogbo *et al.,* 2019; Wolderufael, 2018; Morgan *et al.,* 2018), many focus on isolated aspects and have not explored ANC utilization in the context of Systems Dynamics. Therefore, the study explored the use of the System Dynamics methodology with the aim of gaining a deeper understanding of the key leveraging points that could possibly improve antenatal utilization in low and middle-income countries, hence being a basis to inform decision-making and better policy formulation.

METHODOLOGY

Systems Dynamics (SD) modelling pioneered by Jay Forrester in the late 1950's is a problem-oriented approach that was invented to help managers better understand industrial problems (Forrester, 1958). Since then, it has been used in different fields like environmental health (Currie, Smith & Jagals, 2018), policy analysis (Barlas, 2007), healthcare systems (Rwashana & William, 2009), food security (Guma, Rwashana & Oyo, 2018), policy planning (Soni & Chorasia, 2017), modeling and investigating economy and production structure (Abdollahi & Ebrahimi, 2019), model interactions among sustainable development goals (Zelinka & Amadei, 2019) and dynamics of product development in software start-ups (Shanbhag & Pardede, 2019).. Systems dynamics modelling is "*discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots…systems thinking is a discipline for seeing the 'structures' that underlie complex situations, and for discerning high and low leverage change.*" (Senge, 1990). Dynamism in a problem essentially looks at the changing nature of variables over time. The basic structural mechanism in SD modelling is the notion of feedback loops of mutual causality known as causal loops (Yearworth, 2014). Causal mapping and computer simulation offer an understanding of the systems behaviour which allows policy makers to experiment with their decision before implementation in the real world (Currie *et al.,* 2018). SD deals with dynamic policy problems of systemic, feedback nature, self-organizing, non-linear, adaptive, policy resistant, counterintuitive and history dependent (Barlas, 2007; Sterman, 2000). Unlike the conventional correlational models, SD requires that models consist of causal relations which are relevant in understanding and controlling dynamic problems (Barlas, 2007). SD draws strongly on the concept of endogeneity, meaning that it seeks to find explanations for systems behaviour by understanding the internal structure of the system rather than concentrating on external factors (Currie *et al.,* 2018). For instance, in trying to understand the poor quality services offered in health facilities, one would quickly blame individual factors such as the attitude of care providers. An endogenous stance capitalizes on unraveling systemic factors such as congestion in hospitals, stockouts of drugs, equipment and supplies, poorly motivated and inadequate human resources, poor remuneration, lack of proper training, funding and resources such as water and oxygen among others.

This study employed the research design framework in Figure 1, which drew from existing studies (Rwashana and William, 2009) describing SD research for field studies. This framework integrated systematic review and synthesis as stages which focus on systematic review of literature.

This framework offered a starting point to decipher issues pertaining to ANC. The activities done in the stages are outlined below.

Figure 1. Research design framework for systematic reviews in system dynamics
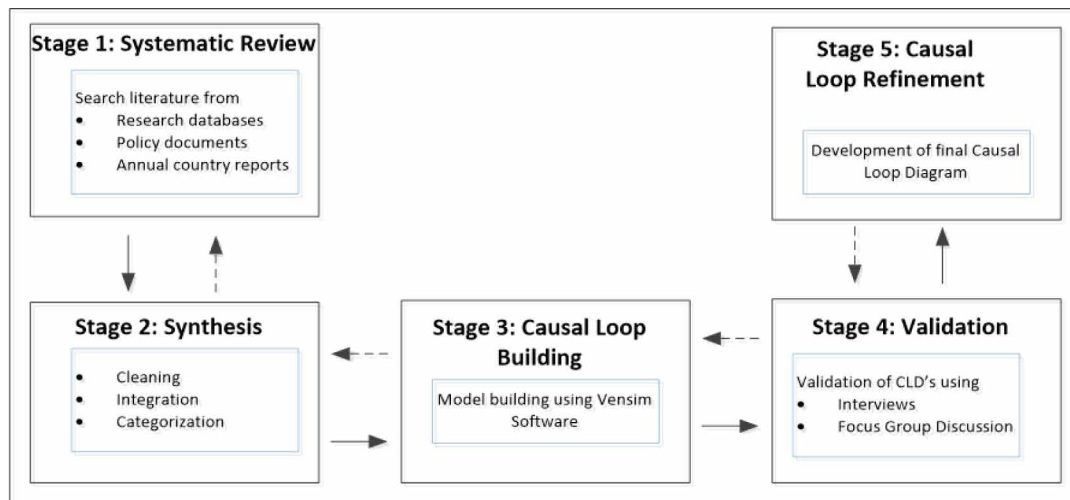
Stage 1: Systematic Review

A systematic review of literature for studies conducted with expectant mothers in LMIC was done with the aim of understanding the factors that influence ANC utilization. This review was conducted between May and November 2019. Searches were made in google scholar, PubMed, Medline, CINAHL (Cumulative Index to Nursing and Allied Health Literature), Embase, ScienceDirect, Taylor and Francis, Springer, Emerald Publishers, IEEE, AJOL (African Journals Online), and Maternity and Neonatal databases for studies conducted between 2010 and 2018. Search terms used include "antenatal care" or "prenatal care" or "maternity care" or "maternal healthcare" or "maternal health" or "pregnant" or "women" or "pregnant women" or "expectant" or "mothers" or "expectant mothers" or "determinants" or "factors" or "utilization" or "barriers" or "facilitators" or "Uganda" or "LMIC" or "attendance" or "systems dynamics" or "systems" or "dynamics".

The selection criteria included studies that were; i) qualitative or quantitative ii) primarily focusing on the barriers, facilitators and / or determinants of antenatal care access and utilization iii) carried out in low and medium-income countries (LMIC). Among other aspects, the study must have been conducted with pregnant women or women who had given birth to at least one child prior to the study. The qualitative studies included articles with semi-structured and structured interviews, ethnography, focus group discussions and discourse analysis. Only full-text articles written in English-language were included. Some articles were obtained from the reference list of the selected articles while others were references from peers. The exclusion criteria included studies; i) not directly related to maternal healthcare, and ii) not conducted in LMIC's.

Data was systematically extracted from the selected articles by the authors following the inclusion criteria checklist. This checklist was drafted by the authors and a data extraction form developed which included: the author(s) name, year of publication, country, study design, sample size, study population, data source and variables under study (Table 2). Out of the 216 articles that were identified from the

original database search, only 24 met the inclusion criteria. All reviews were done independently by both authors following an 8-category checklist. For correctness and consistency, each article was reviewed more than three times by both authors. To eliminate bias, the inclusion criteria checklist was validated by expert researchers in the field of maternal health and Systems Dynamics.

Stage 2: Synthesis

All data from the literature search was cleaned for consistency, integrated to ascertain correlation between the data and categorized for coherence. The overall objective of this phase was three-fold, i) to increase the applicability of the findings ii) develop new patterns in the data to get a deeper insight into the findings, and iii) provide critical knowledge to solve the problem. The variables associated with ANC utilization were categorized as demand factors and supply factors (Table 3).

Stage 3: Causal Loop Building

The cause and effect relationships between the variables were established. The building of the causal loop diagrams was done through an iterative modelling process with the help of Vensim modelling software. The resultant CLD's were presented to different stakeholders for validation in order to identify and provide input to improve the diagrams. All determinants in CLD's are referred to as variables.

Stage 4: Validation

The validation exercise involved presenting the causal loop diagrams to several stakeholders. A naturalistic evaluation was adopted which involved validating the CLD with real people in the maternal health setting. Venable, Pries-Heje & Baskerville (2014) posit that evaluation is an avenue for providing feedback for further development. A qualitative evaluation strategy with expectant mothers, village health teams (VHT), peer mothers, nurses and midwives, gynaecologists/obstetrician and Ministry of Health (MoH) policy makers was conducted to ascertain the validity of the causal factors against antenatal care utilization. Inclusion criteria included i) evaluator consent, ii) a woman who is expectant or has had a child before, iii) a nurse, midwife and VHT with a minimum of two years working with mothers, iv) policy makers in MoH dealing directly with policy issues of maternal health. Policy makers, gynaecologists and VHT's were purposively sampled while expectant mothers, midwives and nurses were randomly selected in health facilities during antenatal care visits. Village health teams were recommended by local council leaders. Each group of evaluators were engaged on different days to enable free expression. A total of seven FGD's that approximately took one hour were conducted with 44 evaluators as demonstrated in Table 1. To get further insight of the variables and the CLD in general, face-to-face semi-structured interviews were conducted with a few participants who had earlier been part of the FGDs. When all the focus groups were done, a random selection of 13 participants was done to participate in the interviews. These included, expectant mothers N=4, peer mothers N=2, village health teams N=2, midwives N=2, SD experts N=2 and gynaecologist N=1.

Table 1. Validation criteria

Method of Validation	Evaluators	Number
Face-to-face Interviews Focus Group Discussions	Expectant Mothers	13
	Peer mothers	8
	Village Health Team	4
	Nurses	5
	Midwives	6
	Obstetrician/Gynaecologist	4
	Ministry of Health policy makers	2
	SD Experts	2
	Total	44

Stage 5: Causal Loop Refinement

The feedback and suggestions that were obtained during the validation sessions were incorporated and the final causal loop diagrams were drawn as presented in Figures 2 and 3.

Findings

Findings in Table 2 present the different determinants of ANC across various areas that were obtained from the 24 papers that were selected during the systematic review. The regional variations of these factors may be due to region-specific differences in socio-economic status, culture, socio-demographic, political status among others. What is peculiar about the findings is the fact that more than half of the determinants are common across the regions, implying that common interventions can be applied in different regions.

Categorization of Variables

The variables associated with ANC utilization that were derived from the systematic review shown in Table 2 were categorized as demand and supply-side as shown in Table 3. On the demand side the factors associated with ANC utilization were placed in eight (8) categories namely, socio-economic status, socio-cultural values, awareness, trust, access, perceived ease of ANC use, health of pregnant woman and familial support. The factors associated with the provision of health care services were placed on the supply-side of the ANC utilization and placed in two (2) categories namely; service provision and access.

Causal Loop Diagrams

Causal loop diagrams are graphical representations of cause and effect structures and processes that have loops (Bures, 2017). They provide a method to map the complexity of a system of interest that consists of variables, causal relationships and polarities of both links and feedback cycles (Hovmand,

Table 2. Determinants identified from the studies related to Antenatal Care

Author and Year	Study Design/ Methods Used	Country/ Sample size/ Study Population	Determinants
Abekar-Nkrumah *et al.*, 2013	Cross-sectional study, Interviews	Ghana 4,916 Women who had given birth in the past three years prior to the study	Use of contraception, timing of first ANC and place of delivery (response variables), religion, Availability of transport, distance, ICT access, education, rural residence, household wealth, age, number of women in a household, Ethnicity
Anastasi *et al.*, 2015	Cross-sectional study. Entry and Exit interviews, semi-structured interviews, focus group discussions (FGD)	Uganda 130 Women, health workers, policy makers, men and traditional birth attendants	Age, woman's education, husband's education, ethnicity, distance to health facility, time to reach health facility, cost of reaching the facility, religion, gravidity, permission to go to a health centre, Perceived ease of reaching the facility, received ANC advice during the last pregnancy.
Andrew *et al.*, 2013	Cross-sectional study FGD, in-depth interviews, observation in healthcare facilities, case studies	Papua New Guinea 210 Expectant mothers, their relatives, biomedical and traditional health providers, opinion leaders and community members	Antenatal care (response variable). Visit fee, transport cost, cost of baby book, availability of transport, duration of ANC visits, desire to obtain medicine, not wanting to take medicine, limited knowledge of ANC interventions, familial support, relationship with healthcare provider, fear of disclosing pregnancy, spite, experience at the clinic, stigma, fear of sorcery. Timing of the first ANC visit (response variable). Perception of the right time to start ANC, strength of the fetus, parity, experience, desire to avoid multiple visits, transport costs, clinic charges, distance, laziness.
Atekyereza and Mubiru, 2014	Cross-sectional study, Informant interviews, FGD	Uganda 45 Women, mothers and expectant mothers	Pregnancy perceptions, socio-cultural beliefs, age, occupation, residence, quality of service, education, religion, marital status, pregnancy experience, patriarchal culture, cultural values and beliefs.
Ayele *et al.*, 2014	Cross-sectional Questionnaire, interview	Ethiopia 495 Mothers	Age, education, health education on ANC, family size, history of abortion, means of transport to the health facility, perception of quality of service, rural-urban residence
Bbaale, 2011	Population based cross-sectional data 2006 Uganda Demographic and Health Survey	Uganda 8531 Women	Maternal education, education of spouse, wealth or economic status, location, timing and frequency of ANC, nature of facility visited, access to media, utilization of professional care, birth history, age, religion, ownership of ANC facility, practice of family planning.
Cumber *et al.*, 2016	Cross-sectional Questionnaire	Cameroon 50 Expectant mothers	Age, religion, marital status, education, profession, knowledge of ANC, poverty, culture/religion, distance, availability of health facilities in remote areas.
Ndidi and Oseremen, 2010	Cross-sectional Questionnaire	Nigeria 494 Expectant mothers	Age, parity, social class, marital status, marital setting, cost of care, ignorance about ANC, perception.
Ganle *et al.*, 2015	Cross-sectional FGD, individual interviews, key informant interviews	Ghana 185 Expectant and lactating mothers, healthcare providers	Decision-making autonomy, age, education, occupation, marital status, religion, type of marriage, location/village, residence, parity, gravida, place of delivery.
Ghose *et al.*, 2017	Population based cross-sectional data 2014 Bangladesh Demographic and Health Survey	Bangladesh 4309 Women	Age, education, occupation, wealth/economic status, parity, decision-making autonomy, residence,

Table 2. Continued

Author and Year	Study Design/ Methods Used	Country/ Sample size/ Study Population	Determinants
Gross *et al.*, 2012	Cross-sectional Qualitative exploratory study, questionnaire and exit interviews	Tanzania 440 Expectant mothers	Perceived quality of care, recognition of pregnancy, support from spouse or partner, age, parity, marital status, history of abortion, education, ethnicity, knowledge of service, perceived healthcare attitudes, tradition medicine use, money, advice received to attend ANC, accompaniment to the clinic.
Kahn *et al.*, 2015	Cross-sectional Questionnaire	Uganda 676 Expectant mothers	Age, gravidity, parity, HIV prevalence, location, cash incentive given per visit.
Kawungezi *et al.*, 2015	Cross-sectional Interviewer administered questionnaire, FGD, key informant interviews	Uganda 401 Expectant mothers	Age, marital status, religion, education, parity, occupation, place of delivery, absence of pregnancy problems, distance, lack of knowledge, attitude of health workers,
Kisule *et al.*, 2013	Cross-sectional Interviews, clinical observation, questionnaire	Uganda 400 Expectant mothers	Age, religion, distance, maternal education, paternal education, marital status, obstetric history, gravidity, history of abortion, history of a problem in current or previous pregnancy, occupation of woman, occupation of man
Morgan *et al.*, 2017	Cross-sectional Group discussions	Uganda 46 Women who had given birth, fathers whose wives had given birth and drivers	Economic status, lack of dedicated transport, lack of support from husband, high workload, perception of women's attitude during pregnancy, attitude towards fatherhood, attitude towards domestic violence, health worker attitude and behaviour, decision-making.
Mugo *et al.*, 2015	Household health survey 2010 South Sudan household health survey. Interviews	South Sudan 9069 Women	Geographical region, type of residence, maternal age, birth order, gravida, pregnancy outcome, parity, marital status, polygamy status, education, literacy, health knowledge, wealth index, pregnancy complications, desire to get last pregnancy
Pell *et al.*, 2013	Cross-sectional Interview, FGD, Observations	Ghana, Kenya, Malawi 645 Pregnant women, health workers, traditional birth attendants, opinion leaders, relatives, community members.	Age, parity, gravidity, previous or ongoing health problems, timing, pregnancy disclosure, women's fear of chastisement from health workers, direct charges of ANC, transport costs, journey to health facilities, inflexible monthly follow-up appointments, decision-making dynamics, delay discovering a woman's HIV status, stigma of adolescent pregnancy, complacency among older multiparous women
Resty, 2011	Cross-sectional Interview, questionnaires, Observations	Uganda 98 Pregnant women, health workers	Residence, age, education level, marital status, occupation, frequency of ANC attendance, attitude towards pregnant mothers, long waiting hours, lack of education, long distances.
Rurangirwa *et al.*, 2017	Cross sectional Interview administered questionnaire	Rwanda 921 Women who had given birth 13 months prior to the study	Maternal age, number of people in the household, marital status, ever attended school, highest level of education, socio-economic status, social support, husband age, husband ever attended school, husband education level, husband's occupation, total household monthly income, pregnancies before the latest one, type of ANC facility visit, time walking to ANC clinic, place of delivery, previous ANC attendance, household head, number of people in the household, household assets, pregnancy complications
Rutaremwa *et al.*,2015	Household health survey 2011 Uganda Demographic Health Survey.	Uganda 1728 Women of reproductive age who delivered a child one year prior to the 2011 UDHS	Level of education, region of residence, religion, age, rural/urban residence, wealth index, parity, distance to health facility, visited health facility in past year, marital status.

843

Table 2. Continued

Author and Year	Study Design/ Methods Used	Country/ Sample size/ Study Population	Determinants
Tran *et al.*, 2012	Cross-sectional Household interviews using structured questionnaires	Vietnam 2132 Pregnant women	Age group, education, occupation, ethnic group, household economic status, community condition, parity, pregnancy at risk, type of ANC facilities, time for first visit, marital status,
Turyasiima *et al.*, 2014	Cross-sectional Interview administered questionnaire	Uganda 427 Pregnant women, midwives	Religion, tribe, marital status, education level, distance to health facility, knowledge of ANC, economic status, husband support, husband status, husband educational level, opening hours, traditional beliefs, HIV/AIDS testing, ANC cards, role of husbands and in-laws, health education, outcome of pregnancy, negative attitude towards ANC, planting season, lack of outreach services, lack of medical equipment.
Wolderufael, 2018	Cross-sectional Questionnaire, face-to-face interviews	Ethiopia 639 Mothers who gave birth in the last five years prior to the survey	Age, marital status, religion, ethnicity, maternal education, paternal education, occupation, previous obstetric history, gravidity, parity, birth order, husband attitude, mother's knowledge, family's income, family size, access to health facility, visit by health extension worker, polygamy, movement of family during recent pregnancy, source of information about ANC services.
Worku, 2013	Cross-sectional Interview, questionnaire	Ethiopia 1668 Women who had births in the year preceding the survey.	Birth order, maternal and paternal education, wealth, awareness on risk of pregnancy, awareness of places to get skilled providers, pregnancy wantedness, ANC in previous pregnancy, health professionals preferred by women, source of income, self-sustained, average distance, presence of signal functions, duty service, availability of obstetric guidelines, payment requirement.

Table 3. Categorization of variables associated with ANC utilization

Category	Determinants
Determinants at the demand-side of ANC utilization	
Socio-economic status	Education level, occupation, total household income, age of mother, place of residence, planting season, poverty, social class
Socio-cultural values	Cultural values and beliefs, practice of sorcery, traditional medicine use, ethnic attachment, religious values
Awareness	Attitude towards HIV testing (fear), access to ICT, mother received ANC advice during previous pregnancy, fear of taking ANC prescription medicine, access to media
Trust	Experience while at the clinic, Fear of chastisement from health workers, knowledge of ANC, relationship with healthcare providers
Access	Duration of ANC visit, perceived ease of reaching the health facility, time to reach the facility, availability of transport, cost of accessing care
Perceived ease of ANC use	Attitude towards fatherhood, laziness, maternal attitude
Health of a pregnant woman	Recognition of pregnancy, unplanned pregnancy, history of abortion, practice of family planning, birth history, strength of the fetus, gravidity, pregnancy complication, parity
Familial support	Influence of family and friends, number of women in the household, marital status, polygamous marriage, husband support
Determinants at the supply-side of ANC utilization	
Service provision	Morale of staff, quality of care, waiting time while at hospital, frequency of monthly follow-up meeting, availability of medical equipment, opening hours, number of staff
Access	Availability of a health facility, distance, cost of transport, cost of service, type of facility visited

2013). From the findings presented in Table 3, two causal loop diagrams were developed to represent the demand and supply side determinants of ANC utilization.

Demand Side

The first causal loop diagram presented in Figure 2 shows the factors associated with the demand for ANC utilization that are related to the pregnant women and the community in which they live. The causal loop diagram has five reinforcing loops (R1, R2, R3, R4, R5) and two balancing loops (B1 and B2). The five reinforcing loops are all virtuous cycles which bring out growing desirable outcomes as illustrated below while the balancing loops are aimed at achieving goals related to improving ANC utilization.

Reinforcing Loop R1: An increase in the maternal and spouse education will linearly improve their occupation status, which will increase their total household income hence improving their ability to seek education. These socio-economic factors that are likely to influence ANC utilization in a positive way, hence a virtuous reinforcing loop that improves the socio-economic status of the households.

Reinforcing Loop R2: An increase in the attendance of ANC increases the mother's awareness of ANC such as potential outcomes. Once mothers' awareness of ANC increases, this reduces the fear of taking ANC prescription drugs. Once the fear among women reduces, there will be confidence to visit health facilities hence improved ANC visits resulting in a virtuous loop of increased uptake of ANC medication.

Reinforcing Loop R3: This loop demonstrates that increased awareness of ANC potentially improves knowledge of ANC, which in turn increases women's trust in the health system. The trust positively influences the women's ability to seek ANC which enhances awareness, resulting in a virtuous loop.

Reinforcing Loop R4: This loop shows that when women have a high level of trust in the health system, their relationship with health care providers will improve which consequently reduces the chastisement by the staff in the health facilities. Chastisement can be alleviated by improving the welfare of the health care providers which positively changes their attitude towards mothers. Once chastisement is curbed, it improves women's trust to seek ANC services.

Figure 2. Causal Loop Diagram of Determinants influencing ANC Utilization at the demand side
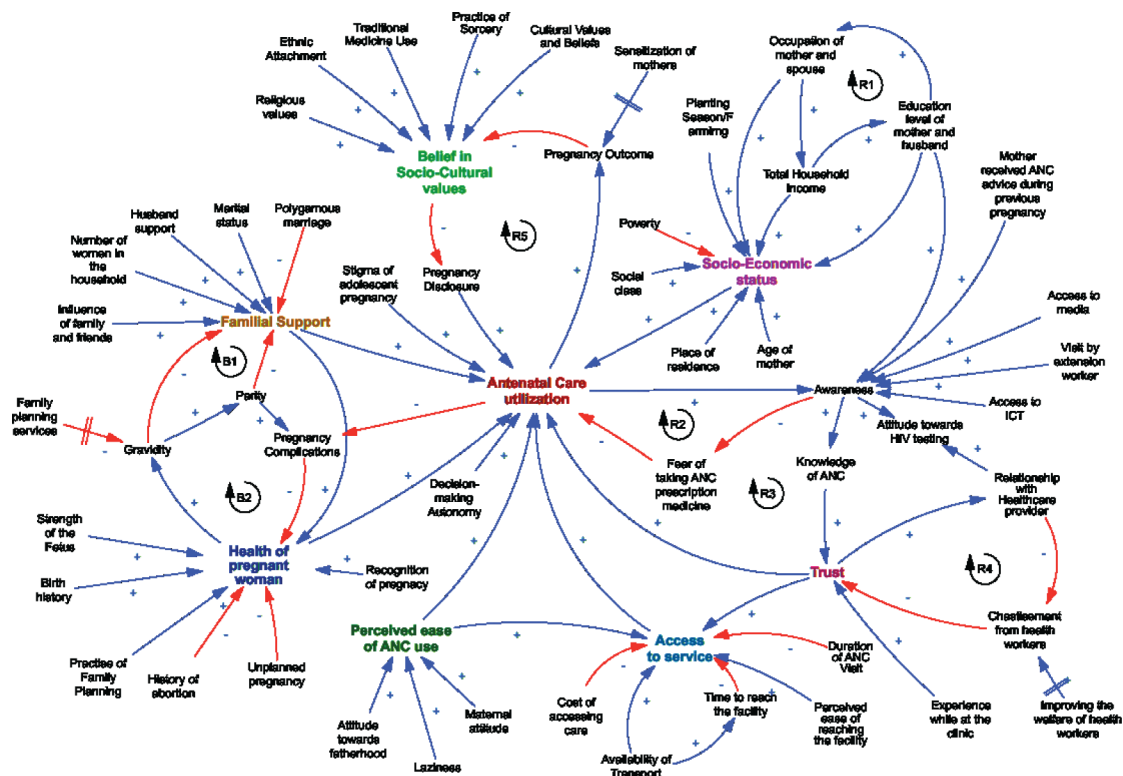
Reinforcing Loop R5: Loop R5 demonstrates that mothers with high attachment to socio-cultural beliefs and values, which is influenced by their ethnic affiliation, religious and cultural values, practice of sorcery and traditional medicine use, are likely not to disclose their pregnancies which negatively affects ANC utilization hence leading to negative pregnancy outcomes. Mothers with negative pregnancy outcomes will in the long run associate less cultural practice with pregnancy, resulting in a virtuous loop of increased belief in ANC utilization.

If the virtuous cycles are strengthened as explained, there will be a tremendous increase in the demand for ANC utilisation which in the long run necessitates an increase in the ANC service provision to match the growing populations.

Balancing Loop B1: Loop B1 demonstrates that women with good health have increased chances of being pregnant (gravidity), which tends to reduce familial support and in turn may affect their health. The reduction in familial support may result in prenatal and postnatal depression and not adhering to professional visits at the hospital. Familial support is the help and encouragement women get from family, friends, spouse and others in the community. As the gravidity increases the family size also increases which eventually lowers the familial support.

Balancing Loop B2: Loop B2 is similar to loop B1, however, it brings out the fact that an increase in gravidity results in increased parity which results in pregnancy complications resulting from having too many children. In order to minimize this, efforts should be put in place by the health sectors to provide easy to use and accessible family planning services which reduce the frequency of pregnancies, thus lowering the parity, leading to minimized pregnancy complications and thereby improving the overall wellbeing of the woman.

Supply Side

The second causal loop diagram presented in Figure 3 shows the factors associated with the supply of the ANC service provision. The causal loop diagram representing the supply side of ANC service provision has six balancing loops (B3, B4, B5, B6, B7 and B8) and two reinforcing loops (R6 and R7) demonstrating factors that influence antenatal care utilization.

Reinforcing Loop R6: Loop R6 shows that staff welfare and training results in improvement in staff morale which results in improved quality of ANC service provision through increased service hours and improved attitude towards the women. When the quality of service is enhanced, ANC attendance will be meliorated, hence health workers' morale towards the service will be heightened, leading to a virtuous reinforcing loop.

Reinforcing Loop R7: Loop R7 shows that increased funding of the health sector tantamount to increased availability of health facilities, which in turn, reduces the distance that mothers have to travel to the health facilities. Once this distance is shortened, mothers' willingness to utilize ANC will increase. When ANC attendance improves, the quality of the ANC service provision is lowered due to the huge numbers of women that exceed the capacity of the health facilities. Once the quality goes down, the need for ANC service provision will go up which increases the funding in the health sector, resulting in construction of more health facilities to increase utilization. This results in a virtuous cycle which leads to construction of more health facilities.

Balancing Loops B3, B4, B5, B6 and B7: Loops B3, B4, B5, B6, B7 are balancing loops that relate to the provision of quality ANC service. Funding in the health sector improves stock (B3), number of health workers in the health facilities (B4), availability of medical equipment (B5), monitoring and supervision in the health sector (B6) and staff welfare and training (B7) all resulting in improvement in the quality of ANC service provision. Increased service provision lowers the need for ANC funding whereby the priority is shifted to more urgent needs. This in turn will affect the funding for the health sector which eventually affects the ANC service provision.

Balancing Loop B8: Loop B8 demonstrates that when the quality of ANC service provision increases, the ANC utilization also increases which with time lowers the quality of service since the resources become inadequate due to the huge numbers. This calls for adequate planning and monitoring to ensure that as growth takes place in utilization the health service is equipped to manage the expansion.

Both cycles produce negative loops, indicating a problem that requires intervention. Government can intervene by increasing funding to improve staffing numbers, staff welfare and stocking health facilities with drugs, equipment and supplies to improve service provision. This, in time, will improve on the deflated morale of staff and quality of care will subsequently improve, thereby improving ANC attendance.

Figure 3. Causal Loop Diagram of Determinants Influencing ANC Utilization at the supply side

RESULTS FROM THE VALIDATION

For each focus group, CLD's were presented to the evaluators to ascertain and validate the determinants of ANC and whether the representation was correct. Responses from all the FGDs were followed by anecdotal statements, which have also been integrated with interview responses. Participants were asked whether the CLD's especially the variables, loops, delays were correctly represented. Except for nine, the rest identified some variables being ambiguous for example stigma, religion; other variables were repeatedly represented like tribe and ethnicity; while others didn't show the right polarity. In some CLD's for example the demand-side, some loops were misrepresented and others not presented at all. When participants were asked about interventions that would change mother's health seeking behaviour, majority of mothers (8 out of 13) advocated for sensitization of mothers, 3 out of 13 advocated for ANC incentives like giving small presents to mother who adhered to ANC, while 2 out of 13 emphasized improving the welfare of health workers,. Some midwives alike noted that improving their welfare would

improve service delivery. Other health workers posited that introducing free family planning across the continuum of health will help reduce pregnancies. One gynecologist in particular explained that improving on staffing numbers will greatly decongest hospitals, in his expressions he narrated *".... working in government hospitals is very frustrating because of the many patients yet we are few…...if the government improved on staffing, this will greatly help mothers……"* Except for one mother, the rest were in agreement that stocking health facilities would improve the quality of care. One mother offered a statement that was representative of the opinions of many of the focus group participants; this statement sums up some of the interventions that would help alleviate non-utilization of ANC.

I urge the government to increase on the number of health facilities especially in the rural areas where access to services is very hard. This should be coupled with improvement of services like recruiting more staff which in long run will reduce on waiting time and improve quality of service. Also, healthcare workers should routinely be evaluated for performance and reprimanded, in the worst-case scenario, dismissed for poor performance.

Leverages

From the analysis of the two CLDs, high leverage points that can affect significant improvement in ANC have been identified. Leverages are small changes that can be used maximumly to cause substantial change and benefit a system. Eight leverage points that could substantially improve antenatal care utilization both at the demand and supply side include; sensitization of mothers, offering family planning services, improving the welfare of health workers, socio-economic status, community-based counselling, peer support groups, stocking health facilities, recruiting more healthcare workers and certainly increased funding for the health sector by government. These interventions combined may result in improved ANC utilization.

Sensitization of Mothers

ANC utilization provides an avenue for mothers to identify and treat complications that may or may not have arisen due to pregnancy. It is highly envisaged that a knowledgeable mother has high chances of seeking care than her counterpart (Abekar-Nkrumah *et al.,* 2013). So once mothers have been properly sensitized, their likely adherence to ANC is most certain hence this will improve their level of awareness which will improve their pregnancy and neonatal outcomes as illustrated in loops R2, R3 and R5. Government through the Ministry of Health and community leaders can embark on sensitizing mothers on the benefits of ANC, and the likely pregnancy outcomes of non-utilization.

Family Planning Services

Family planning is the practice of controlling the number of children one can have and the intervals between their births done using contraceptives or voluntary sterilization. As shown in loop B2, there is a need to encourage women to use family planning services. Highly gravid and parous mothers especially in the rural setting do not adhere to family planning because of inaccessibility and the misconception that is associated with it. This can be corroborated to a study that was conducted in Atiak Health centre IV, Amuru district in Northern Uganda (Ouma *et al.,* 2015). For these women to comply, the govern-

ment must invest in massive sensitization of family planning benefits and offer affordable services to all women in their reproductive age.

Improving the Welfare of Health Workers

The welfare of workers significantly improves their morale, performance, absenteeism, theft of drugs and equipment and improves the overall attitude towards service delivery. Governments should improve welfare through enhanced salaries, flexible working hours, career development, improving the work environment and resource availability as shown in loop R4. This will positively impact on performance such as being available during opening hours and having a positive attitude towards the mothers which intrinsically trickles down to saving mothers' lives, children treated or protected against disease, fewer missed opportunities, and more effective use of money (Berman, 2011).

Socio-Economic Status

The improvement in the livelihood and income of the families will result in support from family and community in the following ways; i) better feeding which will improve the health of the mothers, ii) money for transport to the health facilities and resources needed for ANC, iii) moral support, and iv) time off to attend ANC appointments as illustrated in loops R1 and B1. Many pregnant women, especially adolescents, receive little or no support from their families. This not only prevents mothers from attending ANC but further aggravates their condition especially those that are highly stigmatized hence fall into depression. These studies (Morgan, *et al.,* 2017; Turyasiima, *et al.,* 2014) corroborate this. Government should spearhead campaigns to encourage men and other family members to support pregnant women both financially and morally in order to deal with stigma and improve health seeking behaviour. Additionally, governments should provide support programmes to improve the income and livelihood of women in order to supplement the support given by family and community.

Community-Based Counselling

Government should also seek intervention from respected community elders, especially village health teams and traditional birth attendants (TBA) to guide and counsel women in situations where the number of health workers is dismally low. Many studies (Adatara, Afaya, Baku, Salia & Asempah, 2018; Nyirenda and Maliwichi, 2017) indicate the fundamental roles of TBA's and the respect accorded to them in the community hence a good alternative to offer moral support to women. Counselling can be an avenue to minimise certain tribal and cultural beliefs, myths and stereotypes and can, in the same vain, help build confidence of stigmatised and socially discriminated women in society as illustrated in loop R5.

Peer Support Groups

Using local council and village elders, the government should encourage and advocate for peer support groups among women to help troubled and stigmatised mothers especially adolescents appreciate their circumstances, which may positively change their attitude towards seeking ANC care.

Funding for ANC Service Provision

One of the demotivating factors among health care workers is the quality of ANC service provision which is demonstrated by inadequacy of resources as illustrated in loops B3, B4, B5. B6 and B7. Government must ensure adequate funding, supervision and monitoring of the health facilities to ensure adequate and timely supply of drugs, equipment and supplies as well as in order to improve the quality of care, save lives but also build confidence among women. Women with little or no trust in the healthcare system see no reason to visit a health facility with no supplies.

Improve Staffing Levels

Government should consider improving the number of care providers, especially midwives and nurses in order to improve the quality of care as shown in loop B4. Emphasis should be on hard-to-reach and remote areas since most health care providers shun these places which compromises on service delivery.

CONCLUSION

For balanced and focused interventions, there's need to tailor maternal initiatives on both the demand and supply-side. This review revealed several factors such as educational level, economic status, cultural values and beliefs, parity, cost of service, distance to the health facility as determinants of ANC utilization in low and middle-income countries. This can largely be mitigated through awareness campaigns at familial and village level and advocating for community-based engagement between mothers and village health teams. Improving maternal and/or neonatal outcomes requires national, community, individual and familial intervention. Since the challenges are systemic, it necessitates a holistic intervention approach for instance improvement of quality of services, change in women's behaviour and attitude, enhancing women's decision-making autonomy and empowering communities.

FUTURE RESEARCH

Future research should investigate the role of information and communication technology specifically focusing on digital technologies for maternal health. It is premised that digital technologies can improve patient outcomes, patient-to-provider relations and can track patient's health status. Relatedly, efforts should be cognizant of traditional birth attendants whose influence over expectant mothers especially in the rural areas is great. They can be key change agents and can greatly influence mother's health seeking behaviour.

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