A novel complex systems model of treatment seeking behaviour for postpartum haemorrhage in Nigeria

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Declaration of own work

I, Meghann Lindsey Gregg, confirm that the work presented in this thesis is my own. Where information has been derived from other sources or others have contributed to the work, I confirm that this has been indicated in the thesis.

Meghann Lindsey Gregg

February 2020

Preface

I have a diverse background of work experiences and education, beginning in Anthropology where I worked for several grassroots and non-governmental organizations, in Brazil, the Cook Islands, and Canada. These organizations were focused on health and social development, and I wanted to expand my contribution in these areas, so I decided to pursue a Master of Science in Epidemiology and Biostatistics. This is where I began honing my quantitative research skills and worked in an academic research group and then for a vaccine company. Some thought it was out of character for me to work for a vaccine company, but with greater exposure to how health and health care is developed, I understood the prominent role of pharmaceutical (and biologics) companies, and I wanted to understand better how they operated. I also wanted to bring in more rigorous research practices to biologics companies, particularly with evidence used in decision modelling.

At the vaccine company I was the Lead Global Health Economist for one launching vaccine and one developing (pipe-line) vaccine. I gained insight into government decision maker needs, motives for, and understanding of evidence for vaccine uptake. One day the company announced that a partnership was being created with Save the Children to provide vaccination programs to the Democratic Republic of Congo (DRC). They requested staff to donate their time on a multi-disciplinary team to support this initiative. Included in the list of positions were a Health Economist and an Anthropologist, I decided to apply for the anthropology job and I was selected for the position.

In the initial meetings with the larger team it struck me as interesting that they included an anthropologist on the team, but rarely gave importance to my contributions, focusing heavily on building an infrastructure for vaccine delivery and exploring long-term financial goals beyond the initial project so the country could continue vaccination programs without substantial outside assistance. It reminded me of one of the main reasons I decided to pursue an education in epidemiology, as often my insights as an anthropologist were not given consideration. Within a few months of the vaccine partnership starting, it was announced that there were budget cuts and the least important aspects of the initiative would not continue: anthropology was included in this short list. This decision was made despite the information I shared with the team: people in DRC are refusing vaccines, even though they were delivered to communities and free of charge, due to significant trust issues between the people and the government and international development organizations. I was told that uptake and trust were not as important as ensuring a delivery structure was in place.

Regardless of the motivations for this decision, perhaps driven by profit and building power relationships for development aid, I began to think about the lack of importance placed on uptake, considering there is such a heavy focus on developing delivery systems (and products), when challenges to uptake are somewhat known. If we strive to improve health, do we not need to look more widely at how to do this, beyond the typical access, availability and quality of care framework, and include health seeking behaviour? My studies and work in anthropology provided me with a holistic perspective of behaviour, and I wondered if there was a way to combine my modelling, anthropology, and epidemiology skills to investigate the details of how behaviour occurs and communicate it with a model that may overcome some of the challenges of the translation of qualitative research to policy decision makers. In this thesis I explore these ideas further. With the creation of a *de novo* process model of patient treatment seeking behaviour for postpartum haemorrhage, using the example country of Nigeria.

Abstract

Background

Postpartum haemorrhage (PPH) causes a significant burden worldwide, as a leading cause of maternal deaths. Strategies to reduce PPH mortality and morbidity include improving health services and biomedical interventions. For success these strategies require patient uptake. Supporting uptake is challenging, due to in part to mechanistic approaches explaining behaviour and the absence of details explaining interactions. This research aims to improve understanding of treatment seeking behaviour for postpartum haemorrhage with the creation of a *de novo* process stage model informed by complexity theory using the example country of Nigeria. The model portrays complexity by considering “all” influencing elements, interactions between elements within and across stages, and interaction uncertainty and variation on collective element effects.

Methods

Structure and inputs were informed by a systematic literature review and by key informants. The model includes six stages, where women can move through the process of care seeking, and move forward, loop back, or exit the model based on collective interaction effect, which is described in detail. Additionally, an example of practical model use is provided, that estimates system changes to access and availability elements, which demonstrates the interconnectedness of elements in the system and the need for holistic change. Further developments of the model are also presented: logic expressions representing interactions and effects by stage, and a model tree that expresses variation.

Results

The model demonstrates a potentially important venture into using complex systems theory to describe behaviour, by demonstrating the existence and importance of interactions, proposing how numerous collective interactions occur, and with considerations of uncertainty and variation. Evidence to inform the model also highlights the importance of the multi-directional effect of elements, thereby contesting approaches that address elements as singular units. The model also provides through an evidenced informed approach, new identification and insight into the key stages of the care seeking process, which includes the pivotal role of beliefs and judgments.

Conclusion

These findings and results can help to improve how treatment seeking behaviour for postpartum haemorrhage is understood and thereby inform more effective policy to reduce mortality and morbidity.

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Abbreviations

ABM	Agent based model
AMTSL	Assisted management third stage labour
ANC	Antenatal care
CASP	Critical Appraisal Skills Program, Qualitative Checklist
CLD	Causal loop diagram
CERQUAL	Confidence in the Evidence from Reviews of Qualitative research
FCM	Fuzzy cognitive map
GRADE	Grading the Recommendations Assessment, Development, and Evaluation
GNI	Gross national income
HIV/AIDS	Human immunodeficiency virus/acquired human immunodeficiency syndrome
LSHTM	London School of Hygiene and Tropical Medicine
MMR	Maternal mortality ratios
MeSH	Medical subject headings
MLRM	Multi-level regression models
NOS	Newcastle-Ottawa Scale
PPH	Postpartum haemorrhage
PHC	Primary health care
SEM	Socio-ecological model
SoQF	Summary of qualitative findings table
SDG	Sustainable development goals
UNICEF	United Nations children's fund
WHO	World Health Organization

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This PhD would not have been possible without the support of my supervisors, collaborators, experts, friends, and family.

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On a personal note I would like to thank all of my friends and family for their support during these last few years. I could not have made it through without all of your love, laughter, and support. My success is your success, and now we move forward to do even more to make this world a better place for all people.

Chapter 1: Introduction

Summary of Chapter 1

This chapter presents background information and rationale for the creation of a novel process model of treatment seeking behaviour for postpartum haemorrhage (PPH) informed by complex systems theory. It begins with a presentation of the burden of maternal mortality and highlights the largest cause of maternal mortality, PPH. Biological and social causes and treatments for PPH are then presented, followed by a discussion of development strategy to support maternal health and the essential, but often ignored, role of patient uptake in the success of health development strategies. The need for improvements in understanding treatment seeking behaviour is linked to limits in current theories and models of health behaviour, and the application of complex systems theory is proposed to build a new model of treatment seeking behaviour for PPH.

Maternal mortality and PPH

Maternal mortality

Maternal disorders and complications contribute to significant mortality globally. According to the Global Burden of Disease Study, in 2013, maternal disorders and complications caused an estimated 293,336 deaths worldwide(1). Low and low-middle income economies suffer the majority of these deaths. The countries with the highest number of maternal deaths are in sub-Saharan Africa, South Asia and East Asia, and the countries with the highest maternal mortality ratios (MMR) are in sub-Saharan Africa(2) (see Table 1 below).

Table 1: Maternal death and maternal mortality ratio estimates 2015

Rank	Country	Maternal Deaths		Country	MMR*
1	Nigeria	58,000		Sierra Leone	1,360
2	India	45,000		Central African Republic	882
3	Democratic Republic Congo	22,000		Chad	856
4	Ethiopia	11,000		Nigeria	814
5	Pakistan	9,700		South Sudan	789
6	Tanzania	8,200		Somalia	732
7	Kenya	8,000		Liberia	725
8	Indonesia	6,400		Burundi	712
9	Uganda	5,700		Gambia	706
10	Bangladesh	5,500		Democratic Republic Congo	693

*Maternal mortality ratio: maternal deaths per 100,000 live births.

Maternal deaths and disorders/complications are those that occur during pregnancy, the end of a pregnancy (abortion, birth, and miscarriage), and during the postpartum/post-termination/post-loss period(3). The postpartum period typically ranges from four weeks(4) to greater than six months after the end of a pregnancy(5), and includes pregnancy related deaths that can occur up to one year after childbirth(6). Direct and indirect causes of maternal deaths include haemorrhage, hypertensive disorders, infections/sepsis, abortion, obstructed labour, anaemia, HIV/AIDS, ectopic pregnancy, embolisms, and other direct and indirect causes(7).

Though good progress has been made in reducing maternal mortality in many countries since the implementation of the Millennium Development Goals, a 2015 report on United Nations member states' progress on achieving maternal mortality reduction goals concluded that 21 countries made insufficient progress (including Burundi, Chad, Liberia, Sierra Leone, and Somalia), and 26 countries made no progress (including Central African Republic, Gambia, Kenya and Nigeria)(8). Information was not available for the Democratic Republic of Congo. This estimated lack of progress in countries with the highest maternal deaths and MMR emphasises the urgent and continued need to improve maternal health, including surveillance and reporting, in countries where the greatest burden lies.

Maternal haemorrhage and PPH

Worldwide maternal haemorrhage is reported to be the leading cause of maternal deaths, estimated at 44,200 in 2013(1). Maternal haemorrhage includes bleeding from or into the genital tract during the antepartum, intrapartum and postpartum periods(9). Antepartum haemorrhage occurs between 24 weeks of pregnancy to before labour(10), and intrapartum haemorrhage occurs during the first three stages of labour(11). PPH is abnormal and life-threatening bleeding after childbirth, in the fourth stage of labour, and is typically defined as a ≥500 ml loss of blood by way of the genital tract within the first 24 hours after childbirth(12). Of the three types of maternal haemorrhage, it is estimated that PPH accounts for the majority of these haemorrhage deaths worldwide (73%)(13). Reflecting the global burden of overall maternal disorders and complications, the vast majority of PPH deaths occur in developing regions (>99%), with 42% of deaths occurring in sub-Saharan Africa, and 43% in Southern Asia(13).

PPH can also cause morbidity resulting from severe blood loss, such as organ dysfunction or failure, or from interventions to stop PPH (e.g. hysterectomy)(14). Physical consequences to a woman are only one dimension of the impact of PPH, it can also

affect a woman's wellbeing and the wellbeing of her family. For example, there can be stigma from having a hysterectomy(15), mental health consequences from a near death experience(16),and the need for more recovery time after childbirth can delay the return to economic participation, childcare and family care and responsibilities(17).

Pathophysiological causes and treatment for PPH

There are numerous pathophysiological causes for PPH. The primary cited cause is uterine atony(12, 18), where the musculature of the uterus is unable to contract quickly. Other causes of PPH include trauma to the genital tract from birth (tears), retained placenta tissue, uterine rupture, and coagulation disorders(12). Though it is not possible to predict PPH, there are risk factors associated with it; though women who suffer from PPH may have no risk factors(19). Some of the risk factors include: being overweight, multiparity, previous caesarean section leading to placenta accreta/percreta, surgical procedures to assist in delivery (e.g. caesarean section)(19), and recent/the most severe form of female circumcision (Type III World Health Organization classification of female genital circumcision(20)) (21).

The World Health Organization (WHO) has published evidence-based recommendations for the prevention and treatment of PPH identifying pharmaceutical interventions and other medical procedures to be administered at the time of childbirth, when labour/caesarean begins, until the diagnosis of PPH, or in the case of a retained placenta(12). PPH prevention interventions are recommended to be administered/conducted during the third stage of labour, and are known collectively as 'active management of the third stage of labour' (AMTSL)(12). Active management versus expectant management is to actively assist in delivery of the placenta (and foetal membranes) with a number of interventions, as opposed to expectant management that allows for the natural contraction of the uterus(22). The third stage of labour is after the child has been delivered and when the placenta is delivered(23). The third stage of labour is complete when the placenta and all membranes have been delivered(22).

Prevention interventions include medications (uterotonics) to stimulate uterine contractions, and recommendations on when to administer these (considering timing, availability, and attendant skill)(12). Prevention interventions also include recommendations for medical procedures including control cord traction, cord clamping, assessment for abdominal uterine tonus, and recommendations against certain procedures, i.e. sustained uterine massage when prophylactic uterotonics have been administered(12). Procedures are also outlined according to skill of birth attendant.

Treatments for PPH are recommended at the time PPH is diagnosed, and for placenta retention. Treatments include pharmaceuticals (oxytocin, anti-fibrinolytic), fluid therapy, procedures such as uterine massage, intrauterine balloon tamponade, uterine artery embolization, and surgical interventions(12). Compression techniques and garments are also recommended when awaiting care(12). Additionally, the guidelines recommend how treatment for PPH should be organised. For further details of these recommendations please see Appendix A. The evidence supporting just over half of these recommendations were judged by the guideline authors to be of very low and low quality: please see Appendix A for details.

Social causes and change for PPH

Though PPH is a biological complication and occurs in every country(24), the occurrence and risk of this complication is also influenced by social phenomenon. This is evidenced by the significantly higher number of deaths that occur in developing countries (>99%) as opposed to developed countries (<1%)(13). An examination of social causes helps to explain this disparity. For example, poverty is a distal/social cause of maternal deaths (including PPH), and it influences and interacts with other social causes of maternal health, including the availability and accessibility of appropriate quality health care(25). Lower-income groups have less access to health care, and may be more vulnerable to disease due to poor nutrition due to inability to access or grow food (e.g. due to low personal/household income, lack of food in urban areas, and conflict). For some women poor nutrition is compounded from social exclusion based on gender (in resource poor areas women can be given less food or less nutritious food than men, this can also occur with pregnant women(26)). Poor nutrition can result in iron deficiency, a main cause of anaemia(27), and this can further exacerbate iron deficiency from pregnancy (a common occurrence in pregnancy due to the body's need to increase blood volume)(28). Being anaemic can affect haemostasis(29), and disable a woman's ability to recover from PPH. Please see Figure 1 for a list of social causes related to maternal health.

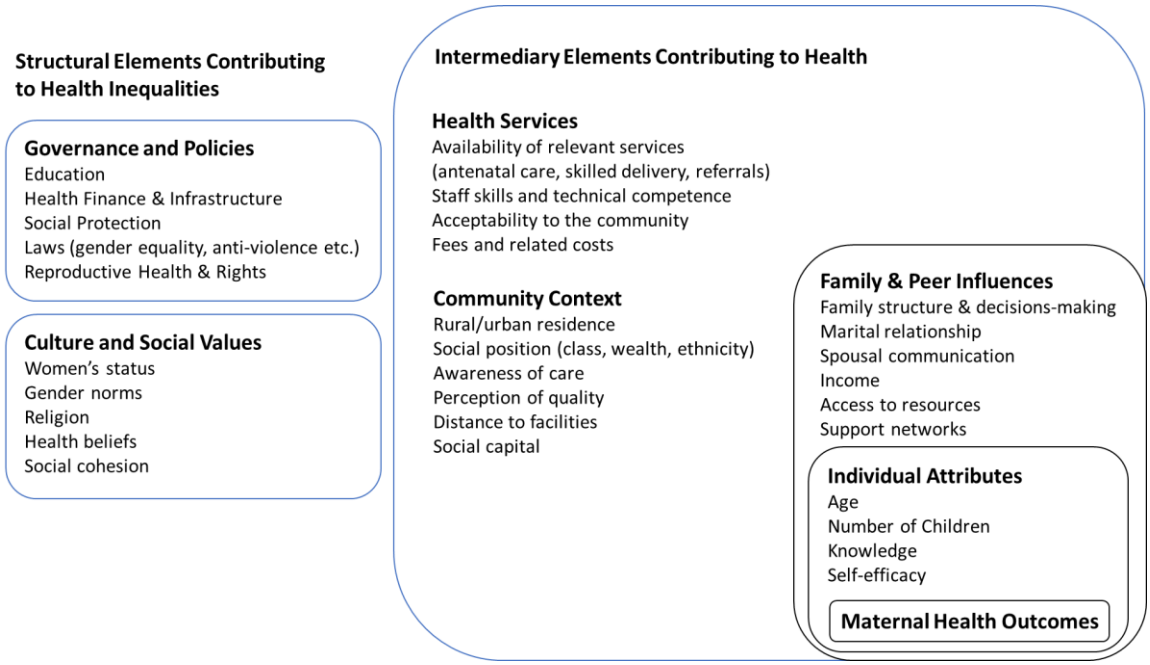

Figure 1: Social elements influencing maternal health.

Source: Redrawn from World Health Organization. Maternal, newborn, child and adolescent health: Social determinants approach to maternal deaths 2019(25). The word 'determinant' was used in the original figure and here has been changed to 'elements contributing to' as the word determinant conveys a fixed position of effect and predictability, which is likely not how social elements influence health.

Addressing these social causes of health requires policy and action that recognizes the influences of these causes, and people's role in creating and contributing to these. To successfully influence social causes we require a coordinated effort, that is created and implemented by all stakeholders including community members, government, and influential institutions (e.g. religious institutions).

Maternal health development strategy and uptake

International health development strategies, many of which prioritize maternal health, focus on the development of health technologies that predominantly support or develop the provision of biomedical health care to improve population health. Health technologies are defined by a joint task force of health technology assessment agencies and the WHO as "an intervention, health product or service developed to prevent, diagnose or treat medical conditions; promote health; provide rehabilitation; or organize healthcare delivery. The intervention can be a test, device, medicine, vaccine, procedure, program, or system"(30). Developing health technologies includes developing the health system, to which WHO has a Framework for Action (WHO health systems strategy) that includes six 'building blocks': health services; health workforce; health information; medical products, vaccines and technologies; health financing; and leadership and governance (31). Though patient uptake is essential to the success of many health technology

development strategies, including a health system being successful in improving health outcomes, it is not always listed as a priority in health development policy.

To illustrate, in 2015, the 2030 Agenda for Sustainable Development was adopted by all 193-member states of the United Nations, and included the Sustainable Development Goals (SDG)(32). The third SDG, 'good health and well-being', prioritizes three areas for action: reproductive maternal new-born and child health, infectious diseases and non-communicable diseases, and health systems and funding(33). The targets and indicators identified to satisfy goal three, include the reduction of mortality and morbidity through the development of prevention and treatment, improvement of financial access to quality care (safe and effective care), and improvement of the provision of care(33). The importance of improving and ensuring patient side uptake of biomedical healthcare interventions is absent from the target and indicators list. The absence of the explicit mention to develop patient uptake, or health treatment seeking behaviour, also occurs in other international health development strategies, for example the Organization for Economic Co-operation and Development's Official Development Assistance targeting health development(34). This is not to suggest that development of patient uptake is not occurring, it is to demonstrate the strong focus on the development of health technologies and policy to improve global population health by influential international organizations. Community involvement is as an essential component to the success of development strategies, and this is recognized by organizations such as WHO(35).

There could be a number of reasons why patient uptake is not prioritized in health development strategies. These include the assumption that uptake will simply occur if appropriate quality care is made available and accessible, and the belief that uptake is not important relative to other prioritized areas of health development, i.e. effective treatment and prevention development (pharmaceutical and biologicals) and effective distribution systems (processes, care delivery locations, staff, supplies). These reasons may be present together, and the first can inform the second (if one believes uptake will automatically occur with development, then uptake may not be a priority relative to other development areas).

First, let us explore in more detail the assumption that patient uptake will simply occur. The need to actively build uptake may not be appreciated when it is assumed that the development of appropriate quality health technologies, that are available and accessible, will automatically result in the uptake of these technologies. Evidence of this assumption can be inferred from the absence of the development of uptake as a highlighted aim in health care development plans that aim to improve health with the

development of health technologies (as mentioned in the paragraph above). This assumption is also explicitly mentioned in the Three Delays Model, one of the most influential maternal health models that explains patient delays to treatment (36) and is used to structure maternal health research on these delays. If this assumption is incorrect, then health development goals will not be realized, as uptake is essential to the success of health development strategies that rely on the effect of offered health technologies. Though it is likely uptake will be impacted in response to health technology changes, one cannot be certain how uptake will be impacted in an environment of numerous interacting elements.

This complex dynamic of how uptake is the result of many interacting elements is well evidenced in the example of vaccine hesitancy. “Vaccine hesitancy refers to delay in acceptance or refusal of vaccination despite availability of vaccination services. Vaccine hesitancy is complex and context specific, varying across time, place and vaccines”(37). Vaccine hesitancy can occur when vaccines are easily available and accessible (vaccination campaigns available at convenient-for-patient areas such as schools, pharmacies, and other frequently accessed community locations), affordable (also they can be free of charge to the public in some settings), and when there are strong evidence bases for vaccine safety and effectiveness that are known to the public, for example in high-income settings(38). Despite supportive health technologies that may be in place to encourage vaccine uptake (e.g. vaccine development, provisional organization, funding strategies, education campaigns) vaccine uptake does not always occur. Vaccine hesitancy is a worldwide phenomenon and is driven by multiple interacting elements including access and availability elements and a lack of trust. This lack of trust stems from past relationships/endeavours producing harm, including but not limited to: vaccination campaigns used to hide violent motives from external groups against community members beliefs and interests(39), vaccine clinical trial deaths of children when consent was not informed(40) and falsified evidence on harmful side effects of vaccines(41) that took years to uncover(42). It is likely that treatment seeking behaviour for maternal health operates in this way: within an environment of numerous interacting elements. An examination of this system, that considers interactions, can help to elucidate how uptake occurs when treatment is sought for a maternal complication such as PPH, and support the recognition of uptake as essential to health development strategies.

Second, let us consider why patient uptake can be seen as not important relative to other prioritized areas in health development strategy. As mentioned above, the lack of importance could be due to the assumption that uptake will simply occur when

appropriate quality health care is available and accessible. It could also be due to beliefs that behaviour is too complicated of a topic to understand and that behaviour is too difficult to change, and takes too long. These beliefs may be supported by a bias against qualitative research and methodology; which are often used to study behaviour. There exists tensions towards qualitative research in social sciences and the broader scientific community, with qualitative research being regarded by some as not a 'true' science, for example, because of the potential for researcher bias, and issues with reproducibility and generalizability (43, 44). In my experience this view of qualitative research is also supported by a lack of understanding of how to design and conduct qualitative research, and perhaps an absence of a social constructionism perspective ("anthropological theory holding that all sociocultural phenomenon are products of historically-situated interpersonal "negotiation," as accomplished through patterned language and activity"(44)). This tension between qualitative and quantitative research guides us towards generating evidence that bridges the two types of research, thereby manoeuvring around the prejudice towards qualitative research and potentially allowing for an advancement in behavioural research that may result in the importance of uptake being better recognised.

Improving our understanding of uptake, beyond an inevitable and/or 'too difficult to understand' phenomenon, can ameliorate the success of international health strategies that are focussed on health technology development and delivery. This improvement in understanding can include a detailed description of how behaviour is influenced (including interactions), and a presentation of qualitative research in a more acceptable/accessible way to decision makers.

Representations of behaviour, theories and models of health behaviour

In order to improve how uptake is understood, it is worthwhile to review the existing theories and models of behaviour that can be used to explain treatment seeking behaviour for PPH. Identifying the gaps and opportunities in theories and models of behaviour helps to demonstrate the value and need for creating new research and a new model of treatment seeking behaviour for PPH. In this section I will compare and contrast the existing theories on health behaviour, and their application to understanding uptake, and propose a way forward with complex systems theory.

A review of theories of health behaviour and their application with models

Behaviour is constantly evolving in response to input to, and feedback from, the social and physical world(45). In order to support the occurrence of behaviour in a specific way

it is advantageous to present a 'correct as possible' representation of what influences behaviour and how this influence occurs. I am interested in how one may create a 'correct as possible' representation of the use of biomedical care by women at clinics for PPH, to support the above international health strategies in developing maternal health.

There are many theories that can explain health seeking behaviour, and include those that examine single levels (individual, intrapersonal, community) or look at multiple levels (see Figure 2). These different levels can also be identified by other terms, for example: micro, meso, exo, and macro(46). Theories can also be differentiated by the larger disciplines' theoretical frameworks that informed them, for example psychology (cognitive psychology, stimulus response), anthropology, and sociology. Some theories developed from multiple disciplines (e.g. diffusion of innovations) and others were developed combining multiple disciplines (e.g. social cognitive theory: cognitive and humanistic psychology, sociology, political sciences(47)). More recently theories beyond the social sciences including physics (complexity theory(48)) and engineering (systems theory(49)) have been adopted to explain public health topics. Discipline underpinnings also direct how validity of results is considered, and therefore how data is collected (e.g. asked versus observed).

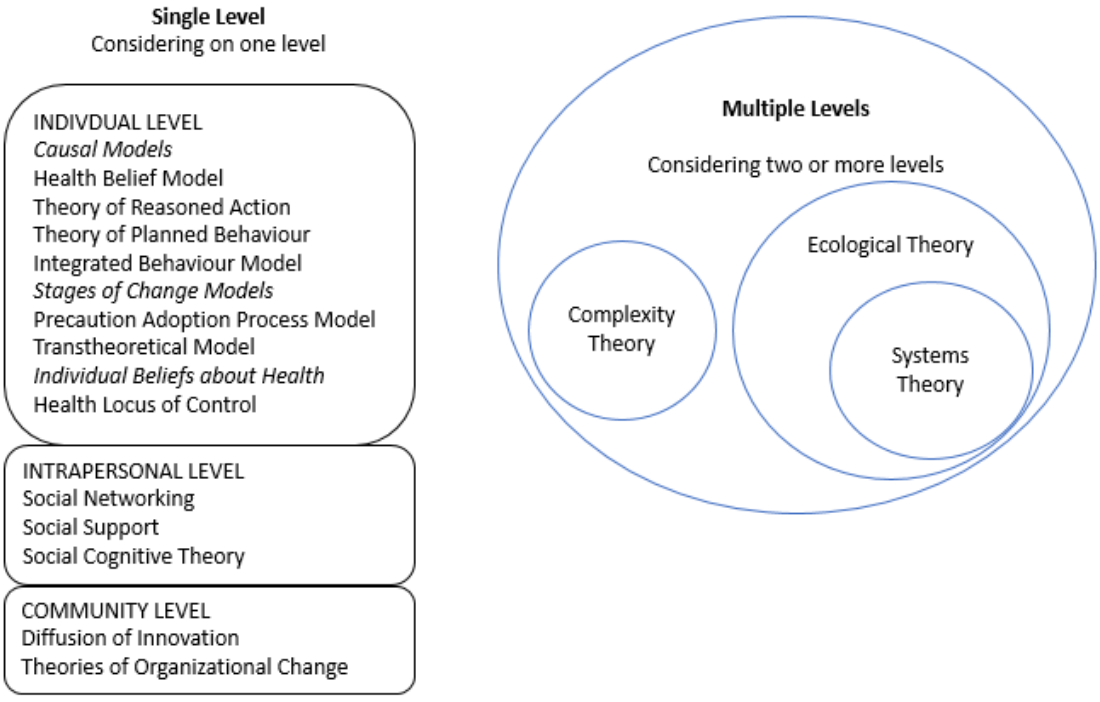

Figure 2: Examples of theories explaining health behaviour by level.

This list is not exhaustive of all theories that can be used to explain/examine health behaviour.

Before continuing to discuss theories (which are sometimes called models), and the application of theories (that can be applied in the creation of a model) to create a 'correct as possible' representation of behaviour, it is important to define for the reader what is meant here by the terms theory and model. A theory can be defined as "a set of interrelated concepts, definitions, and propositions that present a systematic view of events or situations by specifying relations among variables, in order to explain and predict the events or situations"(47). A model is a representation of reality, either actual or supposed. In health sciences, models are typically conceptual maps to help understand a concept or organize work (medical models), or mathematical models that use the language of mathematics to describe and examine the world, and to predict change. When models are conceptual and have wide applicability, their definition can closely reflect that of a theory (e.g. Health Belief Model). Models begin to differ from theories when they are used/built to explore in detail a phenomenon. Theories are applicable to multiple settings and populations, whereas models can exist along a spectrum from being generalizable to multiple setting and populations and making general statements about a phenomenon, to being context specific and detailed in explaining a phenomenon (for an illustration please see Figure 3).

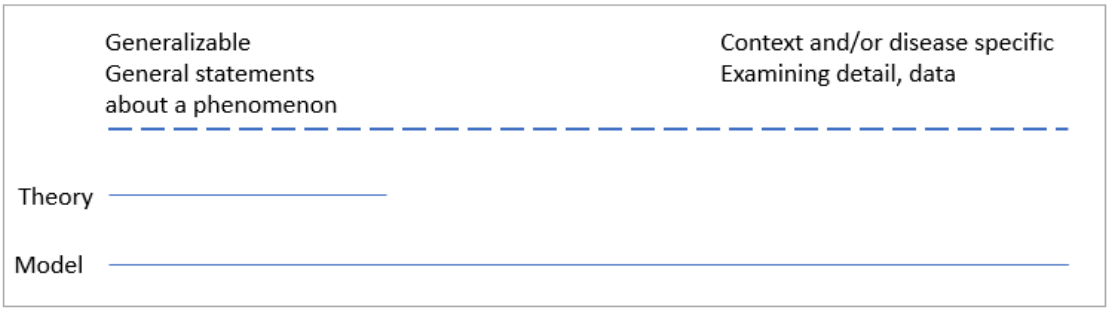

Figure 3: Theory model spectrum: differentiation by generalizability and detail level.

From here on in this thesis, models that present a detailed examination/explanation of behaviour with qualitative and/or quantitative data will be called models, and frameworks that describe general rules/explanations of behaviour will be called theories (even when the word 'model' is used in the title of the theory, e.g. Health Belief Model).

Continuing from above, choosing a 'correct as possible' theory to inform a representation of behaviour (e.g. a model) depends on the question being asked about behaviour and the theoretical/philosophical position taken by the researcher. Choosing a theory, 'correct' or not, is also informed by what is requested or expected from the researcher, for example 'accepted' or 'standard practice' in the research field and from stakeholders

such as health policy decision makers. Also, more than one theory can be used to inform a model(47).

If one would like to understand what (and how) elements influence treatment seeking behaviour for PPH, then the ‘how’ of the question informs the theoretical position(s) and methodology one can take to ‘correctly’ represent this phenomenon. The ‘how’ is a key differentiator between non-systems theories and models, and theories and models of systems of health behaviour. Non-systems models typically explain ‘what’ elements influence behaviour, whereas models informed by theories about systems can investigate ‘how’ elements influence behaviour.

Here it will be helpful to the reader to define what the phrase ‘theories and models of systems’ refers to and explain why the term ‘systems theory’ is not being used. ‘Theories and models of systems’ refers to theories and models that define systems as “groups or combinations of interrelated, interdependent, or interacting elements forming collective entities”(50) and where the whole is more or less than the sum of the parts(48). ‘Systems theory’ is a specific type of theory about systems (as defined above), however there is another theory about systems that is different in important ways from ‘systems theory’: complexity theory. Therefore, the phrase ‘theories and models of systems’ will be used to encompass these two theories.

Though ‘systems theory’ can be categorized as an ecological theory, an ecological theory is not synonymous with ‘theories and models of systems’. This is because the systems perspective taken in systems theory is not adopted across the ecological perspective. For instance, many theories and models that are categorized as ecological take a mechanistic approach to behaviour, and not a systems approach (more on these approaches below). One may question if complexity theory can be grouped into the ecological perspective. I argue that it cannot, as the current definition of an ecological perspective does not support the important characteristics of complexity theory: mainly, the ecological perspective presents a fixed segregation of levels of elements and a deterministic nature of representations.

Continuing from above, in addition to the key differentiators of ‘how’ and ‘what’, theories of systems and non-systems theories explain behaviour in other important and different ways, and therefore inform different representations of a phenomenon (e.g. models). Four main differences include: how interactions are understood and examined, how the phenomenon is mathematically abstracted, the type of view taken (mechanistic versus systems), and the number and types of elements included in a model.

Exploring these differences further, the first difference is a theoretical positioning of how interactions are conceived. While the presence of interactions is mentioned in non-systems theories it is typically a general statement of how constructs and/or variables interact with each other (e.g. interactions are generally stated in: social systems perspective, precaution adoption process model, ecological theory, three delays model). Models informed by non-systems theories may use regression analysis to explore associations between independent and dependent variables, and can explore interactions of single variables with the independent and depended variables (sometimes more than one interacting variable is explored, but the model does not allow for a large number of variables to be interacting). Regression models can be informed by the following behavioural theories: theory of reasoned action, theory of planned action, precaution adoption process model, linguistic model of patient participation in care, Mikhail and Cox's interaction model of client behaviour, health locus of control, and the health belief model(47). In theories of systems, and in other discipline theories (e.g. anthropology), the view of interactions is that all, or a large number of elements, can be interacting with each other (45, 48). This position allows for representations of behaviour and models that rely strongly on qualitative descriptions and mathematical abstractions that consider large numbers of interacting elements (e.g. reflected in non-linear relationships).

The second difference, is the way in which mathematical abstractions can be made in model representations that include mathematics. As noted above, non-systems models, informed by non-systems theories, that use mathematics to explain phenomenon are typically linear. Models of systems, informed by theories of systems, are typically non-linear.

This second difference is due to a third difference: whether behaviour is viewed as mechanistic or as a system. A mechanistic view understands the phenomenon of behaviour as a machine that is comprised of numerous parts that function together in an additive way (i.e. the sum of the parts equals the whole)(48). In this view the parts of the phenomenon are distinct entities that fit together to make up the whole. Here, an aspect of the phenomenon can be understood by focussing on one of its parts in isolation from the other parts. This view typically regards relationships between the elements as linear, which is reflective of a stable phenomenon(48). In theories of systems (e.g. systems theory and complexity theory) a systems view is defined as understanding the phenomenon of behaviour as a system (as define above) where groups of interacting elements form collective entities, where the sum of the parts is less or more than the

whole. In a systems view, phenomenon can only be understood in its entirety, not in segments as with a mechanistic view. In systems theory and complexity theory relationships between elements are typically non-linear, which reflects the instability and changing nature of the system(48).

The fourth main difference is the number and types of elements that can be included in examining a behavioural phenomenon. As theories of systems understands phenomenon only by considering the entire system, they allow for the inclusion of 'all' elements within the system to be considered. The use of the term 'all' means that an attempt is made to be comprehensive and obtain as many elements as possible that could influence a system. This includes elements that can be spoken to (e.g. those elements identified by behavioural research informed by cognitive theories: mentally processed), and those that cannot typically be spoken to (hidden elements), hidden either due to taboo or because beliefs and culture may not be easy to personally examine and therefore not easy/possible for people to speak about. Additionally, elements can be included in a representation of the phenomenon from various levels (e.g. individual, interpersonal, and community) and from various areas (e.g. physical and representative objects, natural and built environment, beliefs). Models of systems are modelled as 'closed' systems, though all systems are actually 'open' systems (i.e. systems are connected to other systems)(48). Drawing (assuming) a boundary to define a system is necessary to help focus on a particular area or question of interest, and this also helps to identify the elements that can be included in the defined system. Non-systems theories can range from including a smaller number of elements from a single level, to a larger number of elements from multiple levels, as supported by the majority of ecological models (not including systems theory: dynamic systems modelling). However, the number of elements included in non-systems theories is typically not as large as in theories and models of systems, because in non-systems theories the theoretical perspective adopts a mechanistic view (if only interested in one part of the phenomenon then only need to look at the part of interest) where it is possible for generalizations to be made about phenomenon with consideration of only the included constructs (categories of elements), or of a few elements (not all the elements) within a construct(47). Also, the mathematics typically used in non-systems models are not supportive of the inclusion of many elements (e.g. a high number of independent variables within a regression model compromises the model validity (multicollinearity)(51)).

Considering these above differences between theories and models of systems and non-systems theories and models, one is able to clearly see a potential for growth in the field

of health behaviour research: towards an explanation of 'how' behaviour occurs, where the many interactions between 'all' elements are estimated, within a framework that reflects the changing nature of behaviour. Theories and models of systems are somewhat new to the field of public health, with a predominant focus on systems theory and dynamic systems models. Complexity theory and complexity models are not as prevalent, and perhaps used/created even less due to confusion over what complexity theory is (52), which in part may be due to different uses and meanings of the term 'complexity', and models explicitly addressing complexity in other approaches (systems theory). Let us here review the differences between complexity theory and systems theory, and their typical application in representing phenomenon in models.

Complexity theory and (dynamic) systems theory

Accepting the above definition of system, and taking the perspective that a behaviour (e.g. uptake) is a system, then we can choose from two of the main theoretical approaches that explain how a behavioural system operates: complexity theory or systems theory. There are other theories of systems, but they often take a linear approach to explaining physical systems (e.g. state space models)(53), and therefore adopt a mechanistic view, which is inconsistent with the second part of the systems definition above (i.e. the sum of the parts equalling more or less than the whole). I will therefore confine the discussion to two non-linear approaches: complex systems theory and systems theory.

The similarities and differences between complexity theory and systems theory can be viewed below in Table 2. Similarities include: a system can only be understood in its 'entirety'; non-linear equations are used to explain relationships between elements (though in different ways); feedback can occur between elements and groups of elements; both approaches attempt to exhaustively identify all of the elements that can influence the systems (with boundaries and scope informing what 'all' can include). The main differences between the two, are how the stability of the elements is explained and how this leads to deterministic (predictable) versus non-deterministic (uncertain, evolution) models of behaviour(48).

Table 2: Mechanistic, systems, and complex systems theory comparisons

Theory Name	Mechanistic Theories*	Systems Theory	Complex Systems Theory
View of system	The whole (system) can be understood as the sum of its parts, relationships are linear and additive, therefore examinations are of aspects of a system, level(s) or construct(s)	System can only be understood as a whole (whole is more than the sum of its parts), due to nonlinear relationships, however the system is more stable, therefore linear mathematics can explain the system	System can only be understood as a whole (whole is more than the sum of its parts), due to nonlinear relationships
Stability versus Uncertainty	Aspects of systems are stable as relationships between elements and outcome are predictably relative to each other. Predictions are possible	Systems are more stable, and therefore predictions are possible	Due to the uncertainty of change in the system, predictability is not possible, estimates should be taken as such
Describing Interactions	Interactions are not typically seen as clustering (groups), they are singular imposing upon a variable's relationship to an outcome.	Compared to complex systems theory, groups of interactions are more stable	Groups of interactions are somewhat stable and almost always in a state of change
Result on describing treatment seeking behaviour for PPH	Easy to understand relationships and effects but these are likely incorrect, showing incomplete, potentially misleading relationships between elements and results	Hard to understand relationships and effects, follows only the most probably pathway (solvable equation), 'predictable' and most probable results can be incorrect, especially if system is changing, does not typically display possible variation	Harder to understand relationships and effects, follows all possible pathways, results 'correct' because they encompass many possibilities and have caveat of uncertainty, some users may be uncomfortable with an 'unsolvable equation'

A systems approach can also use non-linear mathematics to describe interactions and their effect upon the system, but it makes an additional assumption that complexity

theory does not: it assumes that only the most probable events occur and that these events/actions/decisions occur at average rates(48). This assumption allows for one to estimate (predict) the impact of different interventions in the system and receive a single answer to problem/equation. Unlike complexity theory, a systems approach does not allow for inclusion of variation. This is acceptable in a system that is stable, where little change is occurring. But in a system where change is occurring and the system is adapting to change, this approach can provide incorrect predictions(48).

There appears to be a stronger interest in systems/dynamic systems approaches versus complexity theory approaches currently in the field of public health. This is perhaps due to the ability of models informed by systems approaches to produce a 'probable' prediction. However, this approach should be used cautiously with consideration of the assumption and limitations. If one is to explain treatment seeking behaviour for PPH in a resource poor and/or unstable setting, a complex systems theory approach would provide a more 'correct' representation in comparison to a systems/dynamic systems approach. A point of difficulty in deciding which approach to use, and which type of model to create, is the value and preference of a model that provides a prediction (probability) as opposed to a model that provides possibilities. Though in some instances one may prefer a predictive model, I believe there is an important opportunity to create a model informed by complexity theory that can illustrate variation and uncertainty. It may well contribute to the efforts to expand thinking about causality and behavioural change, ultimately improving health development efforts.

Chapter 1 conclusion

This chapter provided background on the burden and causes of maternal complications and PPH, followed by a discussion of international development strategies to reduce this burden though the provision of health technologies and care delivery. The important role of uptake in these strategies was presented and why it important to improve our understanding of it: its essential role in health development and limits in current theories and models of health behaviour. Complex systems theory was proposed to improve our understanding of health behaviour, due to its ability to capture important characteristics of a behavioural system: holistic perspective, interactions, variation, non-linearity and uncertainty. The next chapter reviews the published literature on models of maternal health behaviour, and helps to justify the creation of a new model.

Chapter 2: Literature review of other models of maternal care seeking

Introduction: Literature review of other models of maternal care seeking

Before proposing to build a new process model informed by complexity theory to describe the uptake of treatment for PPH, it is important to review the published literature to identify any similar models. Similar models will include any model (simulation or conceptual) that explains the process of seeking care by women who have given birth at home, including elements that influence uptake and their interactions, for any maternal health complication (including PPH), and in any country setting.

Methods: Literature review of other models of maternal care seeking

A protocol was written *a priori* for this review on October 2, 2017, and can be found in Appendix B. The format of the protocol was adapted from the Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0, Chapter 2 Preparing a Cochrane Systematic Review, Box 2.2.a: Sections of a protocol for a Cochrane review(54). This literature review attempts to be a comprehensive review of the published literature, and follows some of the guidance on conducting a systemic review with many important exceptions: a quality assessment of the included studies was not conducted, only English languages studies were included in the search, and only one reviewer conducted screening and extraction.

Criteria for selecting studies

Any study type was included in this review, provided the main aim of the study was to describe a model (statistical/simulation/conceptual) that examined how elements influence the uptake of PPH/maternal complication interventions by women (or those who govern her behaviour), in a clinic or hospital setting (where recommended biomedical care for PPH, AMTSL, is delivered). If the aim of an article was to examine an element (factors, determinants) that could influence uptake, but the examination was not within the question of uptake (e.g. estimating the affordability of a service), the article was excluded from selection. Models that examined elements that influence uptake could include the following:

- Conceptual models: models that explain or hypothesize how elements interact and/or influence uptake. These are not mathematical models, they describe the components and interactions of a process/system/idea/phenomenon

- Statistical models: with statistics these models estimate if a relationship exists between elements and uptake (e.g. regression models, structured equation models)
- Process simulation models: these mathematical models explain or predict how elements are interconnected, and the influence of these interactions on uptake, these can include linear and nonlinear equations and/or logic equations
- Spatial models: models that explain or predict interaction between physical locations and uptake (e.g. gravity model)

Models of care, that describe procedures of how care should be undertaken, were not included in this review.

Participants included in the search were women seeking prevention or treatment for PPH/maternal health complications. Typically, this is a woman who is pregnant or has just given birth. However, she herself may not have made the decision to seek care, therefore the review will include persons who may have made the decision for her (i.e. husband, partner, parent, relative, community member, or other). For studies of this population to be included they needed to explicitly state in the article that this other person has made the decision for the prevention/treatment to be used by the woman.

Interventions included in the search were those provided at a clinic or hospital setting. These settings can possibly provide the *Recommendations for the Prevention and Treatment of Postpartum Haemorrhage,* presented by the WHO(12). These interventions are given for prevention of PPH (at the time of birth) or in the case of PPH (in the 24 hours after birth), and the majority of these recommendations require a clinic or hospital setting. Initially the *de novo* model proposed for this thesis aimed to explain only elements that influenced biomedical care, and therefore this review only included articles that modelled biomedical treatment seeking. Though the *de novo* model now encompasses biomedical and other care, this review is still relevant as it did capture models that examined biomedical and other care, as well as models that examined only biomedical care uptake. Models that only examined other care were excluded, but this is acceptable as they did not include the biomedical care aspect that is of interest to this thesis.

It should be noted that prevention and treatment for PPH may not be modelled specifically as uptake of PPH interventions and this effects the search sensitivity. PPH interventions can be included within other maternal care services during the perinatal (intrapartum) period. Also, researchers can group together many maternal complications

for examination. Therefore, to ensure that all relevant studies were captured, a wider search was conducted that included other maternal complications. Articles were included that examined choice of delivery location, as biomedical care for PPH can be encompassed in this choice (even if it is unknown if PPH will occur or if care seekers know what PPH is). Please see Table 3 for eligibility criteria of the included studies.

Table 3: Eligibility criteria of the included studies: Literature review of other models of maternal care seeking

Study Type	Any, with the aim to describe a model of elements influencing uptake of PPH interventions by women
Participants	Women seeking prevention/treatment, or those taking the decision for her
Interventions	WHO recommendations for prevention and treatment of PPH
Setting	Clinic or hospital

Search methods for identifying studies

Search

Three terms and variations of terms were searched in two databases (PubMed and Web of Science). Please see Table 4 for search terms and variations.

Table 4: Search terms and variations: Literature review of other models of maternal care seeking

TERM	VARIATIONS
PubMed	
model	modelling OR modelling
patient acceptance of health care [MeSH Terms]	
maternal health services [MeSH Terms]	
Web of Science	
model	modelling OR modelling
uptake	accept OR acceptance OR acceptability OR adopt OR adoption
maternal	(obstetric OR postpartum) AND (healthcare, OR clinic OR hospital OR centre OR health care OR surgery)

MeSH: medical subject heading

Each article in the PubMed database is indexed by medical subject headings (MeSH terms), that describe the content of the articles(55). Given this, it is appropriate to use MeSH terms in a PubMed search. The MeSH terms *patient acceptance of health care* includes all articles that focus on uptake, and the MeSH term *maternal health services* includes all articles that focus on maternal health services (including the prevention and treatment for PPH and other maternal complications).

All years were searched and the search was restricted to studies on/about humans, and the English language. To make the search more specific, the search in PubMed included only the title and abstracts of articles. It is reasonable to assume that an article about a model of uptake on PPH/maternal complication interventions would state this in the title or abstract. Some articles may not have been captured in the search if they do not have an abstract presented on the databases. As noted above, PPH interventions can occur alongside other maternal health services, therefore the search included PPH and maternal health as keywords: this increased the sensitivity of the search. Please see Table 5 for search strings.

Table 5: Search strings for databases: Literature review of other models of maternal care seeking

DATABASE	SEARCH STRING
PubMed	((((modeling[Title/Abstract]) OR modelling[Title/Abstract]) OR model[Title/Abstract])) AND ((patient acceptance of health care[MeSH Terms]) AND maternal health services[MeSH Terms])
Web of Science	(model OR modelling OR modeling) AND (maternal OR obstetric OR postpartum) AND (healthcare OR clinic OR hospital OR centre OR health care OR surgery) AND (uptake OR accept OR acceptance OR acceptability OR adopt OR adoption) Timespan: All years. Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI.

In Web of Science, after the search results are generated, citations are categorized into subject categories. Given this, searches in the Web of Science were made more specific by refining the results by these automatically generated categories. For example, as the search was interested in patient uptake, the category ‘Occupational Health' was excluded. Results were then moved to endnote 8.1 and duplicates were removed.

Identifying studies: Screening for Inclusion

One reviewer, Meghann Gregg (MG), assessed articles for inclusion over two screening stages. In primary screening the title and abstract were reviewed to determine inclusion. Please see Table 6 for primary screening questions. In primary screening, if all answers were yes/unsure the article was moved to secondary screening (full-text review) to confirm whether the article would be included or not. The result of 'unsure' can occur when the title and abstract do not give enough information to confirm inclusion. When this was the case, articles were marked yes/unsure. If the answer was 'no' in primary screening, the article was excluded from the review.

Table 6: Primary screening question, title and abstract: Literature review of other models of maternal care seeking

Question	Possible Responses	
Is the main aim of the article to describe a model of elements that influence uptake of PPH interventions (as defined by WHO Recommendations for the Prevention and Treatment of Postpartum Haemorrhage) in a clinic/hospital setting, by women/her decision group?	yes/unsure	no

Secondary screening was conducted on the full text of articles that were designated as yes/unsure in primary screening. 'Unsure' articles are screened the same as 'yes' articles in secondary screening. After full text review articles that met the inclusion criteria were included in the review. The question asked to determine inclusion in secondary screening was the same as the primary screening question. The exception was that the response to the inclusion question after full text screening could only be 'yes' or 'no'. If the answer was 'no' in secondary screening, the article was excluded from the review and the reason for exclusion was recorded and reported in the results.

Data collection and analysis

Extraction

Information was extracted from included articles using a pre-determined extraction form (Table 7), and input into an Excel spreadsheet. Information was extracted by one reviewer (MG).

Table 7: Extraction form questions: Literature review of other models of maternal care seeking

PUBLICATION
Author(s)
Title
Study type
Study aim
Year published
POPULATION
Country
Study population
MODEL
What type of model is used to examine/explain uptake?
RESULTS
What are the results of the model and pertaining to PPH?

Analysis

The extracted data were described qualitatively and quantitatively. A narrative synthesis of each model type was presented, and classified into model categories (regression/statistical and conceptual). This discussion reflects the strengths and weaknesses of each model and how they relate to the thesis aim and objective.

Results: Literature review of other models of maternal care seeking

The literature search was conducted on October 2nd 2017 (and updated to December 31st 2019) of PubMed and Web of Science, and 904 articles were identified. There were 35 duplicates identified resulting in 869 articles including for screening. In first level screening 780 articles were excluded and 89 articles moved to stage two screening. In stage two, 32 articles were excluded for the following reasons: not on topic/outcome of interest (20), unable to access (9), not a model as defined in this review (2), and not English language (1). This resulted in 57 articles being included in the review. Please see Figure 5 for the flow diagram of screening and selection.

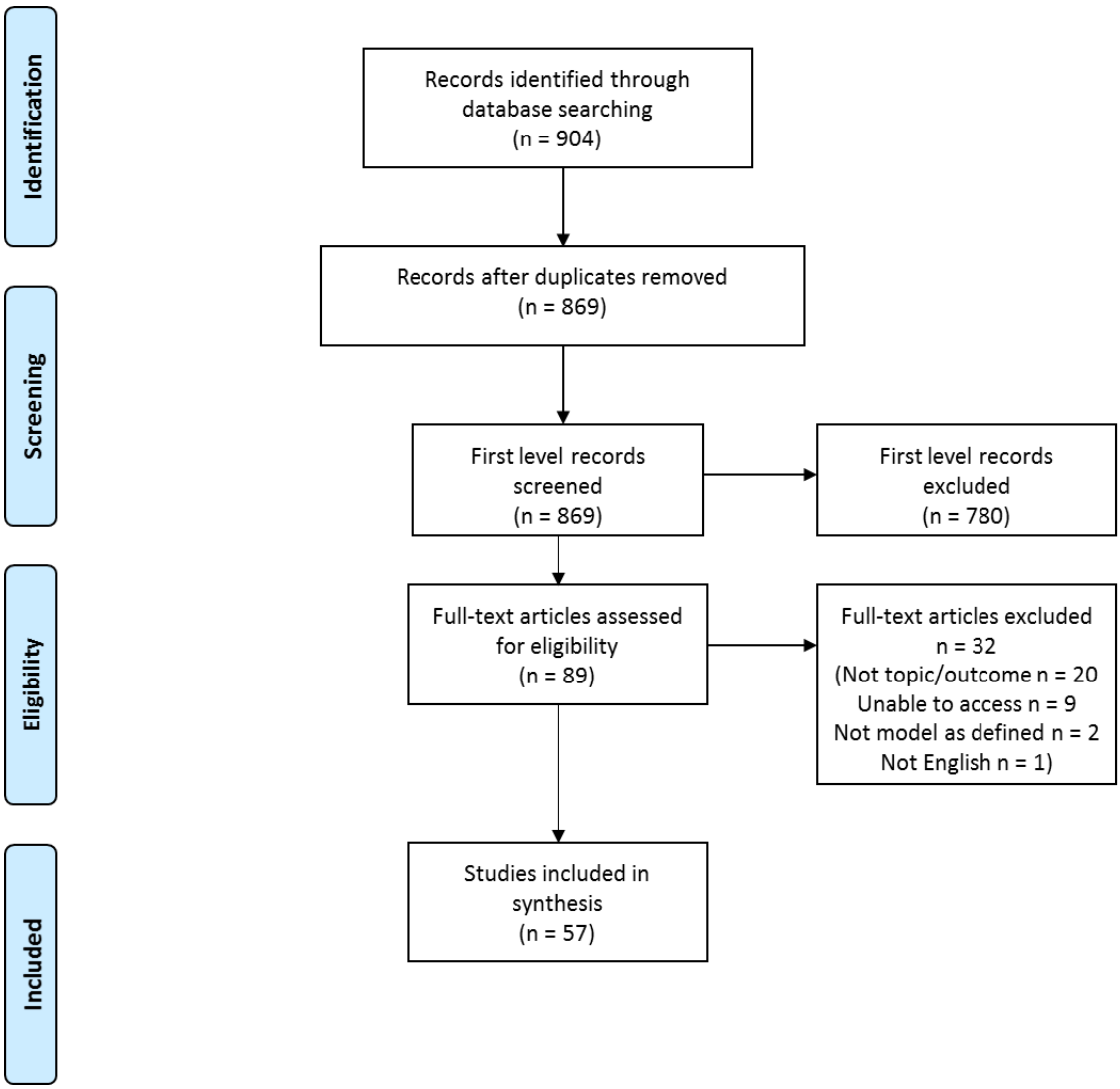

Figure 4: Flow diagram of screening and selection: Literature review of other models of maternal care seeking.

The 57 included articles include examinations of 28 countries, and two main model types: statistical/regression (49 articles) and conceptual models (8 articles). Details of the included articles can be found in Table 8 below.

Table 8: Included articles: Literature review of other models of maternal care seeking

Article #	Author	Year	Country	Population	Study Aim	Study Type	What type of model is used	Results (related to level 1 inclusion criteria and model results)
1	Adjiwanou & LeGrand(56)	2014	4: Ghana, Kenya, Tanzania, Uganda	12228 women, age 15–49, live birth past 5 years.	To examine influence of gender inequality on use of antenatal care and skilled birth attendance.	Modelling-demographic health survey	Multilevel structural equation	Where gender norms accept violence against women, women are less likely to use care (Ghana and Uganda) and in Tanzania, women in this environment likely to have 4+ antenatal visits.
2	Alcock et al(57)	2015	India	3848 women, birth in the past 2 years.	To quantify determinants of choices about maternity care provider.	Mixed methods (model and qualitative)	Multivariable logistic Regression	Institutional prenatal and delivery care: odds increased with duration of residence in Mumbai, education, and economic status. Odds decreased with parity.
3	Anyait et al(58)	2012	Uganda	500 women, birth in the past 2 years.	To identify predictors of health facility delivery.	Cross-sectional study	Bivariate and binary logistic regression	8 independent predictors favouring health facility delivery: socio-economic status, previous difficult delivery, preference of supine position (2nd stage labour), parity <4, prefer health workers dispose placenta, no difficulty with transportation, autonomous decision making to attend antenatal care, depending on others for decision making.
4	Asseffa, Bukola, & Ayodele(59)	2016	Ethiopia	751 women, birth in the past 3 years.	To determine proportion of facility delivery, assess factors influencing use of health care facility for childbirth.	Cross-sectional study	Bivariate and multiple logistic regression	Bivariate analysis: 12 variables associated with facility delivery (maternal age, wealth quintile, husband's level of education, education, place of recent antenatal care attended, antenatal care, possession of radio, parity, planned pregnancy, birth preparedness and complication readiness, distance from nearest health facility, being a model family).Multiple logistic regression analysis: 8 variables associated with facility

								delivery (age, wealth quintile, educational status, antenatal care, distance from the nearest health facility, planned pregnancy, place of recent ANC attended, being a model family).
5	Benova, Campbell, & Ploubidis(60)	2015	Egypt	7896 ever-married women aged 15–49, 5 years.	To determine maternal health-seeking behaviours related to maternal care.	Modelling-demographic health survey	Logistic regression	2 independent positive associations with receiving any antenatal care and facility delivery: economic capital, socio-cultural capital
6	Berhan & Berhan(61)	2014	Ethiopia	Not explicit	To summarize factors for increased risk of maternal and perinatal deaths.	Conceptual model	Three delays conceptual model	22 individual factors placed into three delay categories (Delay 1: 7 factors, Delay 2: 6 factors, Delay 3: 9 factors, narrative presentation of factors by delay category
7	Bintabara, Nakamura, & Seino(62)	2018	Tanzania	13266 women, aged 15–49 years.	To explore factors associated with problems accessing healthcare.	Cross-sectional study: Demographic Health Survey	Logistic regression	Associated with greater problems of accessing healthcare: no health insurance, no formal education, each year of increasing age, poorest class in wealth index, not employed for cash, divorced/separated/widowed. Effects were additive.
8	Budhwani, Hearld, & Harbison(63)	2015	Pakistan	7399 mothers who answered a government demographic survey.	To examine individual & area level factors associated with maternal health care use.	Modelling-demographic health survey	Multilevel logistic regression	Use of postnatal care. Individual level variables: increased odds education, wealth age; lower odds distance, higher birth order. Community level variables: no significant effect, use of prenatal care, secondary education, poverty. Variation in care use based on geographic location in country
9	Choe et al(64)	2016	Tanzania	30830 women, birth in past 5 years.	To explore how frequency of antenatal care visits mediates	Modelling-demographic health survey.	Linear regression	Variables increase in facility delivery rate: in urban areas, higher number of antenatal care visits, exposure to medical; rural areas, no significant relationship between

					longitudinal trends of facility delivery.			antenatal care visits and facility delivery. Physical distance is the most frequent reason for home delivery
10	Dadi et al(65)	2019	Ethiopia	789 mothers, birth within previous year.	To assess new born, maternal health services use, & factors affecting health service use.	Cross-sectional survey, key informant interviews	Multivariable logistic regression	Obstacles to health service utilization: personnel and supply shortage, home delivery, delay in arrival to care, unsafe delivery settings.
11	Duong, Binns, & Lee(66)	2004	Vietnam	200 women, birth in last 3 months.	To investigate factors influencing use of delivery services at primary health care level.	Mixed methods (model and qualitative), survey then regression	Logistic regression	Odds of birth at health facility: higher odds, secondary education, first time birth; lower odds, living with extended family; little influence: distance and access.
12	Enuameh et al(67)	2016	Ghana	1497 women aged 15–49 years with live/stillbirths between 01 2011 & 04 2013.	To explore factors influencing delivery location in predominantly rural communities.	Mixed methods: model & qualitative survey, questionnaire, regression	Multivariate & univariable logistic regression	Factors associated with health facility delivery: healthcare provider's influence on decision, place of residence, possession of a valid health insurance card, socio-economic status.
13	Furuta et al(68)	2016	Nepal	1375 married women 15-49, birth in past 5 years.	To examine associations between women's experiences of spousal violence & receipt of skilled maternity care.	Modelling-demographic health survey	Univariate logistic regression	Spousal violence associated with receiving low levels of skilled maternity care, adjusted for accessibility of health care. Controlling sociodemographic factors (age, number of children born, educational level, husband's education level, husband's occupation, region of residence, urban/rural residence, wealth index), associations disappeared.
14	Furuta & Mori(69)	2008	Sudan	10 married women, birth in last 2 years.	To provide deeper understanding of a broader range of	Qualitative-interviews then	PRECEDE PROCEDE conceptual model	For individual women factors frequently were uncontrollable, suggests importance of

					factors affecting risk behaviours related to safe motherhood.	conceptual model of results		supportive political, social, and educational environment. Narrative, quotes/vignettes
15	Gage, Ilombu, & Akinyemi(70)	2016	Nigeria	2710 women, aged 15–49 years, birth in last 5 years.	To analyse role of supply-side factors for provision of quality maternal health services.	Cross-sectional study	Multilevel logistic regression	To odds of health facility delivery: positive association, antenatal care provision in 2009 in rural areas versus 2005 and urban areas; low association, management practices in rural areas versus urban areas; unrelated, facility readiness to deliver basic emergency obstetric and neonatal care.
16	Gayawan(71)	2014	Nigeria	28,362 women, live birth in past 5 years.	To analyse special patterns in choice of place of delivery	Modelling-demographic health survey	Multinomial logit regression within linear model	Likelihood of institutional delivery: lower, living in majority of states in north; higher, age, antenatal care services, urban dwelling, mass media, parity
17	Govil et al(72)	2016	India	424 women, birth in past 1 year.	To examine variation in out-of-pocket expenditure & accessing maternal health services.	Cross-sectional study	Logistic regression	Significant predictors of out-of-pocket expenditure: economic status, educational level, pregnancy complications.
18	Hailu et al(73)	2011	Ethiopia	812 pregnant women.	To assess practice & factors associated with birth preparedness & complication preparedness.	Cross-sectional study	Multivariate logistic regression	Significant predictors for birth preparedness: use of antenatal services, first pregnancy.
19	Hotchkiss et al(74)	2005	Morocco	1607 women, birth in past 5 years.	To examine the role of household out-of-pocket costs and structural	Modelling-demographic health survey	Multinomial logit regression	Social insurance strategies increase out of pocket charges (co-payments) yet can be implemented without negative effects on appropriate use of maternity care for non-

					attributes of quality on the use of maternity care.			poor women, but have a negative effect on poor and rural households.
20	Jalu et al(75)	2019	Ethiopia	50 interviews & 17 focused groups, with women of reproductive age, their partners, health care providers, extension workers, & administrators.	To explore factors affecting health seeking behaviours.	Cross-sectional study, collecting qualitative data	Socio-ecologic Model (SEM)	22 elements individually categorized into 5 levels: individual (6), interpersonal (4), community (5), organization (4), and policy (3). Narrative with vignettes/quotes.
21	Johnson(76)	2016	Ghana	12226 women, birth in past 5 years.	To examine geospatial dependence in use of skilled birth care at district level relationships with maternity fee-paying policies.	Modelling-demographic health survey	Bayesian Geoadditive Semiparametric (BGS) regression	Maternity fee-paying policies: positive influence on use of skilled birth delivery care; insignificant influence on reducing between-district inequalities.
22	Johnson et al(77)	2015	Ghana	4,349 births.	To investigate the impact of proximity to community-based health planning and services on facilitating uptake of skilled birth care in rural areas.	Modelling-demographic health survey	Multilevel logistic regression, bivariate, multivariate	Skilled birth care: higher odds, when health facilities and community-based health planning and services within 8km and only a health facility within 8km; less pronounced uptake when communities are within 8 km of community-based health planning and services but do not have health facilities.

23	Johnson, Padmadas, & Brown(78)	2009	Ghana	2 level analysis: 2,342 and 2,757 mothers, birth in past 5 years.	To investigate the changes in spatial inequalities associated with type of delivery care.	Modelling-demographic health survey	Multilevel multinomial regression	Inequalities stayed high and unchanged in both urban and rural areas in Savannah zone and widened in urban areas of Forest and Coastal zones.
24	Kante et al(79)	2016	Tanzania	597 women who recently delivered at a facility in past 2 years.	To estimate bypassing (did not deliver at nearest facility) for childbirth & assesses factors associated with bypassing.	Modelling-demographic health survey	Multivariate model, logistic regression	More likely to bypass: women with previous complications, and with previous complications and primigravida. Less likely to bypass: when emergency obstetric and new born care signal function was available at nearest facility.
25	Kea et al(80)	2018	Ethiopia	44 in-depth interviews & 14 focus groups: with: women, men, traditional birth attendants, local administrators, health professionals & extension workers.	To identify factors influencing use of maternal health services at primary health care level in rural communities.	Qualitative study (in-depth interviews and focus groups)	Three delays model	18 elements were individually placed into three categories (socioeconomic/cultural 9 elements, accessibility of facilities 4 elements, and quality of care 5 elements) and each category was connected to a delay (all three categories influences delay 1, only accessibility of facilities influences delay 2, and only quality of care influences delay 3. Narrative description with vignettes/quotes
26	Kc & Neupane(81)	2016	Nepal	4148 married women, birth in past 5 years.	To explore association between women's autonomy & skilled attendance	Modelling-demographic health survey	Binary logistic regression	Women's autonomy significantly associated with maternal health care utilization by skilled attendants.

					during pregnancy and delivery.			
27	Kifle et al(82)	2017	Ethiopia	561 women birth in last 2 years.	To assess factors associated with maternal health care seeking.	Cross-sectional study	Bivariate and multivariate logistic regression	Significantly associated with antenatal, delivery, and postnatal care: known pregnancy complication, religion, education status.
28	Kitui et al(83)	2017	Kenya	Data from 9095 facility deliveries from 28 health facilities.	To estimate the impact of two community health programmes aimed to improve skilled birth assistance.	Modelling-registry and report data	Binomial generalized linear (regression)	Significant variables: provision of Motherpacks, reorientation of traditional birth attendants, number of months passed since intervention start.
29	Lakew, Tachbele, & Gelibo(84)	2015	Ethiopia	798 women, birth in past year.	To assess women's skilled assistance seeking behaviour for pregnancy complications among those who gave birth.	Cross-sectional study	Bivariate and multivariate logistic regression	Significantly associated with seeking assistance from a skilled provider: monthly household income $US25- 100, receiving antenatal care from a skilled provider, age 20–34 years old, availability of transport access.
30	Lindstrom & Munoz-Franco(85)	2006	Guatemala	1838 women, live birth last pregnancy.	To examine relationship between migration & use of formal maternal health-care services.	Modelling-survey, questionnaire	Multilevel logistic regression	Migration experience at all levels is strongly associated with formal delivery assistance; this association operates through the positive association between enabling resources and migration.
31	Masters et al(86)	2013	Ghana	Data from 1172 women, most recent birth n births: 1649.	To test if travel time negatively affects the use of facility delivery and other maternal services.	Modelling-demographic health survey (location and birth place)	Multilevel logistic regression	Significant effect on likelihood of facility delivery for rural households: maternal age, wealth, female autonomy, holding constant education, facility capacity, season of birth. No detectible effect: the ability of the facility to offer sophisticated care.

32	McKinnon et al(87)	2015	10 countries: Cameroon, Congo, Ethiopia, Gabon, Ghana, Kenya, Mozambique, Nigeria, Senegal, Tanzania	Women ages 15-49, live birth between 1995 and 2012.	To estimate the effect of removing user fees on births delivered in facilities, Caesarean section, and neonatal mortality.	Modelling-policy and demographic health survey	Difference in differences logistic regression	Removing user fees: increase in facility deliveries and reduction in neonatal mortality. No evidence of increase in Caesarean sections.
33	Mills et al(88)	2008	Northern Ghana	4,070 women with pregnancy outcomes in 2004.	To assess factors associated with use of health professionals for delivery after implementation of free obstetric care policy.	Modelling-demographic surveillance, interviews, regression	Multilevel, bivariate and multivariate logistic regression	Statistically significant associations with use of health professional for delivery: physical access factors. Women more likely to use care if knew care was free. Negatively associated: higher parity (>4). Community perception of care quality not associated.
34	Moyer et al(89)	2013	Ghana	1102 women, birth in last year.	To determine types of care access associated with facility delivery.	Modelling-demographic health survey	Multivariate, univariate and bivariate logistic regression	Strongly associated with facility delivery: affordability. Not significant: accessibility (except urban residence), availability, acceptability, social access.
35	Ochako et al(90)	2011	Kenya	1675 women, aged 15-24, most recent birth.	To determine relationship between timing of first antenatal care visit & type of delivery assistance, & to establish determinants of timing of first ANC	Modelling-demographic health survey to model effect between variable and outcome	Multivariate logistic regression	Strong influence on timing of first antenatal care visit and type of delivery: age at birth of the last child, education, marital status, household wealth, place of residence, parity, ethnicity.

					visit & type delivery assistance.			
36	Pebley, Goldman, & Rodriguez(91)	1996	Guatemala	5160 women, age 15-44, live birth in past 5 years.	To investigate family choices about pregnancy care & use of childhood immunization.	Modelling-national health survey, regression	Multilevel logistic (logit) regression	Significant difference in use of formal health services by availability of health care, social and economic factors, ethnicity. Community and family membership are also important determinate of care use.
37	Posthumus et al(92)	2016	Netherlands	1532441 singleton pregnancies.	To explore joint association of individual characteristics & hospital density with prototype obstetric interventions.	Observational study-retrospective data, perinatal registry	Multilevel logistic regression model, random intercept for postcode	No association with greater obstetric interventions: higher hospital density. General association with low probability of interventions (adjusting for higher hospital density and maternal characteristics): non-Western ethnicity, living in low SES neighbourhoods.
38	Pradhan & Fan(93)	2017	Nepal	8785 children born 7/2005-12/2008.	To assess impact of co-payment exemption compared to cash incentive on increasing skilled birth attendance.	Case control Demographic health survey	Difference in differences probit regression	No significant increase in skilled birth attendance relative to cash incentive: incentive of user-fee exemption.
39	Pulok et al(94)	2016	Bangladesh	11743 ever-married, 15–49 years, live birth past 3 years.	To analyse trends in inequity and identify the equity gap in use of antenatal care and delivery care.	Modelling-demographic health survey	Multivariate model, logistic regression	Significant predictors of use of health care: women and husbands' education, autonomy in healthcare decision-making, involvement in microcredit programs, exposure to mass media.
40	Rutaremwa et al(95)	2015	Uganda	1728 women, ages 15–49, birth in past year.	To investigate predictors of maternal health services use.	Modelling-demographic health survey	Multinomial logistic regression	More likely to use care: women with secondary and higher education, wealthy household. Less likely to use care: women

								who lived outside the capital region, residing in rural area, Muslim faith, married.
41	Sepehri et al(96)	2008	Vietnam	9400 live births, women 12–49 years, most recent birth in past 5 years.	To assess individual, household & commune-level characteristics on decision to use prenatal care, number of prenatal visits, & birth location.	Modelling-national household survey	Logistic regression	Increase likelihood of birth at facility: more prenatal visits. For middle- and high-income women with health insurance increases odds of birth at a health facility. But for lower incomes health incurrence increases likelihood of prenatal visits but no effect on place of delivery.
42	Shah et al(97)	2015	Nepal	673 women, birth in last year.	To identify socio-cultural, socio-demographic, and health service factors influencing institutional delivery uptake.	Cross-sectional study	Univariate and multivariable logistic regression	Significant increase likelihood of institutional delivery: advantaged caste/ethnicity, husband support for institutional delivery, joint decision by woman and family members for delivery place, birth preparations, complications during most recent pregnancy/delivery, perception that skilled health workers are always available, birthing facility located within one hour's travelling distance. Decreased likelihood: not knowing about the adequacy of physical facilities.
43	Shahabuddin et al(98)	2017	Bangladesh	Interviews (married pregnant adolescent girls: 25, married non-pregnant adolescent girls: 10) 3 focus groups,	To explore maternal health care-seeking behaviour of adolescent girls.	Qualitative study (interviews), results analysed by a SEM model	Socio-ecological model (SEM)	20 factors identified: 7 individual, 4 interpersonal/family, 6 community social, 3 organizational/health.

				total 19 participants, 4 key informants (health care workers and community people).				
44	Sharma et al(99)	2013	India	85 participants: 8 focus groups (women 20-55 years of age), 5 in depth interviews (women, traditional birth attendants, service providers).	To explore perspectives of women on childbirth (choices, conceptualisations of complicated childbirth).	Qualitative study (focus groups, interviews), to produce a model of transition in birth practices	Conceptual model (conceptual map)	The transition in child care practice across generations is captured in 3 sub-processes: external factors (6 elements), home to hospital [status] (2 elements), cultural conceptualizations of childbirth (3 elements).
45	Sikder et al(100)	2011	Bangladesh	40 women reporting severe acute obstetric complications.	To describe health care decision-making in women and families during severe acute obstetric complications.	Qualitative study	Conceptual model (conceptual map)	16 elements placed into 5 categories capture the care pathway: socio economic and demographic factors, sociocultural and structural factors, delays to seeking certified medical care, referral linkages, how death was averted. The first two categories independently feed into the last three which occur in a linear order.
46	Skiles et al(101)	2013	Rwanda	7899 women 15–49 years of age, birth in past 18 months.	To examine the effects of performance-based financing on equity in	Modelling-demographic health survey	Difference in differences linear regression	Probability increase of facility delivery in intervention group compared to control. No significant effects: modern contraception use, antenatal care. Service use increase across both populations across wealth quintiles, and when insurance is held.

					maternal health service use.			
47	Thind et al(102)	2008	India	1510 ever-married women, 15-49 years of age, most recent birth.	To assess determinants of sector utilization for a delivery (home, private, public).	Cross sectional analyses of the National Family Health Survey	Multinomial logistic regression analyses	Greater odds of delivery at home versus public facility: living in rural area, higher birth order. Greater odds of delivery at facility: greater media exposure, increasing maternal age, more than 3 antenatal visits. Predictors of private facility birth versus public: media exposure, maternal and paternal education, caste/tribe status.
48	Trujillo, Carrillo, & Iglesias(103)	2014	Columbia	14492 women, birth in past 5 years.	To identify determinants of institutional delivery and professional antenatal care, and considering interdependence. of these two decisions.	Modelling-Demographic and Health Survey (2010)	Univariate and bivariate probit regression	Results inefficient when factors affecting decision to birth in facility and prenatal care are neglected. Effects of numerous factors are underestimated in univariate model (economic status, education, regional location, parity). Jointly several factors influence likelihood of facility birth and antenatal care (level of education, economic status, parity, medical insurance affiliation).
49	Vellakkal et al(104)	2017	India	732358 married women, ~4 years after pregnancy end.	To evaluate effect of health program (to strengthen primary healthcare) on socioeconomic inequities in use of antenatal care & institutional delivery.	Cross-sectional study (survey)	Difference in differences linear regression	Inequities declined in institutional deliveries before the program and a steeper decline after. No positive effect on antenatal uptake immediately after program, but later on an increase occurred and decline in inequity in most states.
50	Viswanathan et al(105)	2012	Afghanistan	9633 ever-married women, aged 10-49 years,	To determine if presence of community health workers increases	Cross-sectional survey, Health Survey,	Multilevel logistic regression	Associated with higher use of skilled birth attendance, skilled antenatal care, and modern contraceptives: female community health workers. Not associated: male

				live birth past 2 years.	use of skilled birth attendance, skilled antenatal care, & modern contraceptives.	Multilevel model		community health workers. Also, significant: community-level random effects.
51	Wang et al(106)	2016	Zambia	2159 women: using care at control (1169) and treatment (990) facilities.	To measure impact & cost-effectiveness of 'mama kit' on facility delivery.	Clustered randomised controlled trial	Multivariate logistic regression	Statistically significant increase in facility delivery rates (increased odds): mama kit intervention.
52	Worku, Yalew, & Afework(107)	2013	Ethiopia	1668 women, birth in past year.	To assess effect of characteristics on use of skilled antenatal, delivery, & postnatal care.	Facility and population-based survey	Multilevel logistic regression	Variables related to all skilled maternal service use: individual level (perceptions and awareness). Strong predictors of all skilled maternal service use: previous experience with antenatal care, preference for skilled providers. Strong predictors of postnatal care use: communal factors.
53	Yanagisawa, Oum, & Wakai(108)	2006	Cambodia	980 women, aged 15–49 years, birth in past 3 months.	To identify the determinants of skilled and unskilled birth attendance.	Population-based survey	Logistic regression	Significant determinant of facility delivery: during antenatal care previous contact with a skilled attendant.
54	Yasobant et al(109)	2017	India	997 multiparous women.	To determine effect of previous use of scheme to promote facility birth.	Retrospective cohort study	Linear (poisson) regression model	Previous use of the scheme was significantly associated with subsequent use. Not associated: previous out-of-pocket expenditure and retention in the scheme.
55	Yassin, Laaser, & Kraemer(110)	2003	Egypt	231 women, birth in past year.	To determine maternal morbidity & identify patterns and determinants of care seeking.	Cross-sectional design (interviews, focus groups)	Logistic regression model	Low use of care was significantly associated with: husband illiteracy, poverty. Unattended deliveries associated with: inaccessibility of potable water, non-use of antenatal care, non-ownership of cattle, illiteracy.

56	Wallace et al(111)	2018	Timor-Leste	17 interviews with women, 9 focus group discussions with 80 men, age (18–49 years).	To identify what influences decisions to seek care (antenatal and labour/birth).	Qualitative study, interviews and focus groups	Three Delays Model expanded to 4: includes delays from perceptions of respectful care	Elements separated into 2 categories: antenatal care & care during labour and birth. Narrative with vignettes/quotes.
57	Wu et al(112)	2019	China	760 women	To assess factors influencing use of maternal health services.	Structured questionnaire, face-to-face interviews	Structural equation modelling	Positive correlations with postpartum care visits and hospital delivery: antenatal care, social economic status, time from home to nearest hospital. No direct correlations: perceived quality of care and maternal care knowledge.

ANC: Antenatal care; SES: socio-economic status

Discussion: Literature review of other models of maternal care seeking

None of the models included in the review are similar to the proposed process model of this thesis. Primarily the identified models are not similar in that they do not take a systems approach (do not attempt to explain the collections of non-linear interactions of 'all' elements that influence the behavioural system of uptake). Identified models are either statistical models (regression) or conceptual with no details of interactions. Please see below for a summary of the two main models and articles included in the review.

Regression models

There were 49 regression models collected in the literature review. These included 37 multivariate, bivariate, and univariate logistic/probit regression models and 12 multivariate multi-level models. Regression models estimate the odds ratio between two groups. In the included studies, the two groups include one group with explanatory variables (elements that are thought to influence uptake) and one group without explanatory variables. An odds ratio describes the relative chance of a response variable (uptake) occurring compared between the two groups (113).

Multi-variate regression models consider the combined relationship of explanatory variables on the response variable; they are not able to give details of how the explanatory variables relate to one another, and how this influences the response variable (114), which is key to the question asked in this thesis. Bivariate and univariate models do not estimate combined relationships across multiple explanatory variables (bivariate means two variables, and univariate mean one variable). Multi-level regression models (MLRM) can provide more information on how/why variables relate to each other, by considering certain grouping levels of variables (e.g. institution level hospital settings and individual level patients within the hospitals), and thereby giving some indication about contextual effect (115). However, this thesis aims to describe behaviour in more detail with consideration of 'all' elements influencing uptake and how these elements interact, thereby making estimations about how these interactions cause uptake (or not). Regression models, even MLRM are unable to meet this aim. Additionally, the purpose of these regression models is not to describe a system, which again is key to meeting the aim of this thesis.

Regression models cannot be adapted to describe a system, as they are unable to include all elements within their representation. Regression model strength relies on

statistical power, which is lowered when many variables (elements) are introduced: regression models with many variables are not able to detect significant relationships (114). Another main shortcoming to using a regression model to explain a system of behaviour, is the use of linear mathematics. A behaviour system is likely non-linear as it is ever-changing. Even when nonlinearity exists, in a regression model it is conformed into linear mathematics to estimate coefficients (116).

In summary, regression models can be very useful to address many question types, but they cannot address the thesis aim, as they: do not support a systems analysis, measure a statistical and linear relationship, are unable to analyse 'all' influencing elements, and they do not estimate causation. These regression models illustrate well a mechanistic thinking versus a complexity thinking about behaviour.

Conceptual models

The aim of this literature review was to identify similar models to the one proposed in this thesis (a systems model that describes interactions about use of care for PPH). The search conducted was specific, in that it was aiming to capture models, and inevitably some conceptual frameworks were excluded if they were not called models. For example, the review did not identify Gabrysch and Campbell's 2009(117) literature review of factors influencing health care service use for deliveries, where the authors collect evidence from articles and categorize them into four categories, and develop a conceptual framework about the use of health care services. Though this framework identifies some interactions, it does not describe them within the framework or present a systems view of uptake. Given the specificity of this search, articles like the above would have been excluded.

There were eight conceptual models collected in the review (Table 9). These conceptual models include the Three Delays Model, PRECEDE-PROCEED model, socio-ecological model (SEM), and two conceptual maps of elements influencing use of care, delays to care, and maternal mortality and morbidity.

Table 9: Eight included conceptual model articles: Literature review of other models of maternal care seeking

Article #	Author	Year	Country	Study Type	What type of model is used
1	Berhan & Berhan(61)	2014	Ethiopia	Literature review, conceptual model (3 delays)	Three Delays Model
2	Furuta & Mori(69)	2008	Sudan	Qualitative-interviews then conceptual model to understand results	PRECEDE PROCEDE conceptual model
3	Jalu et al(75)	2019	Ethiopia	Cross-sectional study, collecting qualitative data	Socio-ecologic Model (SEM)
4	Kea et al(80)	2018	Ethiopia	Qualitative study (in-depth interviews and focus groups)	Three Delays Model
5	Shahabuddin et al(98)	2017	Bangladesh	Qualitative study (interviews), results analysed by a SEM model	Socio-ecological model (SEM)
6	Sharma et al(99)	2013	India	Qualitative study (focus groups, interviews), to produce a model of transition in birth practices	Conceptual model (conceptual map)
7	Sikder et al(100)	2011	Bangladesh	Qualitative study	Conceptual model (conceptual map)
8	Wallace et al(111)	2018	Timor-Leste	Qualitative study, interviews and focus groups	Three Delays Model expanded to 4: includes delays from perceptions of respectful care

All of these articles identify elements, and group them into categories in relation to an outcome of interest. Though the articles are informative in identifying and clearly communicating influencing elements though figures, they do not provide detailed information on interactions which is key to furthering our understanding of uptake. The Three Delays, PRECEDE-PROCEED, and socio-ecological models, as well as one conceptual map (Sharma 2013) all mention interactions/relationships but none provide details. One conceptual model does not mention interactions/relationships (Sikder 2011). Please see below for a short description of each model collected in this review.

Three Delays Model

In Berhan and Berhan 2014(61) the Three Delays Model is used to examine elements (called factors) in Ethiopia that influence maternal mortality, and categorize these factors

into three areas of delay (delay in decision to seek health care, delay in getting access to a health facility, delay in receiving medical care). The factors included in this article were collected from literature reviews (118, 119). There is mention in the article that maternal mortality has a “multi-dimensional nature” (61). There is no further description or discussion of how many elements interact together. Kea et al 2018(80) also uses the Three Delays Model to structure factors influencing the use of maternal services in Ethiopia. Factors are identified from in-depth interviews and focus groups. Wallace et al 2018(111) uses the Three Delays Model to organise factors that influence decision making about care (antenatal and labour/birth location), identifying factors from interviews and focus groups. Wallace et al 2018(111) adds an additional delay to the model: delays from perceptions about respectful care.

In the Three Delays Model maternal mortality/use of maternal care is influenced by factors categorized by delay. In the original article on the Three Delays Model ‘factors’ are presented in a singular way and there is mention in text that that elements interact to affect the outcome(36).The authors state that interactions are present (elements affect other elements and the outcome) but they do not take the next step to examine how we can explore or communicate these interactions(36).

PRECEDE-PROCEED model

In Furuta and Mori 2008 (69), in-depth interview data (arranged into factors) is placed into three categories (predisposing, reinforcing, and enabling factors), to direct appropriate interventions to support maternal health related behaviours (including the use of a skilled birth attendant). The article discusses how these factors are related to each other and that all factors must be considered to change behaviour. For use of a skilled birth attendant, only six factors are identified (two in each category). The PRECEDE-PROCEED is used for planning and evaluating behaviour change interventions, not to “predict or explain the relationship among factors thought to be associated with an outcome of interest” (47).

Socio-ecological model

In Shahabuddin et al. 2017 (98), a socio-ecological model is used to examine interview results and elements influencing care seeking for pregnancy and delivery in India. Elements were placed into four categories (individual, interpersonal and family, community and social, and organizations and health care system). Elements are

presented separately and quotes from interviews explain why care was sought or not sought. In the discussion there is one point made about the 'interlinking' of elements illustrated with the example of child marriage resulting in less education, which reduces knowledge and autonomy. Other than this mention, there is no description of interactions, only general statements about the "complex interplay of multiple levels" (98).

In Jalu et al 2019(75) the authors explore factors influencing health seeking behaviours through a cross-sectional survey and a socio-ecological model. The survey results include 22 elements that are individually categorized into five levels: individual (6 factors), interpersonal (4 factors), community (5 factors), organization (4 factors), and policy (3 factors). The authors mention that factors intersect/interact with each other, but they do not provide description of how this occurs.

Conceptual map models

In Sharma 2013 (99), focus groups and interviews are used to collect data about the transition from community managed to professionally managed childbirth practices in India. Elements are placed into a conceptual model of four categories with two to three subcategories in each, that are called "inter-linked sub processes"(99). No further explanation of how these processes interlink, and no details of the components within the subcategories is offered in the article.

In Sikder 2011 (100), interviews were conducted with women reporting severe acute maternal complications to identify themes and create a conceptual model about what causes delay in seeking care in Bangladesh. No description of interactions between elements is presented. Elements are placed into five categories (and two-five elements within) that contribute to delays along a pathway to receiving care.

Other model types to consider

This literature review search and selection was specific to including models explaining treatment seeking for PPH, and found 39 statistical/regression models and eight conceptual models. There are other models that would have been captured if the inclusion criteria were broader, for example including any maternal or neonatal health seeking behaviour. It is of value to review some of the other model publications even though they were not captured in the literature review, as these model types are more frequently used to describe health seeking behaviour in general, compared to complex

systems theory. These model types include: systems dynamic modelling, agent based modelling, and complex adaptive systems.

Systems dynamic modelling

One example of a systems dynamic model can be found in Ahmad et al 2019(120). Here the authors build a systems dynamic model to estimate "how different timing and access to care during pregnancy impact neonatal outcomes"(120). Authors present results that show that when women use antenatal care (ANC) neonatal mortality declines. The model estimates through four scenarios that neonatal mortality declines when: any provider is used for ANC in the first trimester (scenario 1), women opt for skilled care providers in the first trimester (scenario 2), women choose institutional delivery (scenario 3), and when women choose to have an attended delivery at home (scenario 4).

This model predicts and assigns care choices based on decision making determined from qualitative evidence collected from a study of 60 women in Pakistan, but the publication does not share how the factors/elements operate to produce behaviour (using ANC care, choice of provider, and delivery service choice). Authors give some examples of factors that influence care seeking (e.g. household wealth, social mobility, social networks) but the other factors included are not listed. A causal loop diagram names some of the other influencing factors (e.g. awareness/knowledge of care services, woman's literacy education level, perceived risk of not using care, and other factors about social network/influence). The model publication reports only a limited number of elements, it does not appear to comprehensively include elements that influence care choice, and it does not explain whether or not variation is considered in combination factor effects. By choosing which are 'important' factors and eliminating others, one can obscure the complexity of behaviour. Though these simplifications of complexity can be acceptable when a wider understanding of behaviour is present and the environment is stable with little variation.

The benefit of this model is that it allows policies to be tested in a simulation where there is little cost, or issues around feasibility and ethics, that would be substantial if not impossible to manage in a real-world setting. The model is validated against real-world data, showing the model well replicates evidence from the past.

Another example of a systems dynamic model can be found in Semwanga, Nakubulwa, and Adam 2016(121). Here the authors create a model of how the health care system in Uganda interacts with the population (behaviour and characteristics) to explain how

these interactions effect maternal health seeking behaviour (ANC, postnatal care, and delivery services) and neonatal mortality. The simulation model tests ten different policy interventions (e.g. providing clean delivery kits, providing motorbike ambulances to remote areas, and campaigns to improve education/awareness about maternal health) to help decision makers estimate how best to increase participation in health care and reduce neonatal mortality. The results of the various interventions tested in the model show that all decrease neonatal mortality, ranging from a 0.36% decrease to a 23.21% decrease.

The model focus is to explain the dynamic between the health care system and the population, not to explain the complexity of health seeking behaviour (i.e. the details of how elements interact to influence behaviour). Though the model does include the role of health care use as an influencing element and as an outcome, when designated as an outcome the description of element interactions is fixed (supporting or opposing uptake) and does not allows for elements to collectively interact with each other (not presented as a whole but piecemeal). As stated about the previous publication (Ahmad et al 2019), this approach can be useful when behaviour is well understood and the environment is stable. But when elements that can interact/are interacting are excluded, the representation of the system is limited and model results can be incorrect.

Agent based modelling

One example of an agent based model (ABM) can be found in Shrime et al 2019(122). Here the authors use an ABM to explore the possible effects of a policy decision to regionalize delivery care in Malawi. The outcomes of the study (possible effects) include: neonatal morality, distance patients travel to delivery service, redistribution of delivery services, and the impact on individual utility. The model simulates the decision for delivery service care choice in the current context and in four scenarios representing different regionalization policies. Elements influencing care choice include: facility type, how facility is managed (private, public, nongovernmental organization), global positioning system location, obstetrics readiness score of facility, fee for delivery, parity, maternal age, marital status, urban living, predicted risky delivery, and number of antenatal visits. Scenarios include: where deliveries are restricted to facilities that can provide caesarean sections (scenario 1), upgrading facilities to provide caesarean sections and then restricting care to all facilities that can provide caesarean (scenario 2 which also included all facilities already capable of providing caesarean sections), restricting care to facilities that in the last three months has performed five or more neonatal care or basic emergency obstetric procedures (scenario 3; chosen as assumed

more procedures results in improvement of clinical outcomes), and upgrading facilities to provide neonatal or basic emergency obstetric care and then restricting care to all facilities that can provide neonatal or basic emergency obstetric care (scenario 4 which also included all facilities already capable of providing neonatal or basic emergency obstetric care). The model results estimate that regionalization can reduce neonatal mortality in scenarios 1 and 2 but not in scenarios 3 and 4. Reduction of neonatal mortality through regionalization also results in a lowering of individual maternal utility, as this is dependent on distance to facility which increased with regionalization.

Logistic regression (linear association) informs the elements influence delivery location choice. The authors also note that the care choice is assigned probabilistically and refer to the appendix for more information on this. However, upon reviewing the appendix, there is no clear explanation for this assignment (the appendix includes the java code for the model and it is likely included here but not easy to find or understand what the authors did). This calls into question how we understand behaviour and how factors relate. Care seeking behaviour is not linear and creating a linear systems model will not capture closely the complexity of behaviour. Though an ABM could capture this complexity, it would require more data and the inclusion of nonlinearity in the system.

The model is validated, in that it well reflects the evidence used to create it; again as with Ahmad et al 2019 above, the model is validated against real-world data and simulates this well. As behaviour is constantly changing and the environment is constantly changing it is worthwhile to question if a model that provides a good representation of past real-world data adequately describes the current complexity of behaviour, especially if variation is not included to allow for estimation/visualization of adaptation.

The model publication does not focus on why or how care choices are made, but on the implication of choices on other outcomes (neonatal mortality, individual maternal utility, distance to facility, and redistribution of delivery services). The model needs the outcomes of these choices to inform the model, however these outcomes are estimated in limited ways considering what we know of behaviour (e.g. that larger numbers of elements influence care, and nonlinear interactions occur between elements within the behavioural system).

Complex adaptive systems

An example of using complex adaptive systems can be found in Morris 2019(123). Morris takes an interesting foray into using a complex adaptive systems approach to create a

framework that provides some foundational evidence for the construction of a future ABM representing the system of elements that influence diet and physical activity during pregnancy. Morris's framework is informed by: questionnaire data (identifying key elements associated with physical activity and diet, the data is from women not specifically those who have been or are pregnant), a systematic review (identifying behavioural change interventions and effect on elements, and any additional elements influencing physical activity and diet), and interviews with recently pregnant women and a focus group with pregnant women (identifying women's experience with behavioural change interventions during pregnancy). The framework presents a diagram of connected elements but does not go beyond this to explain how elements interact, with the exception of presenting linear regression models to identify associations between elements in questionnaire data. Morris does recognize that nonlinear interactions are present in the system but does not go on to explain these. Nonetheless this work provides a good foundational contribution towards understanding the complexity of elements that influence diet and physical activity during pregnancy.

The complex adaptive systems approach is similar to the complex systems theory approach proposed in this thesis (chapter 1), and was in part inspired by the work of Ilya Prigogine(124) who is credited with shaping complex systems theory in physics(48). The main difference between the two is how they explain and allow for change. Complex adaptive systems represents one stage in the cycle of complexity (self-organization) and allows for system change only with individual adaptations. In contrast, complex systems theory allows for five stages in the cycle of complexity (self-organization, self-regulation, lock-in, collapse, and chaos) and allows for individual and system adaptations to inform systems change(124). This is an important distinction, as taking a complex adaptive systems approach limits the understanding of a system in ways that may result in an incorrect representation of the system. By allowing for a system to be in any stage of complexity, one can build a representation without the prior assumption of what stage of complexity the system is in, thereby potentially creating a more 'correct' representation.

Limitations

There are a number of limitations to this review. First, article selection and categorisation of extracted data was done by one reviewer: these are both subjective tasks and the results will reflect this. This limitation was minimized with clear inclusion criteria and extraction questions. Second, it is possible that some articles were not captured in the search due to searching two databases, language limitations, and using title and abstract search in PubMed. Additionally, eight articles could not be accessed that passed first

level screening due to cost of the articles. The results should be considered with these limitations in mind.

Conclusion

In conclusion, there were no articles identified that described models that are similar to the complex systems process model to be proposed in this thesis. Regression models are very useful at identifying associations and addressing may question types, however they cannot support a complex systems inquiry of describing how interactions between many elements occur and their collective effect. While the conceptual models included in the review mostly identify the presence and importance of interactions, none describe in detail what these interactions may be and their characteristics and effects. If we consider this literature review reflective of publications on the subject, it can be concluded that a new process model informed by complexity theory can help to further understanding about treatment seeking behaviour for PPH, particularly through describing interactions and their impact on uptake of care.

The next chapter presents the aims and objective of the thesis, and Nigeria is introduced as the country example to be used in the model.

Chapter 3: Aim, objective and Nigeria as example country

Chapter 3 summary

This chapter presents the aim and objective of thesis and presents Nigeria as the example country used in the model. Justification for this choice is presented and following the aim and objective, a review of the Nigerian context is presented. This includes an historical and contemporary review that helps to explain the current challenges to maternal health and uptake.

Chapter 3 introduction

The previous chapters highlight the global burden of PPH and the importance of uptake to the success of current health technology focused international health development strategies. Also presented is the minimization of the importance of uptake and the potential to support health development strategies though an improved understanding of uptake. Theories and models of health behaviour were then reviewed demonstrating a divide between research and theories that explain 'what' influences uptake and those that can explain 'how' uptake is influenced, demonstrating the possible contribution the emerging area of systems approaches can make towards investigating public health challenges. With the interest of investigating a behaviour, such as uptake for PPH, it is suggested that complexity theory is used to explore the variation and changing nature of behaviour instead of the deterministic and more commonly used systems theory. Despite not giving certainty in results, complexity models can provide more 'correct' results, if one can embrace an interconnected, ever changing, and predictable worldview. There is potential with a new model informed by complexity to improve the understanding of treatment seeking behaviour for PPH, as no previous modelling studies have been published in this area.

It is helpful to use an example country when creating a new model that explains in detail treatment seeking behaviour for PPH by women who give birth at home. An example country can improve the clarity and correctness of a model: helping to decide what elements to include in the model and determining possible interactions and movement through the model pathways. Nigeria is an optimal country to select as the example country, as there are numerous interacting elements present that influence the uptake of biomedical care there. Numerous elements are desirable when creating a new model, as this will result in an interesting and valuable exploration of the complexity of uptake, estimating collections of interactions from large groupings of elements. Having a large number of elements included in the model will capture important contextual information, that can perhaps help to see rules or patterns in element groupings. In Nigeria numerous

elements reflect a historic and contemporary diversity that spans across a large landmass and population. This diversity allows for more variation to be represented and explored in the model. A lot of variation is important to capture in a model of behaviour and in a complex systems model, as the more variation captured the greater one's ability to see patterns across variation thereby potentially strengthening the understanding of behaviour. A model with a large amount of variation will also be more applicable and useful to decision makers from Nigeria and from other countries. With a large amount of variation, users of the model can identify similarities and differences in their populations and upon viewing the breadth of variation, this can inspire ideas into how one understands and investigates behaviour. As this is a novel approach to modelling complexity, it is wise to choose a country where complexity (including variation) can be demonstrated, in order to provide a foundation to future work. Additionally, due to the high maternal mortality in Nigeria, this research has the potential to contribute to health policy that could reduce a significant number of maternal deaths.

Given the above, the aim and objective of this thesis are as follows:

AIM

To demonstrate the value of using complexity theory, to describe the process of the behaviour of uptake, for the treatment of PPH, by women who give birth at home in Nigeria.

OBJECTIVE

Build a *de novo* process stage model of possible pathways to treatment a woman takes, from the onset of PPH during a home birth, until her recovery or death. The model will be informed by complexity theory as it considers: a comprehensive inclusion of "all" influencing elements, interactions between elements within and across stages, allowance for uncertainty of interactions, and variation of interactions and element effect.

Context of treatment seeking behaviour in Nigeria

Understanding some of the context of life in Nigeria is pivotal to creating a correct representation of behaviour through a complex systems perspective, as behaviour is informed by context. Below in this chapter information about Nigeria is presented to facilitate understanding of the context of treatment seeking behaviour in Nigeria, thereby

supporting model creation (pathways, movement, and interactions), decisions about model applicability, and reader understanding and assessment of the model.

Historical Nigeria

Nigeria is a country in West Africa on the Gulf of Guinea, and shares a boarder with four countries: Benin, Cameroon, Chad, and Niger(125). The landscape of the country is diverse consisting of plains, mountains, valleys and plateaus, rivers, lakes, deltas and the coastal areas(125). Historically Nigeria has been inhabited by humans since human migration began from present day Ethiopia, with evidence of northern Nigeria (Borno State) being inhabited around 1000 CalBC by late Neolithic populations(126). Before colonization by the British Empire in the 1800's, the economy was communal, not wage-based, and social organization was arranged on family relationships (kinship and lineage/blood and ancestry relations), with various political organizations throughout the country: absolute monarchy in the North, constitutional monarchy in the West, and in the East, a village and representative democracy(127). Also, before colonization Nigeria was abundant in agricultural production, typically providing enough food for its inhabitants and a surplus for trade(125).

Significantly shaping the world and monumentally and negatively impacting many Africans was the Transatlantic Slave Trade that began in the late 15th century by the Portuguese(128), and later included the British, Dutch and French(129). The Transatlantic Slave Trade legally continued in the British Empire until 1807, when the Slave Trade Act was abolished, though slavery continued in Britain until 1834 with the Apprenticeship System (moving slaves into unpaid work)(130). Globally, other countries continued trading slaves in the Transatlantic Slave Trade until 1875(129). It has been estimated that 3.5 million people were taken from Nigeria, and forcibly moved to the American and Caribbean colonies between the late 15th century and the latter part of the 17th century(128).

After the legal end of the Transatlantic Slave Trade, Nigeria was soon colonized by the British Empire. Britain established their rule in the South West part of Nigeria in the 1890's with treaties and by force(129). In 1900 the British military invaded the North of Nigeria and by 1906 had conquered the area(129). The two British protectorates (the Nigerian North and the Nigerian South West) were joined in 1914, to form the Colony and Protectorate of Nigeria(129). The boundaries of colonial Nigeria were not the same as the boundaries (zones) created by the people before colonization. The boundaries of modern-day Nigeria were created by the British Empire during colonization(131).

While under British rule the country was predominantly an agricultural producing nation with the economy based on cash crops(125). 'Western' education and Christianity was taught throughout the country but spread more easily in the South than the North due to resistance by Muslim leaders in the North: this resulted in slower development in the North which contributes to disparity between the North and the South(125). Nigeria declared independence from Britain in 1960, and since then the country has experienced much instability and unrest, including many military coups (1966, 1975, 1983, 1985, 1993)(129), which resulted in 29 turbulent years under military governance before democracy was restored in 1999(132).

All of these historical events outlined above, (the slave trade, colonialism, political instability and tensions between tribes and religions), inform contemporary life in Nigeria, and contribute to complex and entrenched power imbalances that exist in the country today.

Contemporary Nigeria

In 2015 the population of Nigeria was estimated at almost 196 million (195,874,740), ranking it the seventh largest population in the world(133). The population is estimated to grow to just over 401 million in 2050(134). There are 36 states in Nigeria(135) with over 250 ethnic groups: the largest groups are "Hausa 30%, Yoruba 15.5%, Igbo (Ibo) 15.2%, Fulani 6%"(136). The main religions in Nigeria include Christian (45.9%), Muslim (53.5%), and other (6%)(136). English is the official language of the country, and people also speak over 520 Nigerian languages (including Hausa, Yoruba, Igbo, and Fulani)(137). In 2018 it was estimated that 49.7% of the population live in rural areas(138).

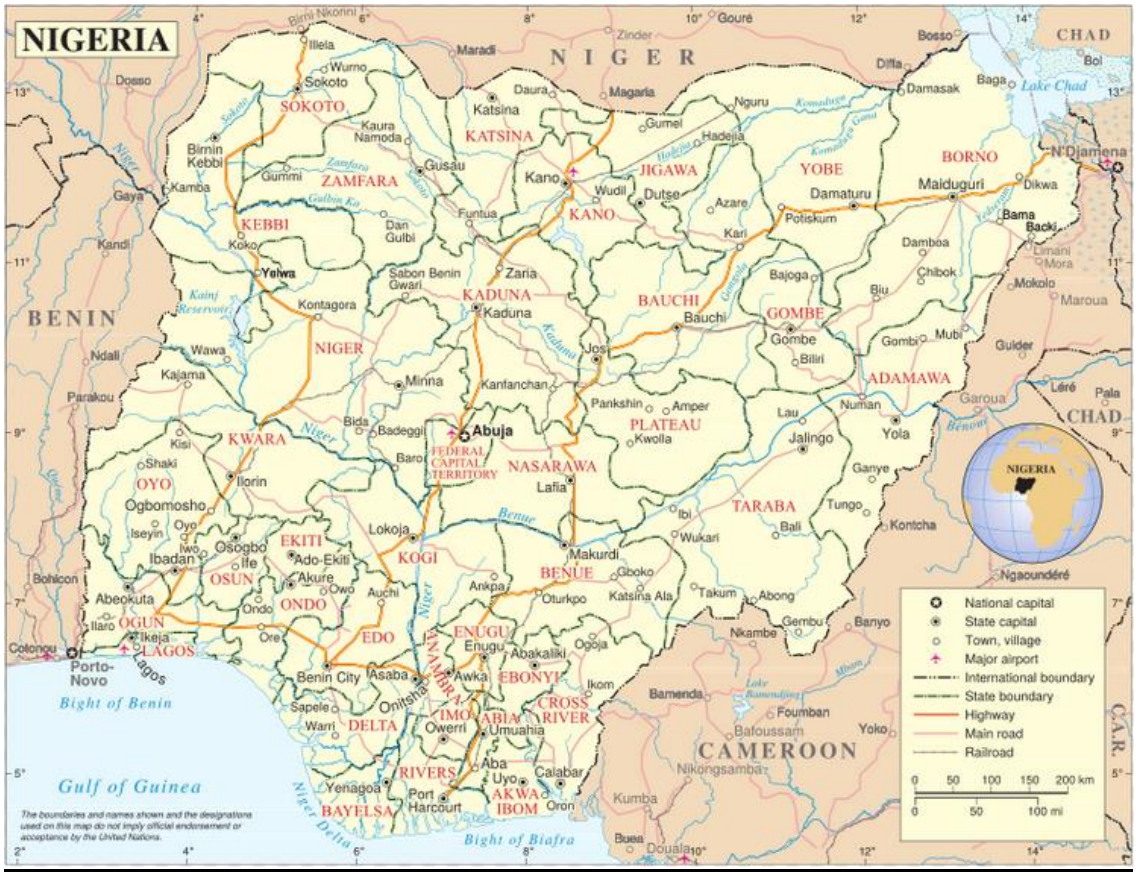

Figure 5: Map of Nigeria.

Source: United Nations Cartographic Section. Political Map of Nigeria 2014. (139)

Economically Nigeria is a very wealthy country and at the same time a very poor country. With an abundance of natural resources, a large land mass, and a large population the country has the potential to transform into a developed nation with a higher income categorization. Currently, Nigeria is the 9th largest oil exporter in the world(140) and the government owns the country's oil and gas reserves(141). This generates a large amount of wealth along with the sale of other natural resources(142, 143). Corruption impedes this wealth from benefiting the Nigerian people. Corruption in Nigeria is a long-standing and substantial issue that effects multiple sectors including government, economic, security, education, and health and development(144). Currently, the country is categorized as a low-middle income country(145), where 53.47% of the population lives on less than US$1.90 a day (2009 estimate)(146). Low-middle income countries are defined by the World Bank as having a Gross National Income (GNI) per capita of US$1,026-$4,035(145).

Today life in Nigeria is difficult, with immense corruption, poverty, and social unrest. In 2019, public sector corruption in Nigeria was reported by the World Bank to be 3 (scale of 1-6, 1=low corruption, 6=high corruption)(147), and by the Corruption Perceptions

Index to be 26/100 (scale of 0-100, 0=highly corrupt and 100=very clean)(148). A 2011 estimate by the World Bank estimates that 53.5% of Nigerians live in poverty ($1.90 a day)(146). The country also experiences much violent social unrest(149, 150), due to several reasons including disparity and hardship (including food crises(151) and terrorism(152)) within the country, that results in conflicts between groups who have less and those who have more, or are perceived to control the imbalance and lack of development. Unrest in Nigeria is also in response to corruption (e.g. in the electoral and voting processes(153, 154)) and perceived unjust State actions towards Nigerians (e.g. imprisonment of religious leaders and banning religious organizations that are viewed as threatening to the State(155)). These are just some examples of why unrest occurs in the country.

It is important to mention that slavery still occurs and impacts Nigeria. Today Nigerians are being kidnapped and sold for labour, including sex work in Nigeria and to other countries (for example in Belgium, the United Kingdom, Italy, and Libya)(156-158). Modern day slavery is in part due to the very poor quality of life for many people in Nigeria, who are vulnerable to kidnapping in their travels, and are prey to those claiming to help them find work or refuge in other parts of Nigeria or abroad(156).

Health care in Nigeria

Western medicine was ‘introduced’ to the country during colonization, and after independence in 1960(159) the federal government continued to develop a biomedical health care system with National Development Plans, National Strategic Health Development Plans, and National Health Policy plans, which are produced by the government regularly to direct the development of the health care system(160, 161). The federal government also has invested in and supported Traditional Medicine as an important part of health care in Nigeria(162). The Nigerian government makes efforts to build the biomedical health care systems, and prioritizes maternal health. Most recently in 2016 with a newly elected government, the reaffirming to develop health care was identified as a priority, including maternal and child health care(161).

The national health care system in Nigeria is decentralized into three government levels: local, state, and federal(163). The Federal Ministry of Health estimated in 2005 that there were 23,640 health care facilities in the country (164). Primary health care facilities account for 85.5% of these facilities, while secondary facilities account for 14% and tertiary facilities 0.2% (164).The private sector owns 38% of all facilities, and provides the majority of health care in the country (60%) (164). There are human resource

challenges in Nigeria, where densities of doctors, nurses, and midwives are too low to effectively delivery health care (1.95 per 1,000) (165). Regarding facility capability to provide care, it is estimated that 20% of facilities are able to provide basic emergency obstetric care (164).Primary health care (PHC), which includes maternal health, is delivered through the local government and the Ward Health System (local governments are comprised of electoral wards)(166). These PHC centres are meant to exist and care for the Ward population, but unfortunately in many locations, particularly in locations lacking other infrastructure and development, these PHC centres are vacant, lacking supplies, and/or do not have qualified biomedicine health care professionals(166, 167). Even where maternal health care is available it can be disrespectful and abusive towards women. A recent systematic review demonstrated that abuse and disrespect towards women during childbirth occurs throughout Nigeria(168). However, most studies were judged to be of low or medium quality, and therefore results should be interpreted with consideration of this.

The 2018 Nigerian Demographic and Health Survey, a government survey, reports that 59% of total live births in Nigeria over the preceding five years occur at home (39.4% deliver in a health care facility [public sector 26.4%, private sector 13%])(169). In the same five-year period, in women who reside in urban areas, 36.3% have home births and 61.1% gave birth in a health facility(169). In women who reside in rural areas, 73.2% have home births and 25.8% gave birth in a health facility(169). Place of delivery trends estimate an increase in facility births(169) (Figure 6). It is reported that women in the lower wealth quintile are less likely to give birth in a health facility than women in higher wealth quintiles(169) (Table 10). It should be noted that issues with data reporting may be present in Nigeria, as explained in the Trends in maternal mortality publication in 2015, reporting on the progress of the Millennium Development Goals. The publication reported that evidence from Nigeria was of poor quality and it was therefore difficult to determine if progress was made toward reducing maternal mortality in Nigeria(8).

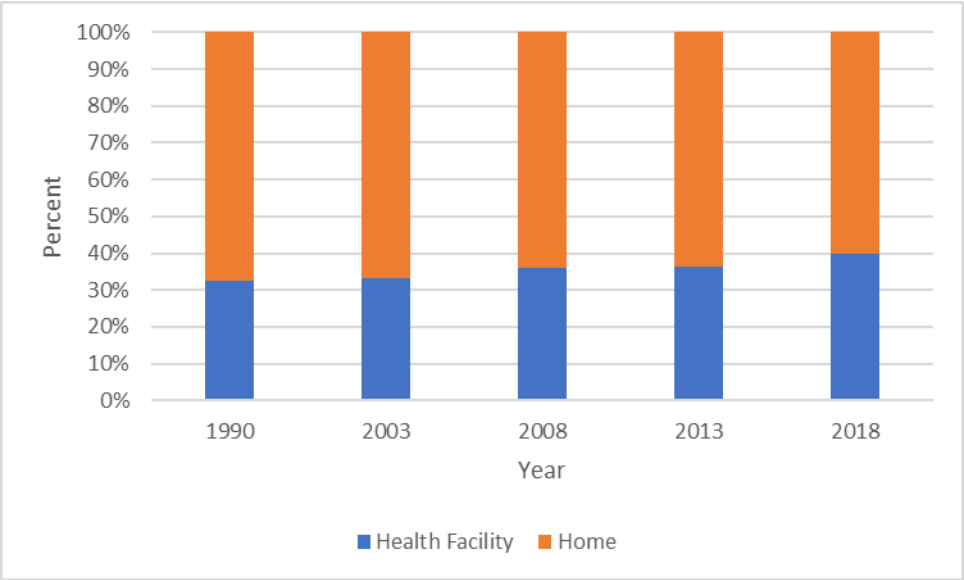

Figure 6: Trends in delivery location 1999-2018.

Source: National Population Commission (NPC) [Nigeria] and ICF. Nigeria Demographic and Health Survey 2018. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF; 2019.(169)

Table 10: Percent and number of health facility births by wealth quintile

Source: National Population Commission (NPC) [Nigeria] and ICF. Nigeria Demographic and Health Survey 2018. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF; 2019.(169)

Wealth Quintile	Percent Births	Number Births
Lowest	11.6%	7,572
Second	21.1%	7,782
Middle	40.3%	7,043
Fourth	59.2%	6,254
Highest	79.5%	5,541

The Nigerian health care system is considered to be underdeveloped(170), and as concluded in a recent World Bank event, the issue is due to how resources are used and distributed, not due to a lack of resources(167). As mentioned in the previous chapter, the United Nations children's fund (UNICEF) estimated in 2015 that Nigeria had the highest number of maternal deaths in the world (58 000, 19% of worldwide maternal deaths)(2). These deaths reflect the large size of the population, and an underdeveloped, unavailable, and inaccessible health care system that is compounded with the complexity of uptake.

Conclusion of Chapter 3

History informs contemporary life in Nigeria, including economic and development levels, and ideas about biomedicine and those who propagate it. These levels and ideas are continually changing today with contemporary events and actions. In Nigeria, there are multiple elements that can influence if a woman uses biomedical health care to treat PPH, and processes of the uptake of care will reflect context. This section has provided an overview of the context of care seeking in Nigeria and highlighted some of the elements that influence care seeking, including contextual elements and those produced by the context. This foundational understanding of Nigeria as an example country situates the model development and helps to guide model assessment. The next chapter will present the methods used to build the process model.

Chapter 4: Methods

Chapter 4 introduction

In this chapter the methodology used to complete the research objective is described and justified. First presented will be an overview of why a model is appropriate to address the research aim, and presented second will be the steps used to complete the research objective: how the model was developed. To review, the research aim is to explain with complexity theory, the process of treatment seeking behaviour for PPH by women who give birth at home in Nigeria, and the research objective is to build a *de novo* process stage model of possible pathways to treatment a woman takes, from the onset of PPH during a home birth, until her recovery or death. From now on the *de novo* process stage model will be referred to as the Uptake Model throughout this thesis (with the exception of the Papers 1 and 2 in the results chapters 5 and 6).

Why a model is appropriate to address the aim

A model is a good starting point when applying a different theoretical perspective (complex systems theory) to an area of research (describing the uptake of treatment for PPH) that has typically been informed by other theoretical perspectives (mechanistic theories). This is because a model allows for the construction of a representation of a phenomenon or object, into a structure (mathematical, visual image, physical object) that organizes information in way that provides clear understanding of a subject/question that is difficult to understand due to novelty(171). When a model of real-life is constructed, it is typically an abstraction, a simplified version of reality to allow for investigation and to provide clarity of understanding(172). This clear understanding can be very helpful in exploring and communicating a different theoretical perspective on a research area.

Another benefit of building a model to explore a phenomenon with a different theoretical perspective, is that a model can be altered to explore change. Using the example of a treatment seeking behavioural system, altering this type of system to explore change may not be ethical or even possible, and if both ethical and possible, it would incur a large cost compared to the creation of a model. Building a model first, can provide useful results to inform a system understanding and generate informed hypotheses that could be further investigated with modelling, interventional or observational studies.

A model is therefore a safe and effective first step to improving our understanding of uptake, by creating a structure, a platform, for the exploration of how complexity theory could be used to describe uptake, providing clear communication about how uptake

occurs as a complex system, and allowing for easy experimentation with change to the system.

Benefits of models: supporting knowledge translation

Models can be very useful in communicating concepts and information to decision makers, especially complex systems which are not as easily understood through text descriptions alone particularly due to the large amount of information and collective interactions. Decision makers are familiar with many types of models and already use them in decision making(173). Models are used by health policy decision makers to describe and project the impact of policies and disease (e.g. financial consequences, disease transmission and frequency, health service use). Decision makers use multiple types of evidence to inform policy(173), and as there is a perception that numbers are free from bias (which they are not)(174), they can be more trusted and influential. Even though a decision maker may not fully understand how a model works (from not having the technical expertise to understand how the model works or the consequences of the assumptions and limitations), they can have confidence in it due to the numerical aspects of it, and due to the requirement of funders for modelling analytics.

Steps to Building a Model

A ten-step process was followed to build the PPH Uptake Model. The ten-step process was partially informed by Squires et al. 2016(175), who propose a nine-step process for developing a conceptual model structure for health economic models. Please see a comparison of these in Table 11 below. As complexity modelling is new to the field of public health for describing behaviour, and no models informed by complexity thinking have been published that describe treatment seeking behaviour for maternal complications (see Chapter 2 and step 1 below), it was decided that developing a new (*de novo*) model was justified to fulfil the research aim.

Table 11: Steps to building a model

9 steps of building a model structure (from Squires et al 2016(175))		10 steps of model building in this thesis
1) Review existing models (in the area of interest)		1) Review literature for similar models
2) Choose model interventions and comparators		2) Choose model type (to address aim) and determine model characteristics (boundary, population, perspective)
3) Determine the model boundary		3) Collect data to determine model structure and inputs
4) Model population and subgroups		4) Interim external validation of inputs
5) Model perspective and outcomes		5) Building model structure
6) Determining the level of detail		6) Inputting elements
7) Choose model type		7) Compiling interactions of elements
8) Search for evidence to inform structure		8) Pathway creation, movement through model over time
9) Develop a qualitative description of the quantitative model		9) Verification and validation (throughout process, in stages 5-8)
		10) Model revision (throughout process)

Step 1: Review literature for similar models

It is important to first review the literature for similar models before beginning the complicated task of creating a new model. As presented in the Chapter 2, a literature review was conducted on PubMed and Web of Science (2 October 2017) that resulted in no systems or complex systems models describing care seeking for maternal health complications. The results of the review identified 46 statistical models, and 5 conceptual models. The collected statistical models made linear analyses of variables and outcomes (elements that influence uptake), and none of the conceptual models presented details of interactions (four articles mentioned that interactions existed, and one did not).

I also conducted a more sensitive literature review (broader search terms) to identify any complex systems models about maternal health that were indexed on the PubMed database (13 December 2019): results showed articles using complexity theory to

describe biological processes related to maternal health, but no articles examined complex systems theory, patient behaviour, and maternal health. Search terms in title/abstract included: (maternal/obstetric/obstetrics) AND (complex system/complex systems/complexity theory). The search was limited to studies about humans. Though this search was limited to one database and to English language publications it is very possible that there are no similar examinations to the model proposed in this thesis: describing treatment seeking behaviour for PPH and informed by complexity theory.

Step 2: Choose model type (to address aim) and determine model characteristics (boundary, population, perspective)

Typically models of complex systems describing health topics are computational models of biological processes, some of which use agent-based models (ABM) to describe these processes. It was decided at this stage not to create an ABM due to the novelty of using complexity theory in maternal health and treatment seeking behaviour. There is first need for the foundational work to be generated on the topic, to create detailed conceptual models. Conceptual models can support future work in complex systems and maternal health and treatment seeking behaviour, including whether a computational model is appropriate to advancing our thinking on behaviour.

The model type was fully defined after the data collection and during the creation of the model structure, which involved several attempts and versions to create a model that captured and reflected clearly the important aspects of complexity theory in the process of treatment seeking. This means that part of the results of this research, is the refinement of the model type (see model extensions below), and that the methodological description of the model type determined *a priori* to creating the model structure was in some ways unspecified. The model type determined *a priori* was as follows: a process model that gives details of how uptake occurs, specifically presenting some characteristics of a complex systems theory perspective. Each of these are described in more detail below.

A process model

Process modelling is often used in business(176), engineering, and computer sciences(177) to describe the pathways a subject (e.g. item, task, person, input stimulus) can take through a system towards an outcome/goal. Process models describe movement through a system in order to support the process (the desired movement

through the system)(178). These model types enable understanding of entire processes and identification of weaknesses in the process.

Process models are less often used in public health and epidemiology, though some health models follow a process to collect consequences (e.g. cost effectiveness models follow a pathway of care). In maternal health, the Three Delays Model is a very simplified process model, assigning influential elements into three stages of delays that one may encounter on a pathway to care (36). It is very simplified in that it does not give detail to describe the pathways a woman can take towards treatment in sufficient detail to understand the system. The Three Delays Model does not take a systems approach: there are no details to how a woman moves through the process, no emphasis on the importance of comprehensiveness of included elements, and no detailing of interactions. In the Three Delays Model the pathway to care is not the focus, the focus is the placement of the elements into the categories/stages. Although the Three Delays Model has its shortcomings, it does make informative steps towards shifting understanding of uptake from a single cause towards multiple causes, and showing that these multiple causes exist within a process.

Process models and placing elements into stages can make an important contribution to understanding how elements contribute to a system. If elements are simply placed all together in one space it can be confusing to those viewing the model and even to those who created it, especially when many elements are included. Separating behaviour into a process gives clarity as to how (and when) elements are influencing uptake. Process modelling also allows for important separation of elements into key decision and event points where elements may display different effects and interactions in different stages.

Details of how uptake occurs

The process model proposed in this thesis will go beyond a broad or implicit conceptual model, to an explicit model that will give details of how movement through the process occurs, including what interactions exists and how they effect movement and uptake. The model will display the process through a mapping of the system (i.e. schematic depictions and flow diagrams). Mathematics will be used to explain the interactions (Boolean algebra). Though complexity theory does not allow for a ‘solvable’ equation (48), mathematics can still be used to describe possible movement (e.g. with logic equations that do not adhere to absolute truths) and can help to clarify and communicate interactions and legitimize the work (due to decision maker confidence in mathematics as described above).

A complex systems theory perspective

The model type (a process model described with maps and mathematics) will also include four key and closely related characteristics of complex systems theory. The first characteristic is a holistic view of the system. This means that it will be attempted to include all stages from PPH onset to recovery/death in the model and also include 'all' elements that can influence the movement through this process (e.g. including cultural [beliefs, knowledge], biological [disease progression], physical [objects, environment], social [exchange, actions] *etcetera*). The second is that the outcome of uptake is multi-causal. There is likely no single cause to why uptake occurs and the model allows for exploration into how multiple elements can influence the outcome of uptake. The third is interactions between multiple elements. The model allows for sub-components (stages) to detail the interactions occurring between multiple elements at each stage in the process. The fourth is variation and uncertainty of element presence, interactions, and effects. Variation and uncertainty will be captured through multiple pathways that can move through the process, reflecting the possible presence of elements and effect of different combinations of element presence and therefore interactions. Different interactive combinations are likely to produce different effects.

Step 3: Collect data to determine model structure and inputs

General overview of determining structure and inputs

The model structure was determined in part by the data (elements, interactions, and their effects upon uptake) that were collected to be included in the model (systematic review, and key informants). Structure was also determined by the descriptions written and spoken about in the data. Inputs for the model were collected through a systematic literature review and interviews with key informants.

A systematic literature review was conducted to collect evidence identifying which elements influence the uptake of biomedical treatment and other treatment (often called traditional treatment). The effect of elements on uptake was also collected, as well as interactions between elements and their collective effect upon uptake. To validate the systematic review results, and to collect additional data, a focus group was planned with Nigerian women of childbearing age (18-45). Due to low turn-out, the focus group became interviews with key informants. A list of unique elements was determined from thematic groupings of the systematic review and key informant results.

Ethical approval for this research was granted by the London School of Hygiene and Tropical Medicine (LSHTM), Observational/Interventions Research Ethics Committee, on 11 July 2018: LSHTM Ethics Reference 14532. Please see Appendix C for the ethics approval letter. As presented below, the validation with key informants was conducted in London UK and therefore further local ethics approval was not required.

It was deemed important to include time in the model as a woman progressed through the decisions and events in the process of uptake. This was included as a single element in the Uptake Model, and as continuous time points in an extension of the model (decision tree model). The estimation of time was informed by the literature. Details of the methods and discussions about justification, benefits, and limits of the methods for the systematic review, focus group/key informants, and time-to-death estimate for PPH can be found below.

Systematic review

Systematic review methods

A systematic review protocol was written *a priori* on September 22 2017. The review had three aims: to identify elements that can influence the uptake of biomedical PPH interventions by patients in a clinical facility setting; to identify interactions between the elements identified in the first aim (i.e. how an element behaves in the presence or absence of another element, the relationship between elements, sequentially, conditionality); and to identify the effect of the elements and element interactions upon uptake. The review was modelled after a Cochrane Systematic Review, with the main difference being that I did not register the protocol of this review. The bibliographic databases MEDLINE (PubMed) and Web of Science were searched for studies that aimed to identify, discuss, or examine elements that influence the uptake of biomedical PPH interventions by patients in clinic or hospital settings. The search was very sensitive and searched two search term sets (uptake and postpartum haemorrhage), within each term set variations of the terms were searched. Search results were screened for inclusion by two independent reviewers in two stages (title/abstract, then full text). I was always one of the reviewers at each stage of the systematic review.

Inclusion and exclusion criteria were as follows:

Inclusion criteria

- English language
- Participants: women of reproductive age who have given birth or may in the future give birth, those who have power in the decision of whether a woman uptakes healthcare services (e.g. husband, mother, mother-in-law, other relative, traditional birth attendant etc), persons commenting on elements that influence the uptake of healthcare services by women (e.g. health care workers, community members, politicians etc.).
- Types of Studies: qualitative, quantitative, mixed method, literature review
- Study aims explicitly to identify, discuss, or examine an element(s) that influences the uptake of biomedical PPH interventions by patients. This may include studies on the delay in seeking/accessing care, if elements are identified, discussed or examined that influence a delay in uptake. Women may seek care for safe birth (PPH prevention) or to stop bleeding (PPH treatment), and may not be able to identify the clinical name PPH or the interventions. Where studies aim to identify the causes of PPH mortality, near-miss, or morbidity, words such as remote causes, environmental factors, cultural contexts, avoidable factors, socio-cultural factors, and associated factors indicate elements may be identified that influence uptake of services.
- Clinical facility setting: a facility where biomedical interventions for prevention and treatment of PPH are administered by health care professionals. For example, a clinic or hospital, but not a community-based program where care is administered in the community.
- Outcome of interest: study reports or concludes in findings/results section an element(s) influencing uptake of PPH interventions (prevention or treatment) concluded from the analysis of the study (original research). Not influencing if from regression, X^2, or percent change.

Exclusion Criteria

- Is not English language
- Study only identifies elements in reference to other published studies, opinion, unknown source, and not from author's original research. References in articles to elements from other studies will be reviewed for inclusion.
- Commentaries, editorials, case studies
- Literature reviews that do not contribute new data/information or new analysis
- Literature reviews that are superseded by an updated literature review

An extraction form was built in Excel to collect and analyse results from the review. Extraction was conducted by myself and checked by another reviewer. The goal of the systematic literature review was to identify from the published literature, elements, element interactions, and their effect upon the uptake of biomedical PPH interventions by patients in clinical facility settings. After data extraction was complete, the included studies were tabulated and outcomes were summarized. Subsequently, a unique list was developed through thematic sorting of the elements and element interactions. Quality assessment of individual studies (by outcome) and across studies (by outcome) was conducted. There were three steps to the analysis of the results: please see below.

Step 1: Creation of a unique list of elements and element interactions by thematically sorting all the extracted elements and interactions. Sorting will be conducted by myself and one other reviewer and finalized by myself.

Step 2: The outcomes extracted from each study were assessed in quality assessment of individual studies. As all data was qualitative being extracted, studies were assessed for qualitative methods, but when extracted from a quantitative study, a quantitative tool was used. Critical Appraisal Skills Program, Qualitative Checklist (179) was used for qualitative studies and Newcastle Ottawa Scale was used for quantitative studies (180).

Step 3: The quality of outcomes extracted was also assessed across studies using the Grading the Recommendations Assessment, Development, and Evaluation, and Confidence in the Evidence from Reviews of Qualitative research method (GRADE CERQual).

For full details of the systematic review methods please see the protocol in Appendix D.

Justification for a systematic review and generalizability of behaviour

Systematic review as primary data collection

A systematic review was chosen as the primary data collection method as opposed to a single qualitative study in Nigeria collecting data on elements that influence uptake, their interactions and their effects. A single study, even a very well designed, conducted, analysed, and communicated one, has limits that multiple studies can minimize (breadth of understanding a topic, variation that can occur due to unidentified and identified but perhaps unavoidable reasons [relationship between researcher and

participants/community, time of year]). A systematic review can provide data across multiple geographic locations and cultures, and can therefore allow for similarities to be captured across studies. As much research has already been done on identifying elements that influence treatment seeking behaviour for PPH, it was decided to consider these studies, and collect, assess, and use them, as part of the evidence base for this model.

Generalizability of Behaviour

Behaviour is contextual, developed in response to historical and contemporary occurrences and situations, to navigate life in order to achieve personal and collective/group goals (typically survival)(45). The common goal of humanity (survival) of course does not results in a collective effort for the survival of our species, as we have separated ourselves into smaller groups, categorized in various and non-mutually-exclusive ways (e.g. nationality, religion, age, kinship, skin colour, wealth, power, sex, gender…), in order to compete for 'scarce' resources (scarcity and resources can be culturally constructed). Due to different historical and contemporary occurrences and situations, and membership in different groups, behaviour varies, even within groups with very small numbers (e.g. within a family). I propose that there are general behaviours and aspects of behaviour that occur in similar environments (low middle-income countries, with underdeveloped health care, and trust concerns with those who provide and create biomedical health care). It is not that there is no deviation or variation, there always will be, but in general, given certain elements, behaviour is likely to occur in certain ways, if we consider interactions of other influential elements, as these are likely collectively shaping behaviour. These collections I believe are likely to be the same.

Because I am attempting to consider 'all' that influences a behaviour, I may be able to capture/propose what the likely outcome will be of the collective relationship of elements. And the variation that can occur, which is due to context. So actually, the model is collecting contextual differences of behaviour, and proposing 'rules' for these. This attempt allows for collection of elements from different countries to be applied to the example country (Nigeria). This is because I am assuming that in general, elements influencing behaviour may operate in the same way, and when they do not, interacting elements resulting in different outcomes are identified. Even when elements, interactions and effects are not generalizable to another setting, their inclusion in the model can still be valuable, as it inspires conversations about application and behaviour in the model user's population and context of interest. This leads to future validation of the element interactions across multiple contexts.

Focus Group

The interviews with key informants was designed as a focus group, and recruitment was estimated to produced more than the two women who attended. Therefore, the methods for the key informant interviews are presented here as it was original planned as a focus group. The aim of the focus group is to validate the model through engagement with Nigerian women. Validation with Nigerian women is to ensure that the model represents uptake (inclusion of possible elements, interactions, and effects, and arrangement of elements) from a Nigerian perspective. A purposeful sample of women of childbearing age (18 to 45 years of age), who have recently relocated to the United Kingdom from Nigeria in the past five years, or Nigerian born women who currently live in London and have spent a significant amount of time in Nigeria in the past five years (6 months continuously), was recruited.

The focus group took place on August 21st 2018, at LSHTM Tavistock Place. It ran for 3 hours, from 6:00 pm to 9:00 pm. Consent and permission to audio record and take photos of the focus group were obtained at the beginning of the focus group. The research aims and objectives were presented, followed by a discussion about the research, then a free-listing exercise to collect data about what should be included in the model (elements, interactions, effects). Preliminary model results were not presented to the participants so as not to influence their responses. Women were asked to do free-listing from two questions: why go to a doctor for postpartum haemorrhage and why not go to a doctor for postpartum haemorrhage. Responses were listed on the walls of the focus group room on large pieces of paper to ensure to participants that their responses were captured and to generate group discussion. Refreshments were provided during the workshop (food and beverages), and transportation costs were reimbursed to participants (lowest cost mode, Transport for London based on round trip from residence). The full protocol for the focus group can be found in Appendix E. Consent form templates and participants information sheets can be also be found in Appendix E.

Time-to-death estimate for PPH

Time is important to the process of treatment seeking behaviour for PPH, as the woman over time loses more blood and this is the cause of death for PPH (exsanguination). As noted above the estimate for time is taken from the literature: a recent publication (systematic review) on estimating blood loss after birth(181). This perhaps may be a fair estimation as the model begins at a stage three haemorrhage. The third stage of

haemorrhage is when a change in vital signs occurs (182). This is where family/community members would likely be able to identify that bleeding at childbirth is an emergency bleed. The six-hour timeline was included in an extension of the Uptake Model (decision tree model in Chapter 7), it was not considered in the Uptake Model in Paper 2.

Step 4: Interim external validation of inputs

As mentioned above in step 3, a focus group/key informant interviews were conducted with Nigerian women to validate the systematic review results, and to collect any additional data (elements, interactions, effects). Model validation is an essential step in model building as it answers the question 'does the model reasonably represent the actual system' (172). This is particularly important if there are limitations in the primary data collection (e.g. if there is low or moderate confidence in the systematic review results after single study and across study quality is assessed). As the model structure is informed by the elements collected, it is important to validate the inputs at this interim stage before model structure development. The choice of validation with Nigerian women was essential, as these women are the experts on treatment seeking behaviour for PPH in Nigeria.

Step 5: Building model structure

The model type is a stage process model, and stages were determined after considering how and when elements related to different events and decisions. It was deliberate that other theories and models explaining health/treatment seeking behaviour were not used to inform the categories/concepts reflected in the stages. This was done so that the evidence could shape the model as opposed to fitting the evidence into pre-existing categories/concepts, as these may yield different groupings. Also creating a structure with the aim of capturing interactions is likely to produce a different type of model than pre-existing behavioural theories and maternal models allowed for.

From the onset it was recognized that stages in the model would reflect my own judgments about how behaviour occurs, and that there is not necessarily one 'right' way to build the structure. It was also recognized that stages are not truly separate from each, they were assigned as separate for clarity, and how stages are connected changes depending on the view one takes of the system (e.g. if the view is beyond an individual treatment seeking timeline then experiences, of a woman or those that that she knows,

will inform the stages of the model differently). One last point that informed how the model structure was to be built, is that the process could occur in multiple ways, and that a simple continual movement though the stages was the ideal but may not occur. Therefore, a woman can move to previous stages in the model whilst moving towards treatment, and can exit the model at any point due to her death.

Step 6: Inputting elements

Elements were assigned to different stages based on how their evidence source discussed them (i.e. how the article(s) elements were extracted from discussed how and when elements impacted uptake, and/or how the key informants discussed how and when elements impacted uptake). In some cases, elements were also assigned to stages based on my knowledge of behaviour. These are clearly marked in the model.

Step 7: Compiling interactions of elements

Interactions between elements were informed by the evidence collected on interactions from the systematic review and key informant interviews. The evidence informed interactions included between two and three elements. Assumptions were made to estimate possible interactions between all elements in each stage. These assumptions were based on my knowledge of behaviour and on the literature.

Step 8: Pathway creation, movement through model over time

Pathways were determined by possible combinations of elements within each stage and what possible outcomes could occur due to these different combinations, and how the element presence, interaction and effect would carry (be remembered) through the movement in the model. Possible movement, depends on possible pathway (outcomes of element combinations) splits (courses) which were determined by the evidence (writing and discussion around the input, interaction, and effect collection [i.e. systematic review articles and key informant interviews]).

Step 9: Verification and validation (this occurred throughout the process, in stages 5-8)

In addition to interim external validation of inputs with Nigerian women, validation and verification of the model occurred throughout the model building process. As mentioned

above, the verification and validation of a model are essential steps in model building. Verification answers the question ‘does the model do what it was intended to’ and validation answers the question ‘does the model reasonably represent the actual system’ (172).

The model was verified with a step-by-step verification technique. Step-by-step is a walk-through examination of how a model works, where the modeler can focus on the different parts of a model in sequence and determine any problems (172). This examination was carried out in three ways: with myself, while presented to my modelling supervisor and supervisory committee, and while writing a publication on the construction and results of the model.

Step 10: Model revision

Model revision occurred through all the steps of building the model. This included multiple versions of number and names of stages to be included, which elements to include in the model, which elements were placed in which stages, how interactions occurred within stages, and how to represent movement though the model. A broad and detailed conceptual model of the stages of the process and interactions was built and called the Uptake Model (Paper 2), and mathematical equations were created to describe the various element groupings and interactions, which informed a decision tree model that follows multiple possible pathways through the model, and incorporates time and memory of element groupings (Results chapter 7).

Thesis structure of modelling results

The results of this thesis are presented in the next three chapters: Chapter 5: Paper 1, Chapter 6: Paper 2, and Chapter 7: further results. Chapter 5: Paper 1, is the systematic review collecting elements, interactions, and effects that influence the uptake of care for PPH. Chapter 5 connects to step three in the model construction above, including the full protocol of the systematic review in Appendix D. Chapter 6: Paper 2, is the construction of the Uptake Model (the process model informed by complex systems theory to describe treatment seeking behaviour for PPH by women who give birth at home in Nigeria), and some of the results. Steps two to ten in the above model construction list apply to this Paper 2, and Chapter 7. Chapter 7: further results, includes a scenario run on the model, the mathematical equations explaining the interactions and collective effects, and an extension in the model construction: a decision tree structure

that maps out possible pathways a woman can take and consequences related to previous stages, interactions, and the passing of time.

Chapter 5: Paper 1 and Chapter 6: Paper 2, as papers to be published are presented as stand-alone pieces of work. They therefore, follow a table and figure numeric sequence specific to each paper. The references however are connected to the entire thesis. Paper 1 has been submitted for publication and is under review, and therefore the text has not been altered to UK spelling. I designed and executed the study, and lead the analysis, and wrote the article. Work of collaborating authors is noted in this paper, and all authors reviewed the manuscript and gave feedback to the writing. I am the sole author of Paper 2, and it has not yet been submitted for publication.

Chapter 5: Paper 1 & additional results

Chapter 5: Paper 1

Elements and interactions influencing patient uptake of biomedical facility care for postpartum hemorrhage: A systematic review and synthesis

Authors: Gregg M, Wharton-Smith A, Li X, Rassa N, Casalotti S, and Cohn S

Introduction

Hemorrhage is estimated to be the largest direct cause of maternal mortality worldwide (37%[1]), with postpartum hemorrhage (PPH) accounting for the majority (73%[2]) of these deaths (13). Deaths from PPH occur predominantly in developing countries, and are estimated to account for over 99%[3] of global maternal deaths (13). One of the main strategic objectives in international health policy efforts to reduce maternal mortality in high incidence countries is the development of national biomedical health care systems, including universal health coverage for the use of these systems (183). To support the effectiveness of these systems in reducing mortality, it is necessary to also develop patient uptake of these systems. Availability of health care does not automatically result in use of health care, as use encompasses many elements beyond availability (e.g. quality of care, and accessibility).

Typically, health seeking behavior for maternal complications is explained through the identification of discrete elements (i.e. factors or determinants) that are designated as facilitators or barriers to patient uptake of care at biomedical health facilities. However, following recent social science approaches that emphasize behavior is always contextual, dynamic, and exists within an interactive environment, here we take a more open approach that acknowledges element direction is often dynamic (as opposed to a fixed directionality implied by the categories 'barrier' or 'facilitator'), and that interactions occur between elements. An interaction is defined as when the directional effect of an element changes due to the presence, absence, or behavior of another element(s). This change can strengthen directional effect, or lessen it to the point that the effect is reversed. Approaching behavior in this way can improve our understanding of uptake, and consequently improve research and policy on the topic.

[1] Calculated from Say et al 2014, table 1.
[2] Calculated from Say et al 2014, table 2.
[3] Calculated from Say et al 2014, table 2.

To explore this approach, we have conducted a systematic review of the published literature to identify and synthesize elements that influence patient uptake of biomedical care facilities for PPH, and describe the directionality of these elements (describing any dynamic directionality), and element interactions including their impact on uptake. To our knowledge no previous review has aimed to capture the variation in element directionality and interactions between elements in relation to patient uptake of biomedical care for PPH. It is important to distinguish PPH from other maternal complications because cultural beliefs around such things as blood are likely to influence behavior in ways that are not relevant for non-hemorrhage maternal emergencies. We have therefore conducted a systematic review and synthesis to summarize the elements that influence uptake, describe their directionality variation, interactions, and how these impact patient uptake of care at biomedical facilities for PPH.

Methods

The methods for this review were specified *a priori*.

Search Strategy

The bibliographic databases MEDLINE (PubMed, since 1946) and Web of Science (since 1900) were searched up to the search date of this review, September 22, 2017. A sensitive search was conducted according to two search term sets: each term set was a variation of one of two terms (uptake and postpartum hemorrhage). Please see Table 1 for search term sets and search strings. The search was not limited by geographical setting or year of publication. Though we recognize there are behavioral and cultural differences between geographical settings, and that the burden of PPH rests in developing countries, we did not seek to limit the search by country or country income ranking. This was to allow for potential patterns in the evidence to be collected across different cultural and geographical locations.

Table 1: Search Term Sets and Strings

Database	Search Term Sets
MEDLINE (PubMed)	patient acceptance of health care [MeSH Terms]
	AND
	(Maternal OR Obstetric OR Postpartum OR “Post partum” OR “Post-partum”) AND (Haemorrhage OR Hemorrhage)
Web of Science	(use OR utlise OR utilize OR utilisation OR utilization OR accept OR acceptance OR acceptable OR access OR accessing OR participate OR choosing OR choose OR choice OR seek OR seeking OR demand OR decline OR refuse OR refusal OR prefer OR preference OR preferred)
	AND
	((health OR delivery) AND (care OR service OR services OR facility)) OR (hospital OR clinic OR centre OR center OR post)
	AND
	(reason* OR facilitator* OR barrier* OR impediment* OR component* OR factor* OR motive* OR motivation* OR cause* OR element*)
	AND
	(maternal OR obstetric OR postpartum OR "post partum" OR "post-partum") AND (haemorrhage OR hemorrhage)
Database	**Search String**
MEDLINE (PubMed)	Search ((((Maternal OR Obstetric OR Postpartum OR “Post partum” OR “Post-partum”)) AND (Haemorrhage OR Hemorrhage))) AND patient acceptance of health care [MeSH Terms] Sort by: Author
Web of Science	
#9	#7 AND #5 AND #2 AND #1 Refined by: [excluding] WEB OF SCIENCE CATEGORIES: (ENVIRONMENTAL SCIENCES OR UROLOGY NEPHROLOGY OR ACOUSTICS OR VETERINARY SCIENCES OR PLANT SCIENCES OR AGRICULTURE DAIRY ANIMAL SCIENCE OR PARASITOLOGY OR TRANSPLANTATION OR FOOD SCIENCE TECHNOLOGY OR OPHTHALMOLOGY OR CLINICAL NEUROLOGY OR ENGINEERING INDUSTRIAL OR DENTISTRY ORAL SURGERY MEDICINE OR GENETICS HEREDITY OR COMPUTER SCIENCE INFORMATION SYSTEMS OR CHEMISTRY MULTIDISCIPLINARY OR NEUROSCIENCES OR BIOTECHNOLOGY APPLIED MICROBIOLOGY OR CARDIAC CARDIOVASCULAR SYSTEMS OR BIOCHEMISTRY MOLECULAR BIOLOGY OR CHEMISTRY MEDICINAL OR BIOLOGY OR ALLERGY) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#8	#7 AND #5 AND #2 AND #1 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#7	#6 OR #4 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#6	TS=(hospital OR clinic OR centre OR center OR post) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#5	TS=(reason* OR facilitator* OR barrier* OR impediment* OR component* OR factor* OR motive* OR motivation* OR cause* OR element*) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#4	TS=(health OR delivery) AND TS=(care OR service OR services OR facility) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#3	#2 AND #1 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#2	TS=(maternal OR obstetric OR postpartum OR "post partum" OR "post-partum") AND TS=(haemorrhage OR hemorrhage) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#1	TS=(use OR utlise OR utilize OR utilisation OR utilization OR accept OR acceptance OR acceptable OR access OR accessing OR participate OR choosing OR choose OR choice OR seek OR seeking OR demand OR decline OR refuse OR refusal OR prefer OR preference OR preferred) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years

Study selection, extraction, and quality assessment

Original research studies were selected if they identified in the findings/results section one or more elements found to influence patient uptake of care at a biomedical facility for PPH: in order to be included, elements had to be explicitly and causally linked to influencing uptake in the text. We therefore excluded articles that linked elements to mortality if they did not explicitly describe that elements and mortality were linked through uptake. We also excluded studies that calculated measures of association between elements and uptake (e.g. regression, chi-square), as these are not causal evidence. Additionally, percent changes in behavior due to an intervention, or set of interventions, were excluded as these are similarly not causal evidence.

Participants included any person commenting on why a women had/would, or had/would not use biomedical facility services for prevention or treatment of PPH, including: women of reproductive age who had given birth or may give birth in the future, women of non-reproductive age who have given birth in the past, those who have power in the decision of whether a woman uses biomedical facility services (e.g. husband, mother, mother-in-law, other relative, traditional birth attendant etc.), and persons commenting on elements that influence the uptake by women (e.g. health care workers, community members, politicians etc.). The following study designs were included: qualitative, quantitative, mixed method, and literature review (if the literature review contributed new data/information from the analysis). Only English language articles were included.

Each article identified from the search was screened independently by two reviewers over two stages: title and abstract, then full text. Screening was conducted by four reviewers (MG, XL, NR, SC1). All disagreements were resolved by consensus between the reviewers. Qualitative data (name of elements, direction of element [support, oppose], interactions of elements, and interaction effect upon uptake) were extracted by one reviewer (MG) using a pre-constructed standardized extraction form, and extracted data was verified by a second reviewer (AWS). Data was extracted verbatim from the included articles, confined to the statement that identified the element or interaction and any description within the statement about directional effect.

Quality assessment of individual articles was also conducted independently by two reviewers (MG, AWS) for qualitative studies and the qualitative components of mixed methods studies. Quantitative risk of bias was assessed by one reviewer (MG). We used the Critical Appraisal Skills Programme (CASP)(179) appraisal tool to assess qualitative

research, and for quality assessment of quantitative studies (cross-sectional) we chose the Newcastle-Ottawa Scale (NOS) adapted for cross-sectional studies (184). The across study quality of evidence was assessed using GRADE CERQual (185), for qualitative studies that contributed to review findings, and was conducted by two reviewers (MG, AWS).

Data synthesis and analysis

After extracting a global list of elements, we performed a qualitative synthesis (thematic sorting) of extracted elements, grouping them into similar thematic categories. Sorting was done by two reviewers (MG, SC2); SC2 is a Professor in Medical Anthropology. Care was given when sorting elements into thematic categories to preserve the meaning of elements. Included articles were re-read to support optimal element placement into categories. The directionality of elements (impact upon uptake) was summarized under each element category. We also intended to synthesize and analyze the interaction of these elements at this stage. However, interactions were infrequently reported and resulted in no duplicates extracted. Consequently, interactions and their effects are described in Table 4 below.

Results

The search resulted in 1429 articles, and after the removal of 20 duplicates, we reviewed 1409 articles in title and abstract screening. We then reviewed the full-text of 76 articles, which resulted in the inclusion of 27 articles in our review (Figure 1). Of the 27 included articles, nine were qualitative, five were quantitative, 12 were both qualitative and quantitative, and one was a literature review presented with a qualitative study. The majority of studies were conducted in sub-Saharan Africa (15, 56%), followed by South Asia (7, 26%), East Asia and the Pacific (3, 11%), and Latin America (2, 7%). Study participants included women who had given birth and those commenting on these women (community members, relatives, community health providers, traditional birth attendants commenting on those women [13 articles]), those commenting on women who had died during the maternal period (health care workers, relatives or community members [8 articles]). There were two articles that did not describe participants and commented on maternal deaths, and one article that did not give information on participants and was unclear if the investigation was on either a PPH complication or a PPH death. Two articles examined both women who survived PPH and died from PPH. All studies reported elements that influenced patient uptake of biomedical facility care for PPH alone or together with other maternal complications. There were 17 articles that

investigated elements relating to treatment of PPH, four investigated prevention, and five investigated both. For further study characteristics see Table 2.

Findings from Included Studies

From the 27 articles, 233 elements were extracted. Elements were sorted into 20 thematic categories, and 34 subcategories (Table 3). In four subcategories, the directionality of the elements was not fixed (i.e. they were reported as potentially both supporting or opposing uptake). These included: perceptions about female strength, pain, if/when to seek care, what kind of care to seek, and need to be in a protected place or be protected. Twelve interactions were extracted from six articles; these are detailed in Table 4.

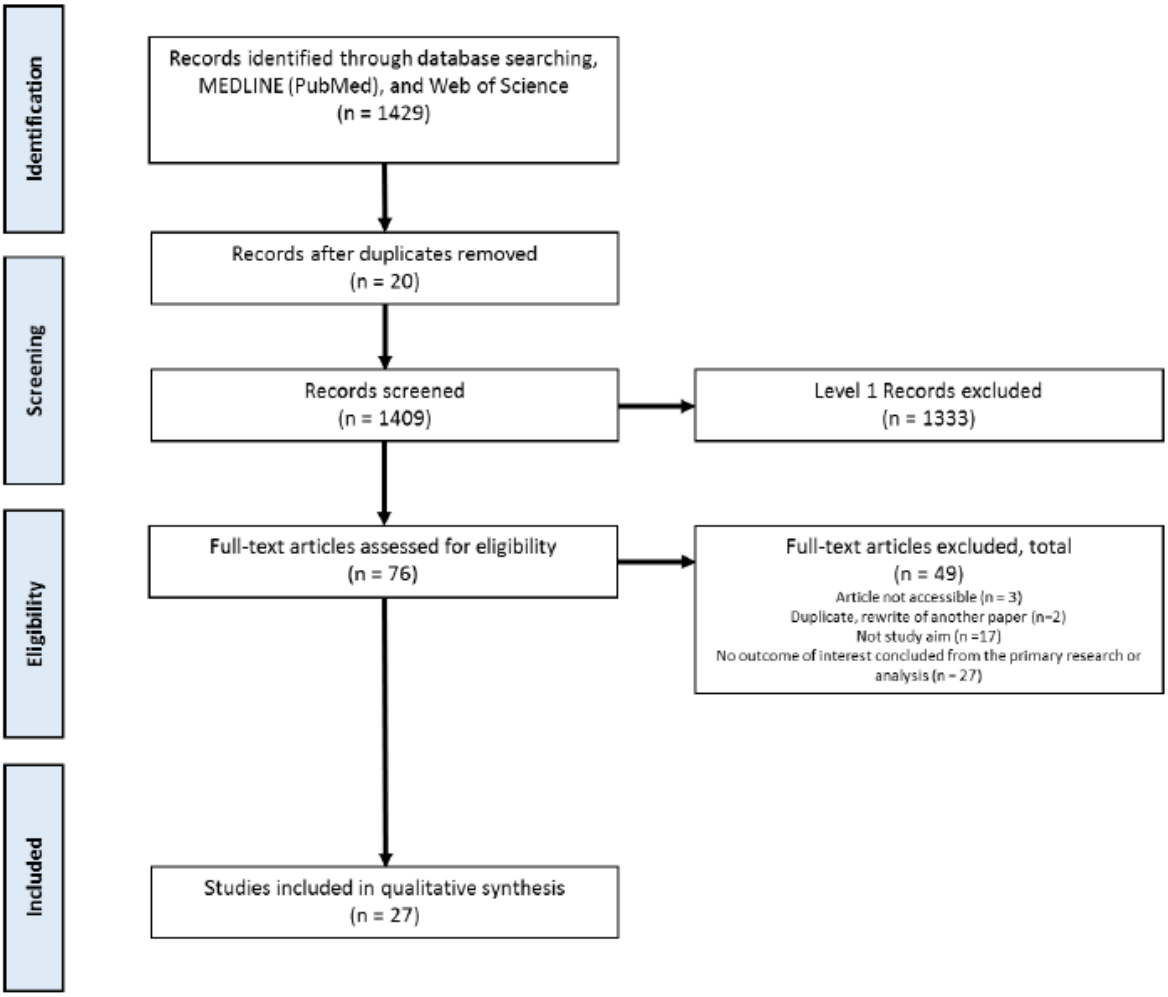

Figure 1: Flowchart of included and excluded studies.

Table 2: Study characteristics of included studies

Author	Year	Country	Study Type (Research Method*)	Time of Study	Sample Size for Review Outcomes **	Participant Type***	Biomedical Facility	Treatment or Prevention of PPH
Ashimi(186)	2015	Nigeria	Quantitative (Cross-Sectional Study questionnaire)	01-02/2014	410	Women who gave birth-in last 15 months	Hospital	Prevention (delivery)
Belton(187)	2014	Indonesia	Qualitative (rapid ethnography, interviews)	2008-2010	8 families †	Relatives of deceased women	Health Care, Health Post, Clinic, Hospital	Both
Chiphangwi(188)	1992	Malawi	Mixed (qualitative questionnaire)	09/1989	140	Women with knowledge of a maternal death	Health Facility	Treatment
Chiwuzie(189)	1995	Nigeria	Qualitative (focus groups)	Not reported	15 focus groups†	Female and Male Community Members	Hospital, maternity center, private clinics and centers	Treatment
Choulagai(190)	2013	Nepal	Quantitative (interviews with questionnaire)	05-06/2011	2481	Women who gave birth-in last year	Facility with Skilled Birth Attendant	Prevention (delivery)
D'Ambruoso(191)	2010	Burkina Faso	Mixed (interview with qualitative questionnaire)	11/2007-01/2008	174	Relatives of deceased women	Hospital, Health Centre	Treatment
Deepak(192)	2013	India	Qualitative (interviews)	05-08/2011	40	Women who gave birth-in last 6 months and grandmothers (mothers in law)	Hospital, Facility	Both
Etuk(193)	1999	Nigeria	Mixed (interviews)	Not reported	149	Women who gave birth-in last year	Hospital	Prevention (delivery)
Garner(194)	1994	Papua New Guinea	Mixed (interviews)	1984-1986	89	Women who gave birth-in last week	Health sub-center, Hospital	Both
Kalim(195)	2009	Bangladesh	Qualitative (in-depth interviews)	7/2006-12/ 2007	18	Women who gave birth-anytime	Hospital, private and government	Treatment
Mbachu(196)	2017	Nigeria	Quantitative (cross sectional study)	09/2014-08/2015	57	Women who gave birth-in last year with PPH, or died from PPH	Private Hospital	Treatment
Mbizvo(197)	1993	Zimbabwe	Mixed (cross-sectional study, questionnaire‡)	24-month period 1989-1990	97	Relatives and HCW of deceased women	Hospital, Clinic	Prevention (delivery)
Mirzabagi(198)	2013	India	Qualitative (interviews)	05/2011-07/2011	20	Women who gave birth-in last 6 months and grandmothers (mothers in law)	Hospital	Both
Okolocha(26)	1998	Nigeria	Qualitative (focus groups and interviews)	Not reported	17 groups, 7-13 people†	Female and Male Community Members and TBAs	Modern Medicine, Modern Obstetric Care	Treatment

Okong(199)	2006	Uganda	Mixed (Cross-sectional study, narrative interviews)	1995-1999	24	Relatives and HCW of deceased women	Hospital	Treatment
Olaniran(200)	1997	Nigeria	Mixed (focus groups and surveys)	01/1990-03/1996	21 groups, 6-10 people plus 140†	Female and Male Community Members and TBAs	Hospital	Treatment
Ononge(201)	2016	Uganda	Qualitative (interviews)	04-05/2012	15	Women who gave birth-in last year, TBA delivered last 6 months	Health Facility	Both
Orji(202)	2002	Nigeria	Mixed (qualitative interview)	1995-1999	24	Relatives of deceased women	Hospital	Treatment
Osubor(203)	2006	Nigeria	Mixed (quantitative questionnaire, focus groups)	07-08/1999	225	Mothers, reproductive age, and community health providers	Government Primary Healthcare Centre	Both
Ramos(204)	2007	Argentina	Mixed (verbal autopsy questionnaire, qualitative component)	2002	25	Not reported, deceased women	Hospital, Health System, Health Facility	Treatment
Rosenstein(205)	2008	Argentina	Mixed (verbal autopsy questionnaire‡)	05-09/2005	20	Relatives of deceased women	Health Facility	Treatment
Sibley(206)	2005	India	Quantitative (questionnaire)	1998	159	Women who gave birth-in last year, and relatives if deceased	Outside of home, facility capable of providing emergency care	Treatment
Sikder(100)	2011	Bangladesh	Qualitative (interviews)	10-11/2009	40	Women who gave birth-in last month	Medical care by skilled provider	Treatment
Supratikto(207)	2002	Indonesia	Mixed (interviews)	1995-1999	130	Not reported, deceased women	Health Facility	Treatment
Thaddeus(208)	2004	Indonesia	Literature Review and Qualitative (survey)	Survey 2001	Not reported	Not reported	Emergency Obstetric Care, Skilled Attendance	Treatment
Thorsen(209)	2012	Malawi	Mixed (qualitative interviews)	01-06/2011	93	Relatives, community members and HCW of deceased women	Hospital, secondary and tertiary care	Treatment
Weeks(210)	2005	Uganda	Qualitative (interviews)	Not reported	30	Women with a NMMM	Government Hospital	Treatment

*The research method for which a review finding was extracted. In a mixed method study, data extracted may have only been from the qualitative/quantitative method, and therefore the method producing a review finding is reported here and assessed in individual and across study quality assessment. **As data is extracted for PPH elements only, and many studies report other complications, the sample size can be different for the entire study, versus PPH cases. Here the sample size for PPH cases is reported. Additionally, studies do report other outcomes in addition to our outcomes of interest, and report sample size for the overall study as well as for our outcomes of interest. Here sample sizes for our outcome of interest are reported, which may differ from the overall study sample size. ***Participants who contributed to our review outcomes. There may have been other participant types in the study that did not contribute to our review outcomes. †No reporting of sample size as number of individual participants. ‡ It is unclear if the extracted results are from a qualitative or quantitative method due to lack of clarity in reporting of methods and/or results. In these cases, we proceed cautiously and deem the study mixed, assessing for both study types.

Participant Type: those who participated in the study, Biomedical Facility: where uptake was discussed; HCW: health care worker (biomedicine); TBA: traditional birth attendant; NMMM: near-miss maternal mortality

Table 3: Sorting results, element categories and direction of uptake

Element Thematic Category	Subcategories/Description of Category	Direction of Biomedical Uptake
Perception of Birth Process	Perceived Normal, not serious Perceived Complication, serious Perception of Blood (e.g. dangerous) Perception about (female) strength, pain	Oppose Support Oppose Support and Oppose *Evidence shows desire to experience pain or belief pain is normal opposes uptake, however perceptions about treatment (uterotonics injections) giving pain supports uptake*
Cause of Complication	Supernatural Biological	Oppose Support
Decision about care, treatment	If/when to seek care What kind of care to seek Where to seek care	Support and Oppose *Depending upon need, knowledge, development of complication. Evidence shown in one article that increased severity of the complication supported uptake, and in another article when hemorrhage developed it did not support uptake.* Support and Oppose *Depending on beliefs about etiology of bleeding* Oppose *Do not know where to go, or wrong facility*
Perception of Intervention (procedure, drug…)	Preferred (General) Effectiveness Quality and Effect, Biomedical Quality and Effect, Traditional	Oppose Support Support *If belief effective will use, if quality of care is perceived positively and is trusted* Oppose *If consider traditional more effective for the complication (cause) and care to be adaptable*
Birth Traditions		Oppose *Home birth/with families in houses with heirlooms/with TBAs and healers, decent/traditional/preference/culturally acceptable*
Fear & Comfort	Fear of Procedures Comfortable with Procedures Fear of location Need to be in a protected place, or be protected	Oppose Support Oppose Support and Oppose *One article supports birth in a facility to avoid village people, another seek protection from spiritual attack by not seeking facility care, or delay care by performing ritual to promote health before seeking care*
Perception of healthcare worker/caregiver (relationship, behavior)	Health care worker TBA, midwife	Support *Positive perception of health care workers and relationship supports uptake* Oppose *Negative relationships with health care workers, and positive, familiar relationship with TBA and midwives opposes uptake*
Care Access (general)	Unable to access	Oppose
System Access (health care, insurance)	Delay in bureaucratic process	Oppose

Transportation	General: difficulties Planning: Arranged Lack of confidence to arrange Availability: unavailable Cost: lack of funds, unaffordable Reliability: not reliable (not functioning)	Oppose Support Oppose Oppose Oppose Oppose
Planning/Communicating Care Access	Prepared, arranged access, communicated care request Communication problems, lack of preparedness	Support Oppose
Physical Barriers (remote, environment, distance)	Remote, environmental barriers, distance	Oppose
Care affordable	Can afford (e.g. save money, borrow money...) Not affordable (e.g. high care and or transportation cost, lack of money, flexible payment schemes non-certified providers, costs unaffordable even when have health care card to cover some costs	Support Oppose
Referral (between levels/types of care)	No referral Successful referral	Oppose Support
Night, time of day (delivery/labor occurs)	No staff/caregivers at night No transportation at night Do not want to travel at night	Oppose Oppose Oppose
Social connectedness	Lack of social connected ness (childcare unavailable)	Oppose
Valuation of Women	Low value placed on women after child is born, women's health care costs not a priority over other uses of money (opportunity costs)	Oppose
Control of women	No males to accompany women or take responsibility for pregnant women, male must give permission, women must wait for permission, reproductive control Monetary fine for giving birth at home	Support and Oppose *Uptake can depend on male and decision making. A monetary fine for giving birth at home could supersede decision, however this fine is not enforced (see interactions).*
Care available	No supplies, equipment, staff, space, lack of consistent availability, long waiting times	Oppose
Social reasons	No description in article	Oppose

Table 4: Interactions between elements and effects upon uptake

Element 1	Element 2	Element 3	Result on Uptake	Study #
Recognize complication				
	+ Far away facility		Oppose	Kalim 2009
	+ No male to accompany		Oppose	Kalim 2009
	+ Difficult to arrange transportation at night		Oppose	Kalim 2009
Improve quality of services	+ Would seek money to pay for services		Support	Osubor 2006
Poor quality of services (government hospital crowded unable to handle complicated cases)	+ Would pay for services	+ Government hospital cheaper than private clinic	Support	Sikder 2011
Woman can no longer endure pain, informs family of complication				
	+ Relatives decide when and where to seek care		Support/oppose depends on what relatives decide	Sikder 2011
Woman keeps money for birth expenses				
	+ Husband used the money to buy food		Oppose	Sikder 2011
Woman's condition became dire	+ Had exhausted options of non-certified treatment providers		Support	Sikder 2011
Labor being late at night	+ Lacked means of getting to hospital		Oppose	Ashimi 2015
System of savings in place for birth expenses				
	+Distrust of the savings system		Oppose	Belton 2014
(Monetary) fine for giving birth at home				
	+ Rarely enforced		Oppose	Belton 2014
Certainty in contemporary medicine	+ Desire for painful labor	+ Belief that uterotonics injection raises pain	Support	Mirzabagi 2013

Individual study quality assessment

Included articles were assessed for study-level quality according to the method used in each study to determine our review outcomes (elements, interactions, and effects upon uptake). Therefore, if an article was mixed method (e.g. qualitative and quantitative), the study-level quality was assessed for the method used to produce the data we were collecting for our review.

Quality assessment of individual qualitative studies

There were 23 qualitative designs assessed in this review. Due to unclear reporting, we found it difficult to assess most of the individual studies favorably. Of greatest concern was the lack of reporting or consideration of the relationship between the researcher and participants and ethics. Only two studies provided what we assessed to be adequate consideration of this relationship. Additionally, only 11 studies reported ethics being considered. The topic of morbidity and mortality during childbirth from PPH is a sensitive topic, and if ethics was not considered or the power dynamics in the relationship between researchers and participants, participant responses could very well be influenced.

Of additional significant is that 11 studies did not adequately design or report the way data was collected and we therefore could not determine if the collection appropriately addressed the research issue. This is important, as investigating and discussing behavior is very delicate: it is notoriously problematic to take on face value participants' subjective accounts of their behavior, particularly if there are relevant cultural issues, such as beliefs around ritual and taboo. Also, the rigor of the data analysis process was not adequately reported in 12 studies, and was not adequate in one study. Given the above points we only judged for six studies that the research was valuable. Please see Table 5 for results of the ten questions in the CASP assessment.

Quality assessment of individual quantitative studies

There were four quantitative designs assessed in this review. Of concern is that three of the studies predefined the elements said to influence behavior, thereby not allowing participants to contribute elements to the results that they determined to influence their behavior. The fourth study (Mbachu) uses hospital records to inform study results, and it is unclear if/how patient delays were captured in the hospital records. We therefore have concerns that elements may not reflect participant experience. Please see Table 6 for results of the six questions in the NOS assessment.

GRADE CERQual

There were 23 qualitative studies that contributed to the 20 review findings (thematic element categories), determined from thematic sorting. As indicated above, all interactions extracted were unique and therefore across study assessment was not done for interactions. Overall, most studies were of low quality and this was reflected in the GRADE CERQual assessment. As mentioned above, this was most often due to lack of

reporting or consideration of the participant and researcher relationship, ethics and consent attainment, and lack of reporting or low quality of study design and/or analysis. Please see Table 7 for the GRADE CERQual summary of findings.

The four quantitative studies that were included in the review contributed 13 elements to 9 categories and 6 subcategories. As indicated above, these four studies were judged to have bias that impacted our confidence in the results. This was mainly due to the elements being proposed to participants, thereby limiting the range of responses elicited, as well as potentially reflecting the power dynamic between the researcher and participant. If we consider these elements extracted from the quantitative studies for 9 elements categories together with the GRADE CERQual results, our confidence in the evidence is not raised, not only due to the potential bias in the studies, but also the small number of elements extracted from quantitative studies that have contributed to the review (4/27 studies, contributing 13/233 elements).

Table 5: Summary of quality assessment for extracted data from qualitative components of studies (CASP; n=23 studies)

Study	SECTION A: Are the Results of the Study Valid?						SECTION B: What are the Results?			SECTION C: Will Results Help Locally?
	Was there a clear statement of the aims of the research?	Is a qualitative methodology appropriate?	Was the research design appropriate to address the aims of the research?	Was the recruitment strategy appropriate to the aims of the research?	Was the data collected in a way that addressed the research issues?	Has the relationship between researcher and participants been adequately considered?	Have ethical issues been taken into consideration ?	Was the data analysis sufficiently rigorous?	Is there a clear statement of findings? *	How valuable is the research?
Belton 2014	Yes	Yes	Yes	Yes	Yes	No	Yes	Can't Tell	No	Can't Tell
Chiphangwi 1992	Yes	Yes	Yes	Yes	Can't Tell	Can't Tell	Can't Tell	Can't Tell	No	Can't Tell
Chiwuzie 1995	Can't Tell	Yes	Can't Tell	Can't Tell	Yes	Can't Tell	Can't Tell	Can't Tell	Yes	Can't Tell
D'Ambruoso 2010	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Can't Tell
Deepak 2013	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Etuk 1999	Yes	Can't Tell	No	Yes	Can't Tell	Can't Tell	Can't Tell	Can't Tell	No	Can't Tell
Garner 1994	Yes	Yes	Yes	Yes	Can't Tell	Can't Tell	Can't Tell	Can't Tell	No	Can't Tell
Kalim 2009	Yes	Yes	Yes	Can't Tell	Can't Tell	Can't Tell	Can't Tell	Yes	Yes	Yes
Mbizvo 1993	Yes	Yes	Can't Tell	Yes	Can't Tell	Can't Tell	Can't Tell	Can't Tell	No	Can't Tell
Mirzabagi 2013	Yes	Yes	Yes	Can't Tell	Yes	Can't Tell	Yes	Yes	No	Can't Tell
Okolocha 1998	Yes	Yes	No	Can't Tell	Can't Tell	Can't Tell	Can't Tell	No	Yes	Can't Tell
Okonge 2006	Yes	Yes	No	Yes	Yes	Yes	Yes	Can't Tell	No	Yes
Olaniran 1997	Yes	Can't Tell	Yes	Yes	Can't Tell	Can't Tell	Can't Tell	Can't Tell	No	Can't Tell
Ononge 2016	Yes	Yes	Yes	Can't Tell	Yes	Yes	Yes	Yes	Yes	Can't Tell
Orji 2002	Yes	Yes	Can't Tell	Yes	Yes	Can't Tell	Can't Tell	Can't Tell	No	Yes
Osubor 2006	Yes	Yes	Yes	Can't Tell	Yes	Can't Tell	Yes	Yes	No	Yes
Ramos2007	Yes	Yes	Can't Tell	Can't Tell	Can't Tell	Can't Tell	Can't Tell	Can't Tell	No	Can't Tell
Rosenstein 2008	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Can't Tell
Sikder 2011	Yes	Yes	Yes	Can't Tell	Yes	Can't Tell	Yes	Yes	No	Yes
Supratikto 2002	Yes	Yes	Can't Tell	Can't Tell	Can't Tell	Can't Tell	Can't Tell	Can't Tell	No	Can't Tell
Thaddeus 2004	No	Can't Tell	Can't Tell	Can't Tell	Can't Tell	Can't Tell	Can't Tell	Can't Tell	No	Can't Tell
Thorsen 2012	Yes	Yes	Yes	Yes	Can't Tell	Can't Tell	Yes	Yes	Yes	Can't Tell
Weeks 2005	Yes	Yes	Yes	Can't Tell	Yes	Can't Tell	Yes	Yes	No	Can't Tell

*this question pertains to clearly presented results about our research finding: elements that influence PPH. If results are presented together with other complications and we were unable to separate out PPH, we answered 'no' to this question.

Table 6: Summary of quality assessment for extracted data from quantitative components of studies (Newcastle-Ottawa Scale; n=4 studies)

Study	Representativeness of Sample	Sample Size	Non-Respondents	Comparability	Assessment of Outcome	Outcome: Statistical Test
Ashimi 2015	Selected group of users (women who attended hospital antenatal clinic)	Justified and satisfactory	Comparability of characteristics between respondents and non-respondents was not described, but response rate was satisfactory (97.1%)	The difference in outcome groups are compared, but some confounding factors are not controlled (distance to facility, time of birth…)	Self-report. Response bias needs to be considered. Presented together with other complications.	For our outcome of interest (reasons for home birth identified by women, the study reports N and %, for measure of association X2. However, association tests are not causal, and therefore do not meet the inclusion criteria of this review, and are therefore not extracted
Choulagai 2013	Report as 2-stage random sample, but do not give clear details of how randomization was done. Therefore, unclear what the sample represents	Unable to achieve their sample size calculation (2481/3030)	Authors indicate all participants selected responded, and that consent was sought, but do not indicate if any person denied consent	The difference in outcome groups are compared, but some confounding factors are not controlled (time of birth…)	Self-report. Response bias needs to be considered. Presented together with other complications.	For our outcome of interest (reasons for seeking SBA services identified by women, the study reports %, for measure of association multiple logistic regression. However, association tests are not causal, and therefore do not meet the inclusion criteria of this review, and are therefore not extracted.
Mbachu 2017	Exhaustive sampling approach of all women who delivered in the private hospital.	Satisfactory (all patients)	All responded (records use). All women were included, no consent was sought from patients to use their records.	Report difference in patient characteristics, but do not relate to outcomes.	Record linkage, unclear how records used to determine patient delays reported. Presented together with other complications.	No statistical test, list of delays reporting N and %
Sibley2005	Authors indicate contact of all women (families in case of death) in study area who had a home delivery planned, and investigated outcomes for all women from this group who reported signs and symptoms suggesting excessive bleeding. An internet search reveals the area has a population of 181,591. It is highly likely that women were missed.	Satisfactory (all women reporting bleeding complication), however see representative-ness	No description of non-respondents, gives the impression all were contacted and consented.	The difference in outcome groups are compared, but some confounding factors are not controlled (time of birth, distance, income level…)	Self-report. Response bias needs to be considered. Results specific to PPH presented clearly.	For our outcome of interest (reasons for seeking care outside of home) N reported. For measure of association, X2 and logistic regression. However, association tests are not causal, and therefore do not meet the inclusion criteria of this review, and are therefore not extracted.

The NOS question 'Comparability' is defined as: the subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled. The NOS question 'Ascertainment of the exposure (risk factor)' was not applicable to this quality assessment, as the prevalence was not of a disease but of reasons for delivering at home, it was therefore not used in this assessment. SBA: Skilled Birth Attendant.

Table 7: GRADE CERQual summary of qualitative findings table

Objective: To synthesis qualitative evidence on identifying elements that influence patient uptake of care at biomedical facilities for PPH
Perspective: Experiences and attitudes of women (or her family/community members in the case of death), and caregivers, about elements that influence a woman's uptake of care at biomedical facilities for PPH.

Summary of Review Finding	Studies Contributing to the Review Finding	*CERQual Assessment of Confidence in the Evidence*	Explanation of CERQual Assessment
1. Perception of Birth Process	14	Moderate Confidence	14 studies assessed together to have moderate methodological limitations. Data from eight countries across the following regions: South-East Asia, Africa, (South) Americas, Western-Pacific. Minor concerns about coherence, and no or very minor concerns about adequacy. Moderate concerns about relevance of data.
2. Cause of Complication	5	Low Confidence	Five studies assessed together to have moderate methodological limitations. Data from four countries across the following regions: South-East Asia, Africa. Minor concerns about coherence, and moderate concerns about adequacy. Moderate concerns about relevance of data.
3. Decision about Care, Treatment	6	Low Confidence	Six studies assessed together to have moderate methodological limitations. Data from five countries across the following regions: South-East Asia, Africa. Minor concerns about coherence, and moderate concerns about adequacy. Moderate concerns about relevance of data.
4. Perception of Intervention (procedure, drug…)	7	Moderate Confidence	Seven studies assessed together to have moderate methodological limitations, some severe. Data from three countries across the following regions: South-East Asia, Africa. Minor concerns about coherence, and no or very minor concerns about adequacy. Moderate concerns about relevance of data.
5. Birth Traditions	3	Moderate Confidence	Three studies assessed together to have moderate methodological limitations. Data from three countries across the following regions: South-East Asia, Africa. No or very minor concerns about coherence, and minor concerns about adequacy. Moderate concerns about relevance of data.
6. Fear & Comfort	8	Low Confidence	Eight studies assessed together to have moderate methodological limitations, some severe. Data from four countries across the following regions: South-East Asia, Africa, (South) Americas. Minor concerns about coherence, and adequacy. Moderate concerns about relevance of data.
7. Perception of Healthcare Worker/Caregiver (relationship, behavior)	9	Low Confidence	Nine studies assessed together to have moderate methodological limitations. Data from six countries across the following regions: South-East Asia, Africa, (South) Americas. Minor concerns about coherence, and adequacy. Moderate concerns about relevance of data.
8. Care Access (general)	5	Low Confidence	Five studies assessed together to have moderate methodological limitations. Data from three countries across the following regions: South-East Asia, Africa. Moderate concerns about coherence, and minor concerns about adequacy. Moderate concerns about relevance of data.
9. System Access (health care, insurance)	4	Low Confidence	Four studies assessed together to have moderate, methodological limitations. Data from four countries across the following regions: South-East Asia, Africa. Minor concerns about coherence, and adequacy. Moderate concerns about relevance of data.

Summary of Review Finding	Studies Contributing to the Review Finding	*CERQual Assessment of Confidence in the Evidence*	Explanation of CERQual Assessment
10. Transportation	17	Moderate Confidence	17 studies assessed together to have moderate methodological limitations. Data from eight countries across the following regions: South-East Asia, Africa, (South) Americas. Minor concerns about coherence, and no or very minor concerns about adequacy. Moderate concerns about relevance of data.
11. Planning/Communicating Care Access	4	Low Confidence	Four studies assessed together to have moderate methodological limitations. Data from four countries across the following regions: South-East Asia, Africa, (South) Americas. Minor concerns about coherence and adequacy. Moderate concerns about relevance of data.
12. Physical Barriers (remote, environment, distance)	9	Low Confidence	Nine studies assessed together to have severe methodological limitations. Data from four countries across the following regions: South-East Asia, Africa, (South) Americas. Minor concerns about coherence and adequacy. Moderate concerns about relevance of data.
13. Care Affordable	13	Moderate Confidence	13 studies assessed together to have moderate methodological limitations. Data from five countries across the following regions: South-East Asia, Africa. Minor concerns about coherence and adequacy. Moderate concerns about relevance of data.
14. Referral (between levels/types of care)	5	Moderate Confidence	Five studies assessed together to have moderate methodological limitations. Data from two countries across the following regions: South-East Asia, Africa. No or very minor concerns about coherence, and minor concerns about adequacy. Moderate concerns about relevance of data.
15. Night, Time of Day	8	Low Confidence	Eight studies assessed together to have severe methodological limitations. Data from six countries across the following regions: South-East Asia, Africa. No or very minor concerns about coherence, and minor concerns about adequacy. Moderate concerns about relevance of data.
16. Social Connectedness	2	Low Confidence	Two studies assessed together to have moderate methodological limitations. Data from one country, Argentina, (South) Americas region. Minor concerns about coherence, and moderate concerns about adequacy. Moderate concerns about relevance of data.
17. Valuation of Women	6	Low Confidence	Six studies assessed together to have severe methodological limitations. Data from six countries across the following regions: South-East Asia, Africa, (South) Americas. Minor concerns about coherence and adequacy. Moderate concerns about relevance of data.
18. Control of Women	7	Moderate Confidence	Seven studies assessed together to have moderate methodological limitations. Data from five countries across the following regions: South-East Asia, Africa, (South) Americas. Minor concerns about coherence and adequacy. Moderate concerns about relevance of data.
19. Care Available	9	Low Confidence	Nine studies assessed together to have severe methodological limitations. Data from four countries across the following regions: South-East Asia, Africa, (South) Americas. Minor concerns about coherence and adequacy. Moderate concerns about relevance of data.
20. Social Reasons	1	Low Confidence	One study assessed to have moderate methodological limitations. Data from Uganda, in Africa region. Coherence not applicable to one study. Minor concerns about adequacy. Moderate concerns about relevance of data.

Discussion

We identified 27 studies that identified elements said to influence patient use of biomedical facilities for the prevention or treatment of PPH. From these studies, we extracted 233 elements that were sorted into 20 thematic categories, and 34 subcategories.

The review results show the different ways in which these elements can influence upon uptake; in particular, while many physical elements have fixed directionality some belief-driven elements are inherently dynamic. This latter point can be illustrated by elements within two key subcategories ('perception about female strength, pain', and 'need to be in a protected place, or be protected'), where the literature presented evidence that elements can either support or oppose uptake. The difference in directionality was due to beliefs about: where a woman will experience painful labor (in a bio-medical facility with uterotonics [thought to give pain], delay to seek biomedical care (an expectation of women to endure pain), and where a woman will be protected (at biomedical facility to avoid village people, or to seek protection from spiritual attack by not seeking biomedical care). Within some thematic categories, subcategorization results show that whether an element supports or opposes uptake is based upon different beliefs. For example, beliefs about whether a complication is normal or serious, and about if the cause of complication is supernatural or biological. Alongside belief-driven elements there are a number of physical elements that directionality is consistent (fixed) and depends upon the presence (or not) of the element. For example, transportation, communications, physical barriers (remoteness, environment, distance), care availability (facility presence and hours, supplies, staff, beds), and care affordability (money).

Drawing out these findings from a set of individual studies emphasizes how important it is to recognize that many elements are interconnected. While collecting and then presenting elements as individual units, isolated from other elements, simplifies a health-related activity such as access to care services, by obscuring the reality of how elements operate and impact uptake can actually restrict the validity and usefulness of a study. Therefore, although there is value in this individual element examination, it must be set within the larger dynamic, interactive web of elements in order to inform effective policy on uptake. This can be appreciated by reflecting upon the interactions collected in this review. Twelve interactions were collected which demonstrates that the presence of other elements influences the direction of uptake. This is of great importance because in reality elements are never isolated from each other, and when viewed as such, can present an incorrect representation of how they influence uptake. It is also important to

consider that whilst we were only able to identify 12 interactions from the literature we reviewed, this is likely to be a result of the theoretical underpinnings of research and design scope in the studies, rather than the absence of many more interactions that influence the actual behavior of women and others in specific context.

After assessing review findings (element thematic categories) with GRADE CERQual we determined that we have low confidence in the majority of review findings (13 findings), and moderate confidence in the remaining seven review findings. When we consider the contribution of the quantitative studies (four studies) into our assessment of review findings, our confidence level does not change. Of serious concern is that the majority of qualitative studies (19) were judged to inadequately consider the relationship between the participant and the researcher, and 12 did not report that ethical issues had been considered. This assessment of the quality of the studies that were reviewed is not unconnected from our main interest in identifying how elements interact with each other: The nature of human behavior is inherently complicated, so the examination of behavior should be approached with this in mind. This therefore includes limits to how a person may talk about their behavior for a wide range of reasons due to such things as custom and taboo, to the fact that often a person is not fully aware why they do what they do, or the normative expectations of being asked specific questions within a research context. Given these considerations, it is essential that researchers consider the relationship between themselves and participants, including a range of ethical issues (beyond merely gaining consent), as without this consideration bias can be introduced into the results. Quality of studies was also impacted by the clarity of reported results. While seven studies presented elements specific to PPH, the remaining 20 studies failed to distinguish the potential relevance of elements for PPH from other potential complications.

Limitations

We must acknowledge limitations to this current review. Although we aimed to conduct a comprehensive search, it is likely that some relevant studies were not included. This is due to language limitations of the search, and searching two databases (albeit with very large coverage). It should also be noted that our potential to capture a realistic picture of element directionality and interactions from a literature search will always be limited, as it depends upon how the original research is designed and conducted. Very few studies included in this review were designed to capture or illustrate any kind of interactions

between elements that they identified; typically, the included studies list elements individually, or sort elements into categories.

The meaning of elements in this review should be interpreted cautiously – not only is meaning likely to be different between participant, researcher, review authors, and review readers but these differences can easily be obscured if a study's design is not constructed to address this potential divergence. Pre-defining survey responses, closed questions, and assigning participant responses under a researcher-chosen term can contribute to this misunderstanding. This potential terminology obfuscation is further obstructed when an article has limited reporting of results, for example when articles simply list a term as an element and do not give a description of the term or contextual information. This affects the placement of the element under an appropriate thematic category. Additionally, it should be noted that it is difficult, if not impossible, to capture the meaning of an element from studies that do not observe behavior directly, attempt to embed the researcher in the field, or give what anthropologists call a 'thick description' of the meaning of an element in its cultural milieu. None of the studies included present data that offers this level of understanding. The above limitations and quality of the articles and review findings should be considered when interpreting the results of this review.

Conclusion

This review provides an important new analysis to improve understanding and future research on health-seeking behavior for patient uptake of PPH at biomedical health facilities. In some instances, interactions occur between elements that change the directional impact of elements upon uptake, demonstrating that directionality of elements can be dynamic and not fixed into barrier or facilitator categories. This review supports an approach to examining health-seeking behavior as dynamic and interconnected.

Chapter 5: Additional results

The purpose of this section of additional results is to present the details of the individual study level and across study level quality assessment analyses, that are summarized in Paper 1, Elements and interactions influencing patient uptake of biomedical facility care for postpartum haemorrhage: A systematic review and synthesis. This section and appendices presenting further details of the individual study level and across study quality assessments were composed and written by myself.

Individual Quality Assessment of Included Articles

Individual quality assessment was conducted on each article included in the systematic review (Paper 1). Individual quality assessment of included qualitative articles was conducted independently by two reviewers (Meghann Gregg and Alexa Wharton-Smith). For quantitative articles quality assessment was done by one reviewer (Meghann Gregg). We used the Critical Appraisal Skills Programme (CASP) (179) appraisal tool to assess qualitative research, as mentioned by the Cochrane Collaboration Qualitative Methods Group(211). Cochrane makes no specific recommendation on which tools to use for qualitative study assessment, they simply state that an author can "select any published qualitative appraisal tool, framework or checklist" (212). CASP was chosen because of its generic approach, allowing for the assessment of a broad range of qualitative study types, and that it has a wide and relevant number of questions to help determine the quality of studies and their results. For quality assessment of quantitative studies (cross-sectional) I chose the Newcastle-Ottawa Scale (NOS)(180).This scale is mentioned as being useful in the Cochrane Handbook 5.1(54) as a tool to assess the methodological quality of nonrandomised studies(213).

The results of the individual study level quality assessment for 23 qualitative studies are only presented in summary in Paper 1: responses to CASP questions are presented in Table 5 as Yes, No, or Can't Tell. Quantitative study assessments are presented in more detail for four articles in Paper 1 Table 6. Both qualitative and quantitative quality assessment analyses were compiled in a single report in order to provide a record of the rationale for single study quality judgments and to support the across study quality assessment (CERQual) that is built from the single study assessments. This report asks four questions: are the results of the study valid, what are the results, will the result help locally, and are the study results generalizable beyond the local setting? The first three questions are the main category questions from the CASP tool. This fourth question was added as the studies included in Paper 1 were from 19 countries, and it was therefore

important to consider if the data extracted from the included studies could be applied in multiple settings.

The summaries of each article in the report follow the same format. First study ID (number assigned to designate the study in CERQual summaries) is noted along with the author and year of the study and followed by the tool used for assessment in parenthesis (CASP or NOS). Then the four questions are addressed in short form (results valid, what are the results, results local, generalizable beyond local). Please see Figure 7 below for an example of an individual study quality assessment description. Please see Appendix F for the entire report.

Study ID 1: Chiwuzie et al 1995 (CASP)

Results Valid:
There is minimal information reported on the study design, and it is unclear if researcher or participant bias was considered and minimised. The authors do not qualify in their data analysis how common or predominant the elements influencing uptake were, making it difficult to determine to what extent these elements influenced uptake. Results are from self-reports in a group setting (focus group), which may influence responses.

There was a somewhat clear statement about the aim of the research and the methodology was appropriate. There is limited reporting of the research design, no reporting of the recruitment strategy, and no justification for the choice of method or number of focus groups. The data was collected in a way that addressed the research issue. It is not clear if the relationship between the researchers and participants had been adequately considered, as it was not reported. Authors do mention women were interviewed by women, and that men were interviewed by men.

What are Results?:
There is no ethical statement or description of ethics being considered. There is no description of how data was analysed so we cannot comment on the rigor. There is a clear statement of findings.

Results Local:
The results could perhaps help locally (e.g. providing transportation) but it is clear that the study results are not fully reflective of the situation. For example, the authors mention in the introduction that issues of sexism are present but this was not collected in the focus groups. Perhaps participants did not feel comfortable to discuss or are taught/told not to discuss sexism, however this was not discussed in the article (why the authors' state sexism is present yet it is not captured in the focus groups). The results should be applied with consideration of limited study reporting, design, and potential researcher and participant bias.

Generalizable beyond Local:
It is possible that these elements are important in other settings, with the consideration of contextual influences and limitations mentioned above. The authors do not discuss these results in relation to findings from other studies.

Figure 7: Example of one article assessment from report on individual study quality assessment.

As many articles are included in the review it was challenging to be consistent with the assessment of individual articles, even with the guidance of the CASP questions and my creation of a summary table. Having a strong understanding of study design and experience in conducting studies strengthens a quality assessment, despite advice given to the contrary that qualitative researchers can conduct qualitative study assessment. Judgments are subjective and there is room for improvement in how qualitative research is assessed, particularly to ensure fair consistency in author responses, and to ensure all appropriate questions are being addressed to adequately assess a study.

For example, the CASP tool did not ask the following question: is it considered that when participants are asked questions, they may not respond in accord with what the researcher is expecting (e.g. due to taboos, norms, participant desire to be perceived in a certain way). Though this question is not explicitly stated in the CASP tool, the quality assessment reviewers discussed its importance and included this question in our assessment of the researcher participant relationship (question 6 under category 1/section A of the CASP tool: has the relationship between researcher and participants been adequately considered?).

Across study quality assessment with GRADE-CERQual

GRADE-CERQual is a framework that allows for a transparent and systematic determining of confidence in review findings across multiple studies. There are four components in the CERQual assessment: methodological limitations, coherence, adequacy, and relevance(185). Methodological limitations examine the design and conduct of the primary studies that contribute to a review finding. Coherence assesses how well the fit is between the data from the primary studies and the synthesis of that data in the review finding. Adequacy of data refers to the richness of the data (including quantity of data) supporting the review finding. And lastly, relevance determines how well the data from the primary studies can be applied to the review question context.

Paper 1, Elements and interactions influencing patient uptake of biomedical facility care for postpartum haemorrhage: A systematic review and synthesis, has 4 outcomes:

1. To identify elements that effect uptake of biomedical services at facility
2. To identify how elements influence uptake of biomedical services at facility
3. To identify interactions between elements, sequence, or conditions for elements
4. To identify the effect upon uptake given interactions, sequence, conditions

GRADE-CERQual was used to assess outcomes 1 and 2 of the review (elements and their effects on uptake). Outcomes 3 and 4 were not included in the CERQual assessment as all interactions collected were singular; there were no multiple studies providing data on any interactions. The elements and their effects on uptake collected in the review were transformed into 20 review findings. Individual quality assessment was done on each single article, for each outcome, which then informed the CERQual review findings. Within single studies when multiple outcomes were present, it was often the case that the majority of outcomes were collected the same way, therefore the individual quality assessment was done on the entire study as it reflected on the quality of the outcomes in the same way. There were three studies where this was not the case and individual quality assessment was done multiple times for different outcome groupings (Osubor, Fatusi, Chiwuzie 2006 (203) , Sikder et al 2011 (100), and Olaniran et al 1997 (200)).

Of the 27 studies include in the review, 17 were qualitative only, one was quantitative only, and nine were a mix of qualitative and quantitative. Quality assessment is done by outcome, and for mixed qualitative and quantitative studies we analysed the study in accord with how our outcomes of interest were collected. In other words, when studies were mixed, quality assessment was conducted on the study type relevant to our outcomes of interest. Given the given lack of reporting in some studies, it was sometimes difficult to tell if a study was qualitative or quantitative, so we did quality assessment for both study types (qualitative and quantitative). This resulted in lower confidence in the outcomes as studies could not be adequately assessed for quality due to this lack of reporting.

The summary of qualitative findings (SoQF) table for CERQual is presented in Paper 1. The SoQF table was informed by the evidence profile table, which provides the details of how the assessment of confidence was determined for each of the review findings. The full evidence profile can be found in Appendix G and an example of the evidence profile can be found in Table 12 below.

Table 12: GRADE-CERQual Evidence Profile, example of a review finding

Summary of review finding	Studies contributing to review finding	Methodological limitations	Coherence	Adequacy	Relevance	CERQual assessment of confidence in evidence
1. Care Affordable influences uptake of facility based HCS for PPH	1, 2, 4, 5, 6, 8, 10, 13, 19, 20, 21, 24, 27	Moderate. There are 13 studies included in this finding. Of concern is that most studies (8) do not indicate that they have considered the PRR, and 2 studies somewhat, but not adequately, addresses PRR (uses nurses who are familiar with local area as opposed to Dr who may diagnose AND use local language). 7 of the studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is the limited reporting of methodology in 6 studies, no reporting in 1 study, and limited design in 2 studies (elements pre-defined, poor records to identify cases AND rapid ethnography but intervening in cultural practices to get information [not observing] should be called in-depth interviews). In 5 studies there was no reporting on data analysis, and 1 study limited reporting. Of additional importance, 11 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. Directionality of the elements is consistent if viewed in isolation (with other interaction of other elements directionality changes)	Minor. The data for this finding are adequate from 13 studies and extracting 28 elements. 3 studies give enough description to include interactions. 5 studies describe elements with descriptions in the text, 3 give vignettes, and 5 studies provide a list of elements in text or table. All sample sizes are of good size, except one is low with 8 women deaths investigated in 8 families.	Moderate. Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. One major issue of concern is that 11 of the 13 studies for this finding do not give clear results particularly to PPH.	Moderate confidence

HCS: health care services; PPH: postpartum haemorrhage; PRR: participant, researcher relationship; P: participant.

Conclusion of Chapter 5 Additional Results

The additional results found above, and in the appendix, provide the detailed analyses that contributed to the individual and across study quality assessments presented in Paper 1. As quality assessments are subjective judgments, it is important to provide rationale for confidence levels in the evidence. The low-moderate confidence in the published literature is often indicative of a lack of reporting, but nonetheless these results warrant careful consideration as the Uptake Model will be in part informed by this review. In the next chapter of this thesis Paper 2 is presented, which explains the building of the Uptake Model and its results. Within Paper 2 the results of the systematic review are validated by two Nigerian women (key informants), which helps to mitigate the confidence levels determined here in the evidence.

Chapter 6: Paper 2

Constructing a Complex Systems Model: A process model to describe treatment seeking behaviour for postpartum haemorrhage in Nigeria

Introduction

Maternal disorders and complications cause a significant burden worldwide(1), particularly in low and low-middle income countries(2). Nigerians suffer substantially from maternal disorders and complications; in 2015 the country was estimated to have the highest number of maternal deaths in the world (58,000), and globally to have the fourth highest national maternal mortality ratio (814)(2). Postpartum haemorrhage (PPH) is one of the leading causes of maternal deaths(13), and is therefore an integral part of strategies aiming to minimize maternal mortality. A large portion of attention and resources for the improvement of maternal health, and population health, are directed towards biomedical treatment and delivery. For health to be improved through biomedical care patients must seek/accept this care. It is therefore important to understand and support treatment seeking behaviour, as this behaviour is not a simplistic process or an automatic occurrence when biomedical care is available and accessible.

Previous work that describes and examines treatment seeking behaviour for maternal health has helped elucidate a process of treatment seeking behaviour, where multiple elements that influence the uptake of care can be categorized into stages: predominantly through the use of the Three Delays Model (36). Though interactions between elements are noted to occur in various theories and models of health behaviour and maternal health behaviour(36, 46), the details of these interactions are not presented (e.g. they do not explain how interactions occur and the collective impact of interactions on the use of care). If we know interactions are present between elements, then simply identifying elements does not indicate how the elements affect the outcome (uptake of biomedical care), and we may draw erroneous conclusions. Therefore, a next step in advancing this area of research is to consider these interactions in relation to treatment seeking behaviour: in other words, as a next step we can consider the complexity of treatment seeking behaviour. One way to do this is by using complex systems theory.

In complex systems theory, a systems view of a health challenge is taken, that describes nonlinear interactions between “all” elements in the system, and their collective effect(48). A systems view captures a philosophical positioning towards causal examinations, that in order to understand cause, one must view the whole interacting system that the cause operates through (as opposed to a mechanistic positioning where it is possible to understand cause by examining one part of a system composed of distinct parts [actual or assumed])(48). Nonlinear interactions do not have a proportional

relationship between the input(s) and the output, meaning a small input can create a large output, or a large input can create a small output. Nonlinear interactions occur in changing systems, and their effects can be uncertain (outputs are not in ratio to certain inputs, and they therefore do not change in a consistent way [growth of the input does not necessarily mean growth of the output])(48). Uncertainty means that predictability is not possible, however one can make estimates about a system with caveats. A complex systems approach attempts to include 'all' elements within a system, though of course there are limits to our abilities to include all elements, or even conceive of these. Model boundaries help us to focus on, and make sense of the system we are interested in. Therefore 'all' elements means an attempt to be exhaustive by including a wide range of elements relevant within the model boundary that has been created. Using complex systems theory to describe the complexity of treatment seeking behaviour for PPH can potentially provide insight into what interactions occur within the behavioural system, and how these can collectively impact the use of biomedical care. This insight could support effective health and development policy, ultimately improving the wellbeing of women and their families.

The aim of this research is to use complex systems theory to inform the creation of a process model that describes treatment seeking behaviour for PPH in Nigeria, that estimates element interactions and their collective effect upon uptake. After a review of the published literature it was determined that no similar model exists, therefore, a *de novo* model was created. Nigeria was selected as an illustrative example for the model due to the high mortality of PPH in the country, and the size and diversity of the population. The diversity and size of the population allows for a larger number of elements and variation to be included in the model: this is beneficial because it increases the possibility to see patterns across the elements and interactions.

Methods

A complex systems theory approach was used to create a *de novo* process model to describe treatment seeking behaviour for PPH after a home birth in present day Nigeria. The majority of births take place at home in Nigeria(169), and seeking effective treatment after a home birth is a main challenge to supporting survival from PPH. The model follows individual women with PPH through the process of treatment uptake of biomedical and/or other (traditional) care. Family members and community members may contribute to a woman's decision to seek care, or they may take decisions for her (due to her physical incapacity and/or due to cultural decision-making rules), therefore an individual woman in the model can represent a group of decision makers. Biomedical and other care are not always distinct from one another and may be practiced together. In this model biomedical care refers to facilities that can offer 'active management of the third stage of

labour' (AMTSL), a collection of treatment and procedures that require biomedical obstetricians and supplies that can be offered in facility and hospital settings(12). It is assumed that AMTSL is the only effective treatment for PPH, due to recommendations by the World Health Organisation(12). In the model, "other care" is care sought outside the home that is predominantly not biomedical, sometimes called traditional care: AMTSL cannot be provided in a traditional/other care setting. Additionally, the model represents actual PPH, not possible PPH. This is an important distinction because whether PPH is actual or not, affects the process of treatment seeking (e.g. when bleeding stops the process of care seeking may end before treatment; choices relating to treatment seeking will be influenced by the severity of bleeding and whether it increases).

The main outcomes of the model are the description of the process a woman with PPH takes towards recovery (or death) and how influential elements and interactions affect this process. Included in the model outcomes are the possible effects of collections of element interactions at each stage, driving elements in stages and across the process, and information about how movement occurs through the process.

There were four main steps in creating the process model: identification of elements and interactions, creating the stages, placing elements into stages, and estimating interactions within the stages. In creating a new systems model, the characteristics of complex systems theory that are of interest to model are first collected and considered, then they are used to create the structure of the model. These characteristics include: 'all' elements influencing the use of treatment for PPH, nonlinear interactions, variation and uncertainty. In a complex systems model, inputs and structure are not strictly distinct from each other, as the inputs (elements and interactions) inform the structure of the model. This is particularly the case in creating a new complex systems process model, as no existing structure capturing complexity in treatment seeking for maternal complications is available to build from or input into.

Four steps in creating the process model

Step 1: Identification of elements and interactions

Elements and interactions were identified through a systematic literature review and validated with Nigerian women (key informants). A systematic review was conducted to collect elements that influence the uptake of biomedical and traditional/other treatment for PPH. Interactions were also collected in the review and their effect on uptake. A systematic review provides a stronger evidence base for the model as opposed to a single study, as it summarized the entire body of evidence on elements that influence the use of care for PPH. On 22nd September 2017 two databases were searched

(PubMed and Web of Science) and the search was not limited by year or geographic location. The search was limited to publications in the English language. Articles were screened in two stages (title and abstract, then full-text) by two independent reviewers. Results were extracted by one reviewer and verified by a second reviewer. Thematic coding of results was conducted independently by two reviewers and finalized by the author (MG). Quality assessment was conducted by two independent reviewers for single studies and across studies. Single study assessment of qualitative studies were assessed with the Critical Appraisal Skills Program (CASP) Qualitative Checklist(179), and quantitative studies with Newcastle Ottawa Scale (NOS)(180). GRADE-CERQual was used to assess the strength of evidence for the extracted outcomes across studies(185). Further details on the methods of systematic review have been published elsewhere(214).

The review results were validated with Nigerian women during a meeting in London UK. These two key informants were Nigerian women of childbearing age (18-45 years) who had lived in Nigeria for at least six months in the past five years. It is common to validate modelling inputs with a small number of experts in the phenomenon the model represents. Nigerian women of childbearing age have the most expertise about treatment seeking behaviour for complications in childbirth in Nigeria, and as a result they were invited to a three-hour workshop on 21st August 2018 to validate the systematic review results and to give additional insight into the process of treatment seeking. Consent was obtained before the beginning of the workshop and subsequently the purpose of the research was presented. Discussion was prompted with questions, and free-listing was also used to gather data on elements and interactions. Details of the systematic review results were not presented to participants, so as to not lead their responses. The workshop was audio-recorded and photographs were taken as there was also a public engagement component after the interviews and discussion where women designed textiles in response to the discussions. Ethics approval for this research was approved by the London School of Hygiene and Tropical Medicine, Observational/Interventions Research Ethics Committee, on 11th July 2018: LSHTM Ethics Reference 14532.

Women were asked two questions in the interviews: Why go to doctor? Why not go to doctor? Answers were captured on poster paper so that the women could see their answers written down, and recorded with an audio device (iPhone). Elements were thematically sorted and designated into subcategories. Where possible the subcategories used in the systematic review sorting were used. Results from the systematic review and the discussions with key informants were combined into element categories and subcategories, generating a unique list. Interactions were listed and described.

The next three steps in creating the process model were conducted simultaneously as refinement of the model was ongoing.

Step 2: Creating the stages and movement between stages

The stages included in the model were determined after consideration of all the different events, decisions, and actions that occurred in relation to the elements identified in the previous step. Determining which events and decisions were related to elements was informed by the contextual descriptions provided from the evidence sources (peer-reviewed literature from the systematic review and expert opinion from the key informants). Stages from pre-existing models and theories of treatment seeking behaviour were deliberately not used in order to let a comprehensive evidence base inform which stages to include in the model. If the stages were determined first, and the elements and interactions placed within these, then important stages may have been overlooked and excluded from the model.

Movement through the process of treatment seeking behaviour is known to be indirect and not always sequential, meaning that women can move to previous stages in the model depending on what occurs during a stage and what the outcome of the stage is. Multiple pathways between the model stages were built to reflect the variation in the evidence and allowed for possible outcomes at each stage.

Step 3: Placing elements into stages

Elements were placed into stages based on how they were presented in the systematic review evidence and the key informant discussions, which resulted in some elements being placed in multiple stages. There were also instances where elements were placed into additional stages based upon the author's knowledge of behaviour. Asterisks (*) have been placed beside elements in the results where this was done.

Step 4: Estimating interactions and effects within the stages

Interactions between elements were informed by the evidence collected on interactions from the systematic review and from the key informants. The evidence informed interactions between two to three elements. Therefore, assumptions were made to

estimate possible interactions with greater than four elements in each stage. These assumptions were based on author knowledge of behaviour and literature.

Results

Identification of elements and interactions

The systematic literature review search identified 1429 articles, and after the removal of 20 duplicates, 1409 articles were reviewed in first level screening (title and abstract). In second level screening the full-text of 76 articles were reviewed, which resulted in the inclusion of 27 articles. Of the 27 included articles, nine were qualitative, five were quantitative, 12 were both qualitative and quantitative, and one was a literature review presented with a qualitative study. The majority of included studies were conducted in sub-Saharan Africa (15, 56%), followed by South Asia (7, 26%), East Asia and the Pacific (3, 11%), and Latin America (2, 7%). Of the sub-Sharan African studies, eight were conducted on Nigerian populations. From the 27 articles, 233 elements were extracted, and elements were sorted into 20 thematic categories, and 34 subcategories. Full results of the systematic review are published elsewhere(214).

Key informants included two women who attended the workshop who had lived and worked in five states (Lagos, Enugu, Federal Capital Territory, Kaduna, Kano) and were born in Abia and Edo. Data collected were thematically sorted into 13 thematic categories, and 15 subcategories.

Subcategories were designated as single elements, and often represent multiple elements that are assumed to have the same meaning. When a category included no subcategories, it was also designed as a single element. In total this results in 41 elements identified from the thematic sorting of the systematic review and key informant interview results. The key informants validated the presence and direction of 10 elements collected from the systematic review, and contributed opposite directionality for four elements: ‘can afford care’, 'cannot afford care’, ‘socially not connected’ and ‘care not available’. The key informants contributed nine additional elements to the final list. Combined, the systematic review and key informants identified 16 elements that can be both supportive or in opposition (multi-directional) to biomedical care uptake. Please see Table 1 below.

Table 1: Systematic review and key informant interviews elements and direction (effect)

Element #	Element Name	Support		Oppose		Multi Directional
		SR	KI	SR	KI	
1	Valuation of women (low)			x	x	
2	Birth traditions	CA		x		x
3	Religion, fate, faith		CA		x	x
4	Supernatural cause/Biological cause	x/		/x		
5	Community expectations about uptake		x		x	x
6	Social cohesion (cooperate)		x		x	x
7	Control of women (mother in law makes decision)		x		x	x
8	Control of women (male to accompany or permission)	x	x	x	x	x
9	Perception about female strength	x		x	x	x
10	Status, reputation, fashionable, wealthy		x			
11	Status, reputation, reference for BM/Other		x/		/x	
12	Status, reputation, female strength				x	
13	Blood perceived dangerous			x		
~~14~~	~~Control of women, fine for giving birth at home~~			~~x~~		
15	Socially connected (A)/Socially not connected	A/	/x	/x		x
16	Quality, effect, BM, Other	x	x	x	x	x
17	Comfortable with procedures	x				
18	Fear of procedures (to BM)			x		
19	Fear of BM location			x		
20	Protected (place)	x		x		x
21	Relationship HCW (good)	X				
22	Relationship TBA, MW (good)			x		
23	No one trusts care: BM				x	
24	Quality and effect general (recommendations references) BM, Other	x	x	x	x	x
25	Where to seek care (not knowing)			x		
26	Desperate, no other option		x			
27	Night, no staff at night			x		
28	Care available/Care not available		x/x	/x	x/x	x
29	Unable to access BM			x		
30	Have a referral (between levels of care)/No referral	x/		/x		
31	Delay in bureaucratic process			x		
32	Can afford care	x	x		x	x
33	Cannot afford care		x	x	x	x
34	Transportation unaffordable			x		
35	Lack of confidence to arrange travel			x		

36	Physical barriers, remote, environment, distance			x	x	
37	Transportation not reliable, not functioning			x		
38	Transportation unavailable			x		
39	Night, do not want to travel at night			x		
40	Planned/Not planned, communicated to access care	x/		/x		
41	Increasing severity	A		x		x
42	What quality effect BM provides	A		A		x

SR: systematic review, KI: key informant, A: assumption from the systematic review. These elements and effects were not explicitly named as elements and/or effects, but from reading descriptive results and discussions these elements and effects were presented, CA: complete assumption. These effects are not based on the evidence gathered in the SR or KI, but it was assumed that these are occurring; Some elements have been combined into one element, designated by a "/" between element names. Where evidence of effect is from different parts of the element, designated by x/ or /x these are not considered multi-directional elements, unless effect from the same part of the element are present in both support and oppose columns. Element number 14 in the table was removed due to the fine causing no effect.

Interactions

22 interactions were collected from the systematic review and the key informants: 12 from the systematic review, and 10 from the key informants. No duplicate interactions were collected. Please see Table 2 for the interactions collected.

Table 2: Interactions collected from systematic review and key informants

Interaction Number	Element	Element	Element	Collective Effect on Uptake	Source
1	Recognize complication *Recognition of PPH*	Far away facility *Physical barriers, remote, environment, distance*		Oppose	Kalim 2009(195), SR
2	Recognize complication *Recognition of PPH*	No male to accompany *Control of women (male to accompany or permission)*		Oppose	Kalim 2009, SR
3	Recognize complication *Recognition of PPH*	Difficult to arrange transportation at night *Transportation unavailable*		Oppose	Kalim 2009, SR
4	Improve quality of services *Quality and effect general (recommendations references) BM, Other*	Would seek money to pay for services *Cannot afford care*		Support	Osubor 2006(203), SR
5	Poor quality of services (government hospital crowded unable to handle complicated cases)	Would pay for services *Can afford care*	Government hospital cheaper than private clinic *Cannot afford care*	Support	Sikder 2011(100), SR

	Quality and effect general (recommendations references) BM, Other				
6	Woman can no longer endure pain, informs family of complication *Recognition of PPH*	Relatives decide when and where to seek care *Control of women (mother in law makes decision)— Control of women (male to accompany or permission)— Perception about female strength*		Support/oppose (Depends on what relatives decide)	Sikder 2011, SR
7	Woman keeps money for birth expenses *Can afford care*	Husband used the money to buy food *Control of women (male to accompany or permission)*		Oppose	Sikder 2011, SR
8	Woman's condition became dire *Increasing severity*	Had exhausted options of non-certified treatment providers *Desperate, no other option*		Support	Sikder 2011, SR
9	Labour being late at night *Night, do not want to travel at night*	Lacked means of getting to hospital *Transportation unavailable— Transportation unaffordable*		Oppose	Ashimi 2015(186), SR
10	System of savings in place for birth expenses *Can afford care*	Distrust of the savings system *No one trusts care: BM*		Oppose	Belton 2014(187), SR
11	(Monetary) fine for giving birth at home *Control of women*	Rarely enforced		Oppose	Belton 2014, SR
12	Certainty in contemporary medicine *Quality and effect general (recommendations references) BM*	Desire for painful labour *Status, reputation, female strength*	Belief that uterotonics injection raises pain *Quality and effect general (recommendations references) BM*	Support	Mirzabagi 2013(198), SR
13	(Biomedical) location far *Physical barriers, remote, environment, distance*	No good roads *Physical barriers, remote, environment, distance*		Oppose	Key Informants 2018
14	Education (women educated and decision makers educated)	Lack of empowerment *Control of women— Valuation of women (low)*	No valuation of women (by husband who has decision making power) *Control of women—Valuation of women (low)*	Oppose	Key Informants 2018
15	Education (women are educated)	(social cohesion) Desire to keep peace with mother in law		Support or Oppose (Depends upon choice of	Key Informants 2018

		(will follow her decision) *Social cohesion (cooperate)*		mother in law not necessarily education attainment)	
16	Cost *Can afford care*	Difficult Logistics of moving woman *Physical barriers, remote, environment, distance — Transportation*		Oppose	Key Informants 2018
17	Availability of care *Care available/Care not available*	Time to access care *Increasing severity—Physical barriers, remote, environment, distance*	Type of care does not matter (traditional or biomedical)	Support or Oppose (In some case depends upon availability and access not care type)	Key Informants 2018
18	Reference what others did 1	Reference what others did 2	Reference what others did 3…	Support or Oppose (know many stories of others, these are used in decision about care)	Key Informants 2018
19	Already have children (can identify problem) *Recognition of PPH*	Want to be alive to care for children, do not think husband will care for children *Increasing severity—Valuation of women (low)—agency*	Lack social connection *Socially not connected*	Support	Key Informants 2018
20	Individual thoughts *Valuation of women (low)—agency*	Opinions of the community *Control of women—Social cohesion (cooperate)—Community expectations about uptake*		Support or Oppose (The community opinion is more important in some cases)	Key Informants 2018
21	Biomedical diagnosis of risky birth (complication) *Quality, effect, BM*	Religious (fate, faith)	Educated abroad (woman and her mother)	Oppose	Key Informants 2018
22	Know what to do in a system that works (e.g. England) *Where to seek care*	Nothing works in Nigeria *Quality and effect general (recommendations references) BM*		Oppose	Key Informants 2018

In italics: the name of the stage, element, or category (sub-stage) of elements in the model.

Quality Assessment

The GRADE-CERQual quality assessment of the included elements judged 13 review findings from qualitative studies to be of low quality and 7 review findings from qualitative studies to be of moderate quality(214). These judgements were mainly due to lack of reporting or consideration of the participant and researcher relationship, lack of reporting or low quality of study design and/or analysis, and lack of ethics and consent attainment.

The four included quantitative studies that contributed to review elements, were judged to have bias that lowered confidence in the results, mainly as elements were proposed to participants, thereby limiting possible responses. Details of the quality assessment of the systematic review are reported elsewhere (214). Validation with the key informants increased confidence in the elements and directionality, and also that interactions are present (due to interactions captured and possibly the additional multi-directionality captured on element effect).

Creating the stages and progression between stages

Six stages were determined to be present in the process model, including: recognition of PPH, decision to act, how to act, arrange travel, travel, and result of care (Figure 1). After stage three the model splits into two pathways, to follow 'other' or biomedical care seeking (see Figure 2).

Figure 1: The six stages of the process of care seeking for PPH.

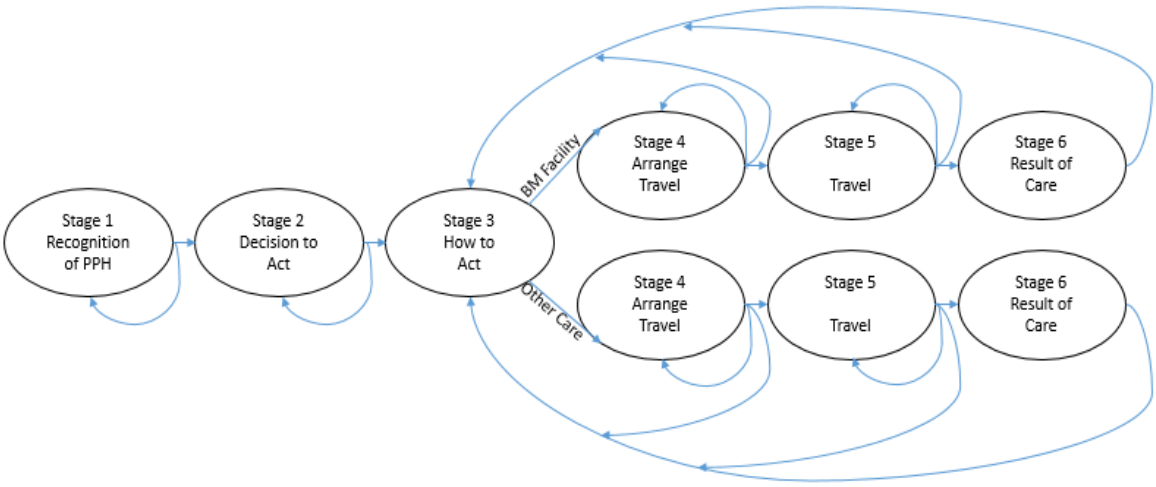

Figure 2: Model stages and movement through the model.

The process model begins with the possible recognition of PPH at a home birth and is complete upon arrival at a biomedical treatment location where PPH is effectively treated. Women can also die before effective treatment and exit the model due to this at any stage. Effective treatment is a natural ending for the process of treatment uptake, as it is possible that care at the first treatment location is inappropriate or inadequate and therefore may result in the continued seeking of care. Considering the aims of a complex systems process model it is essential to have stages that represent all important and distinct decisions and actions, as grouping these together will not allow for clear exploration of interactions within the stages. The stages chosen have within them distinct relationships and interactions that allow a person to move, or not move, through the stage, and therefore provide important insight into what influences uptake through the process (see estimating interactions within the stages below for these details).

It was decided to begin the model with the recognition of a stage-three haemorrhage, instead of when the complication begins. This is because when blood loss occurs at an emergency level in the earlier haemorrhage stages, it is difficult to visually estimate blood loss (215) and therefore differentiate between normal and abnormal postpartum bleeding, furthermore the blood may not show as it can pool in the uterus (216). The third stage of haemorrhage is when a loss of vital signs occurs(182); where family/community members would be able to identify an emergency bleed.

The recognition of the complication by women and others (her decision group), were placed into one stage, because they involve the same decision. It is possible that the woman and her decision group come to different conclusions about what is a life-threatening emergency, and movement forward could be due to the woman's independent assessment which is counter to the group's, or vice versa, however there was not enough evidence collected to describe this dynamic therefore the two decisions were placed under one stage.

As this model describes how care is sought when one believes PPH is present (or an emergency bleed during childbirth) confirmation of PPH does change the entrance of a person into the model. Additionally, given the assumption that entrance to the model is during a stage-three haemorrhage, it is reasonable to assume that PPH or another life-threatening disorder or complication is present. In the first stage, a woman (and her care decision group) can either stay in the stage or continue onto stage 2.

The second stage of the model is important to differentiate from stage one and stage three. Stage two reflects instances where PPH is recognized as life-threatening, but care

is deliberately not sought due to judgement of women's behaviour by her decision-making group and the community. It is important to state that this model includes women who give birth while others people are present and that it is possible in communities displaying control over a woman's movement, ideas about guarding modesty during birth, and severe consequences for behavioural judgments of women about conception, that women may be segregated from the community during childbirth, and therefore in the case of birth complications a woman can die on her own(187, 217). In stage two, if the decision not to act is taken, then a woman rests in this stage and dies from exsanguination. Otherwise, a woman will continue onto stage three.

Stage three, 'how to act' represents the decision made to either seek other care or biomedical care for PPH. It is assumed here that care is sought outside of the community, though evidence shows that care can be brought to the place of birth (midwife, non-biomedical healer) and that phone calls are made from home for remote healing by a spiritual leader (key informants and Belton, Myers and Ngana 2014 (187)). It was decided to not include this 'home care' in the model and to focus on the process of moving to biomedical care or other care. In future work this can be added and explored in a care seeking model, as it describes an important aspect of how care is sought. Additionally, home care is not a successful option for treating severe PPH as blood products are essential to the management of PPH (218).

After stage three, the model splits into two distinct pathways reflecting the seeking of other care or biomedical care. This split reflects how the remaining stages (4-6) typically have distinct differences in relation to the different types of care sought (e.g. biomedical care is often a longer and more expensive journey compared to other care and recovery is only possible with the arrival at a biomedical facility that provides appropriate care).

The fourth stage reflects the arrangement of travel to the care option chosen. The first four stages can occur simultaneously. Stages are presented as separate to each other for clarity in describing how the different elements and interactions affect the different stages. Women can stay in stage four (either die waiting to arrange travel or wait for travel to be arranged), or they can loop back to re-enter the model in stage three where a different care decision is taken due to inability to arrange travel to preferred care, or they can move forward to stage five.

Stage five, 'travel' represents the physical journey to seek care. Over time, a woman stays in stage five (die while traveling), or she can loop back re-enter into stage three where a different care decision is taken due to failed journey, or she can move forward to stage six.

Stage six is the result of care. In this stage a woman has arrived at care, but it is not certain that the arrival will result in effective care received, even if biomedical care is sought. If care in unsuccessful during this stage, the woman with either die, or re-enter the model in stage three.

Placing elements into stages & estimating interactions and effect within the stages

Results for the placement of elements into stages and estimating the interactions and effect within the stages are presented alongside each other. This is for ease of comprehension, particularly as some stages have numerous elements. For each stage a table of included elements is presented. These six tables below (Tables 3-8) present the placement of elements into stages, the direction of effect the element has on uptake, and how this relates to the presence or absence of the element. Tables also indicate the number assigned to each element; these were assigned for clarity when referring to named elements in figures of interactions. Where there was evidence on presence of an element but not absence of the element, it was not assumed that effect of absence was the opposite of the effect of presence. When this was the case, that no data was available for the opposite, the effect was recorded as a point in parentheses '.' . Within each of the six stages, elements interact with each other and effect the movement a woman may make through the stage and through the process. Below each table of elements in a stage, is a figure (or figures) presenting the interactions in the stage and their effects. These are followed by a written description of the elements, interactions and effects in each stage. The elements presented below are those collected from the systematic review and key informants; though they are an attempt to be exhaustive they are not, therefore there are other influential elements that have not been included in this model.

Stage One: Recognition of PPH

Table 3: Elements in Stage One

#	Element Name	Moved*	Effect on Biomedical Uptake When Element is	
			Present	Absent
1	Valuation of women (low)		Oppose	.
2	Birth traditions	*	Support/Oppose	NA
3	Religion, fate, faith		Support/Oppose	.
4	Supernatural cause, Biological cause		Oppose (Supernatural cause) Support (Biological cause)	NA
5	Community expectations about uptake		Support/Oppose	NA
6	Social cohesion (cooperate)		Support/Oppose	NA
9	Perception about female strength		Support/Oppose	.
41	Increasing severity		Support	NA

* : Moved column indicates when an element has been placed in this stage due to Author's knowledge, '.' : no evidence, Support/Oppose: the evidence shows that effect can either support or oppose uptake, NA : not applicable, this element cannot be absent.

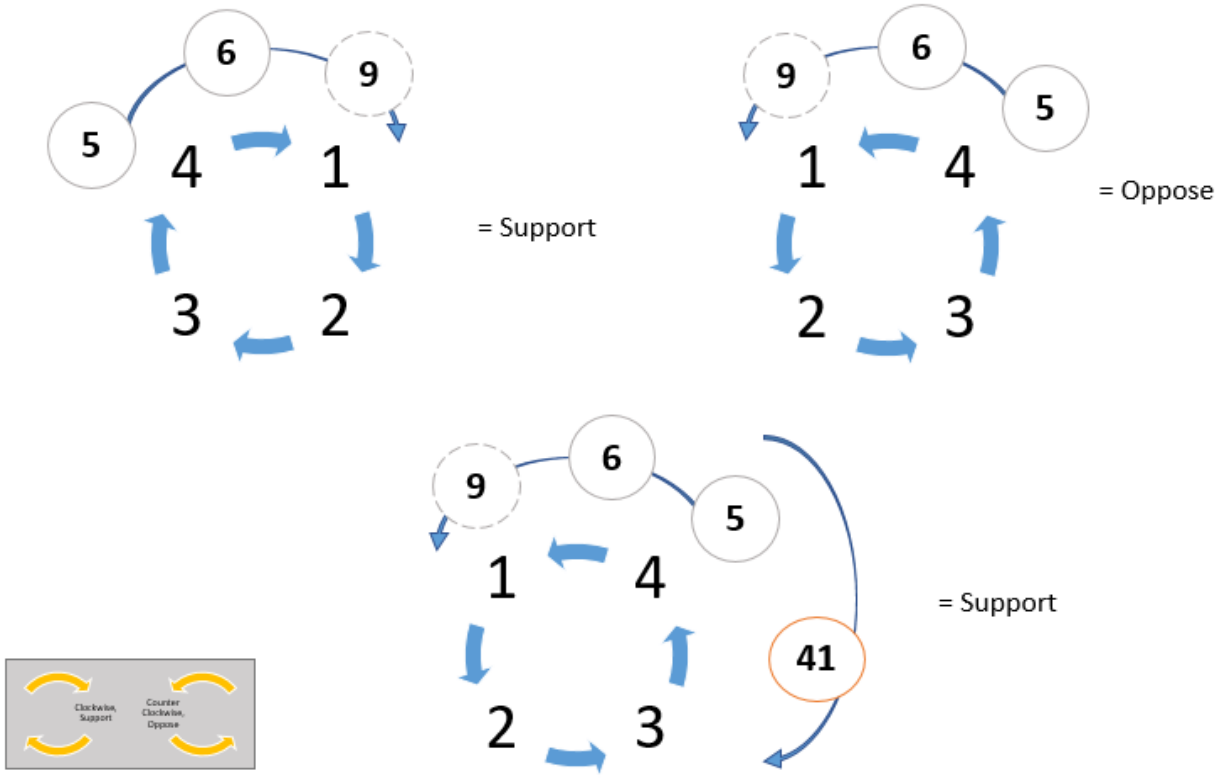

Figure 3: Interactions of elements in Stage One.

In stage one, eight elements interact to support or oppose the recognition of a life-threatening postpartum bleed. And though the figure 3 above indicates that typically elements are collectively moving in the same direction, it is important to note that elements may not collectively move in one direction: elements may be lessening their direction or reversing their direction allowing for a mix of element directions. Therefore, there is no certain outcome of the stage, but either support (likely to recognize a life-threatening postpartum bleed) or oppose (not likely to recognize a life-threatening postpartum bleed).

The model begins with women in a stage three haemorrhage (i.e. loss of vital signs). Whether this stage is completed depends upon beliefs about childbirth: birth traditions which are informed by religion and cause, beliefs about pain, female strength, and severity of the bleed. Low valuation of women can be reflected in religion, and religion can inform low valuation of women. The occurrence of PPH recognition (or the absence of PPH recognition), is also determined by community expectations and social cohesion, as people can follow birth traditions in accordance with community expectations, and also due to desire for prosperity through cooperation with community.

Four of these elements cluster together (birth traditions, religion, cause, and low valuation of women) interact with each other, and produce feedback. This means that each element can inform every other element, and in this way, they are not entirely separate elements. These four elements are the 'core elements' of this stage, as their collective direction can inform the direction of the remaining elements; community expectations and social cohesion likely follow the direction of core elements, as well as perception of female strength. It is unlikely that these three elements would follow a different direction than the core. Over the course of an individual woman's haemorrhage timeline, the severity of the bleed can increase, and may alter the outcome of the stage, thereby nullifying the effect of the other elements if they are in opposition to recognition.

These elements included in this stage are not the only elements that contribute to PPH recognition, they are only those collected in this research, there are certainly others. Additionally, the element directionality collected from the evidence is likely not the only possible directionality. For example, low value placed on women is shown to oppose uptake in the evidence, but it is probable that low value placed on women could support uptake, for example if a high value was placed on producing children. Given the interactions between elements and the absence of potentially important elements, change towards recognition in this stage is unlikely to occur with a change to only one element, unless all other elements are already in support of recognition. The exception to this is severity increase over a woman's individual time in the model. Due to the interactions, change in one element may begin to create slow change over time in other elements.

Stage Two 'Decide to Act'

Table 4: Elements in Stage Two

#	Element Name	Moved*	Effect on Biomedical Uptake when element is	
			Present	Absent
1	Valuation of women (low)		Oppose	.
2	Birth traditions	*	Support/Oppose	NA
3	Religion, fate, faith		Support/Oppose	.
4	Supernatural cause, Biological cause		Oppose (Supernatural cause) Support (Biological cause)	NA
5	Community expectations about uptake		Support/Oppose	NA
6	Social cohesion (cooperate)		Support/Oppose	NA
7	Control of women (mother in law makes decision)		Support/Oppose	.
8	Control of women (male to accompany or permission)		Support/Oppose	.

* : Moved column indicates when an element has been placed in this stage due to Author's knowledge, '.' : no evidence, Support/Oppose: the evidence shows that effect can either support or oppose uptake, NA : not applicable, this element cannot be absent.

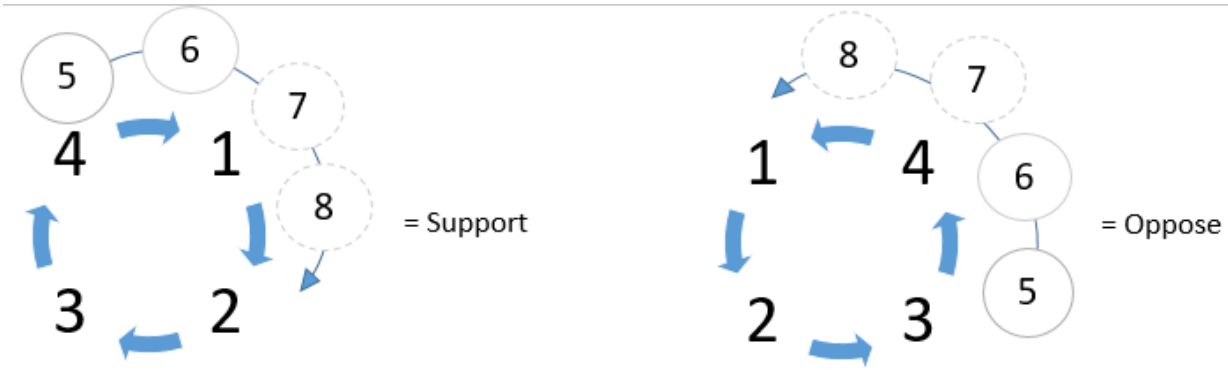

Figure 4: Interactions of elements in Stage Two.

In stage two, eight elements interact to support or oppose the decision to act upon the recognition of a life-threatening bleed. The result of the stage can be either ‘more likely’ or ‘less likely’ to decide to act to treat a life-threatening bleed.

This stage includes six elements in the previous stage, plus two additional elements. The ‘core elements’ (elements 1-4) are the same as Stage 1, with four elements reflecting the core (elements 5-8). Whether this stage is completed (decision to act taken to seek care for life-threatening bleed) depends upon the valuation of a woman's life, and ideas about what is necessary care after birth. There is evidence that when a woman is considered to have behaved inappropriately (pregnant without marriage, disobeying husband), it is determined that bleeding is necessary to absolve the women and therefore it is decided that care should not be given(187). If this is the case, then all other elements would support this judgement.

Change in this stage is not likely to occur within the experience of a single woman moving through the process model, as this stage is driven by a judgment on a woman’s behaviour. In other words, if a woman enters this stage and is judged to have behaved inappropriately, this judgment will not change as a woman’s health deteriorates. This is evidenced in the systematic review. To change the direction of this stage, changes in cultural beliefs about appropriate behaviour and the consequences of this would need to change.

Stage Three ‘How to Act’

Table 5: Elements in Stage Three

#	Element Name	Moved*	Effect on Biomedical Uptake When Element is	
			Present	Absent
1	Valuation of women (low)		Oppose	.
2	Birth traditions		Support/Oppose	NA
3	Religion, fate, faith		Support/Oppose	.
4	Supernatural cause, Biological cause		Oppose (Supernatural cause) Support (Biological cause)	NA
5	Community expectations about uptake		Support/Oppose	NA
6	Social cohesion (cooperate)		Support/Oppose	NA
7	Control of women (mother in law makes decision)		Support/Oppose	.
8	Control of women (male to accompany or permission)		Support/Oppose	.
9	Perception about female strength		Support/Oppose	.
10	Status, reputation, fashionable, wealthy		Support	.
11	Status, reputation, reference for BM, Other		Support (Ref for BM) Oppose (Ref for Other)	.
12	Status, reputation, female strength		Oppose	.
13	Blood perceived dangerous		Oppose	.
15	Socially connected/Socially not connected		Support (Socially Connected)	Support/Oppose (Socially not connected)
16	Quality, effect, BM, Other		Support (Q BM) Oppose (Q Other)	.
17	Comfortable with procedures		Support	.
18	Fear of procedures (to BM)		Oppose	.
19	Fear of BM location		Oppose	.
20	Protected (place)		Support/Oppose	.
21	Relationship HCW (good)		Support	.
22	Relationship TBA, MW (good)		Oppose	.
23	No one trusts care: BM		Oppose	.
24	Quality and effect general (recommendations references) BM, Other		Support/Oppose (BM recommendations references) Support/Oppose (Other recommendations references)	.
25	Where to seek care (not knowing)		Oppose	.
26	Desperate, no other option		Support	.
27	Night, no staff at night		Oppose	.

28	Care available/Care not available	*	Support/Oppose (Care available)	Support/Oppose (Care not available)
29	Unable to access BM		Oppose	.
30	Have a referral (between levels of care)/ No referral		Support (Have a referral)	Oppose (No referral)
31	Delay in bureaucratic process		Oppose	.
32	Can afford care		Support/Oppose	.
33	Cannot afford care		Support/Oppose	.
34	Transportation unaffordable		Oppose	.
35	Lack of confidence to arrange travel	*	Oppose	.
36	Physical barriers, remote, environment, distance	*	Oppose	.
37	Transportation not reliable, not functioning		Oppose	.
38	Transportation unavailable		Oppose	.
39	Night, do not want to travel at night		Oppose	.

* : Moved column indicates when an element has been placed in this stage due to Author's knowledge, '.' : no evidence, Support/Oppose: the evidence shows that effect can either support or oppose uptake, NA: not applicable, this element cannot be absent, BM: Biomedical, Ref: reference, Q: quality, HCW: health care worker, TBA: traditional birth attendant, MW: midwife.

In stage three, 38 elements interact to support and/or oppose the choice of seeking biomedical care for treatment of PPH, as opposed to choosing to seek other care (sometimes called traditional care). The and/or distinction is important, as elements interacting may not always collectively move in one direction (support/oppose). The result of the stage can be either 'seek biomedical care' or 'seek other care' to treat a life-threatening bleed from childbirth.

This stage explanation differs from the format of the previous two stages due to the large number of elements included in this stage. Elements have been categorized into three categories to communicate clearly how interactions occur given the large number of elements in stage three. The grouping of elements into categories can be somewhat misleading, as elements in one category can inform elements in another category: they are placed into categories for ease of comprehension. Where elements overlap is described below. The three categories include: Availability, Accessibility, and Behavioural Expectations and Ideas. The Behavioural Expectations category has been further divided into three subcategories including: related to care, related to power and control, and related to social survival (that impacts physical survival). Interactions are described within and between each category and subcategory, and the effects on the stage outcomes are estimated from these collective interactions.

The result of stage three (biomedical care or other care chosen), depends upon the results of three element groupings: Availability, Accessibility, and Behavioural

Expectations and Ideas. If any category is not 'Support', then 'Oppose' is the result of the stage (i.e. other care chosen).

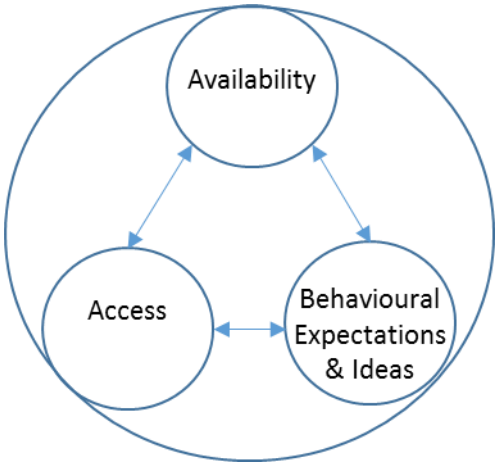

Figure 5: Interactions of categories in Stage Three.

Category Availability

There are two elements that have been categorized under availability: one, physical barriers, remote, environment, distance (distance to biomedical care) and two, night, no staff at night (time of day). Defining availability of a biomedical health facility encompasses more than a facility being 'of use to a person', it also includes the location of care (is the facility within an acceptable distance to a person so that it is considered available to them). The distance that one is willing/able to travel to obtain care, is also informed by access elements. Therefore, the category of Access interacts with the category of Availability. When the two availability elements are satisfied (acceptable distance and daytime), the category supports biomedical care choice. For 'acceptable distance' to be satisfied, the access elements must also be satisfied (in support of care uptake).

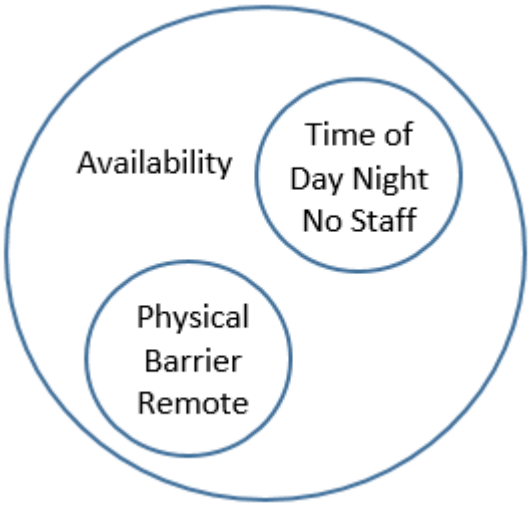

Figure 6: Interactions of elements in availability category, Stage Three.

Category Access

There are 12 elements included in this category, including five elements that do not interact with elements in this category (elements 30 ‘have a referral/no referral’, 31 ‘delay in bureaucratic process’, 36 ‘physical barriers, remote, environment, distance', 37 ‘transportation not reliable, not functioning’, 39 ‘night, do not want to travel at night’). These five elements result from low income, social instability, and lack of development, and in this category, they represent single elements that if present must be supportive for the category to be satisfied (supporting access to biomedical care). Element 15 ‘socially connected/socially not connected’ can interact (strengthen/change) with six elements (25 ‘where to seek care (not knowing)’, 32 ‘can afford care’, 33 ‘cannot afford care’, 34 ‘transportation unaffordable’, 35 ‘lack of confidence to arrange travel', 38 ‘transportation unavailable’).

Affordability of care elements (‘can afford care’, ‘cannot afford care’) can operate in a multi-directional way, where each can support or oppose the uptake of biomedical care. The ability of these elements to be multi-directional can be explained by their interactions with elements within the behavioural expectations and ideas category. For example, if all elements in the access category are in support of biomedical care and ‘can afford care’ is present, then ‘can afford care’ can have an opposing effect on biomedical care uptake if behavioural expectations and ideas elements representing status, quality and trust of care are also in opposition to biomedical care uptake. A similar effect can occur with the affordability element ‘cannot afford care’. It is possible that when ‘cannot afford care’ is present, and all other elements in the access category support uptake (or are

absent), that element 33 can also support uptake. This occurs when element 26 (desperate, no other option) from the behavioural expectations and ideas category interacts with element 33. In this instance the lack of affordability (cannot afford care) can cease to influence/contribute to the access category result, when a behavioural element supports biomedical uptake. Both of these examples demonstrate how behavioural elements can supersede expected effects of affordability and lack of affordability.

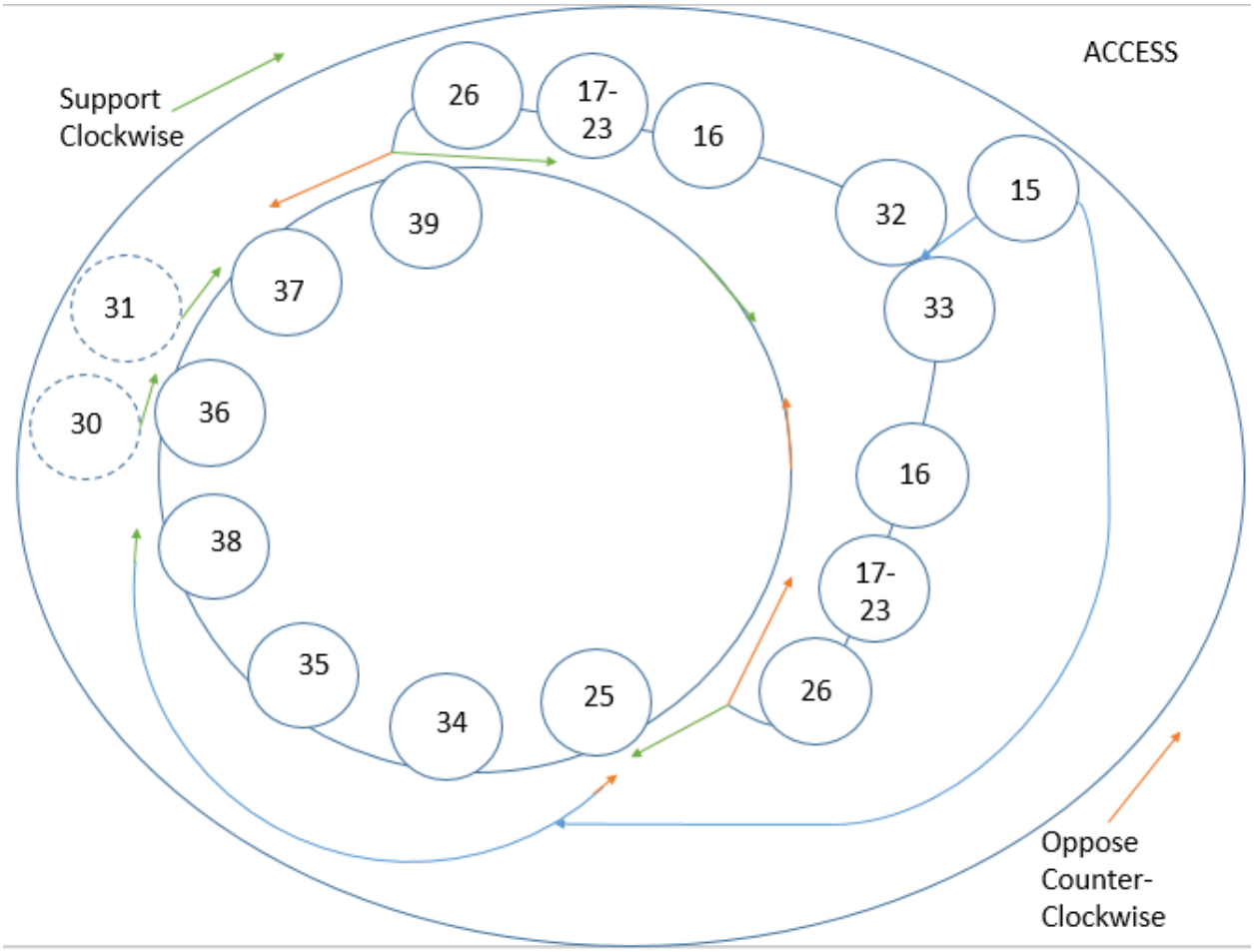

Figure 7: Interactions of elements in access category, Stage Three. Elements 17-23 are behavioural expectations and ideas elements.

Category Behavioural Expectations and Ideas

There are 22 elements in this category, with four elements acting as core elements (2 'birth traditions', 3 'religion, fate, faith', 4 'supernatural cause/biological cause', 16 'quality, effect, BM, Other'). These are core elements because their collective direction can inform the direction of the majority of the elements in this category (the only exception is element 26 'desperate, no other option'). These core elements also inform

each other, and are therefore typically in agreement with each other (have the same effect direction).

In this category elements 9 ‘perception about female strength’ and 13 ‘blood perceived dangerous’ can be considered part of element 2 ‘birth traditions’. Elements 7 ‘control of women (mother in law makes decision)’ and 8 ‘control of women (male to accompany or permission)’, are assumed to be in line with the core elements and supportive of these beliefs and ideas. Element 24 ‘quality and effect general (recommendations references) BM, Other’ is linked to element 16 ‘quality, effect, BM, Other’ and the two may be reflective of each other.

The subcategory of trust elements includes elements 17 ‘comfortable with procedures’, 18 ‘fear of procedures (to BM)’, 19 ‘fear of BM location’, 20 ‘protected (place)', 21 ‘relationship HCW (good)', 22 ‘relationship TBA, MW (good)’, and 23 ‘no one trusts care: BM’. Element 20 ‘protected place’ can be supportive of biomedical or other care. The evidence indicates this depends where a person will have less exposure to people during childbirth (biomedical facility) or where they are safest spiritually (other care), and could be either feels a woman will be protected: this could be home or BM facility depends on beliefs about people near childbirth and where less people will be present. If the core is opposing biomedical care it is possible that one or more of these trust elements is present/absent and opposing biomedical care/supporting other care. If the core is supportive of biomedical care and one of the trust elements is not, then it is possible that biomedical care will not be chosen. Over time if trust lessens it is likely this will be reflected in the core elements and element 24 ‘quality and effect general (recommendations references) BM, Other’.

The subcategory social survival includes five elements: 5 ‘community expectations about uptake’, 6 ‘social cohesion (cooperate)’ 10 'status, reputation, fashionable, wealthy’, 11 ‘status, reputation, reference for BM/Other’, and 12 ‘status, reputation, female strength’. These elements are typically in line with the core elements: if the core is supportive, then these elements are supportive, or if the core is in opposition then these elements are in opposition.

Element 26 ‘desperate, no other option’ can change the entire direction of the core regardless of other elements strengthening the core direction. Element 26 depends upon the category ‘availability’, as desperation cannot change a care choice to biomedical care if no biomedical care is available.

Variation exists within the interactions and relationships above, and therefore at any point these elements may begin to weaken and change direction.

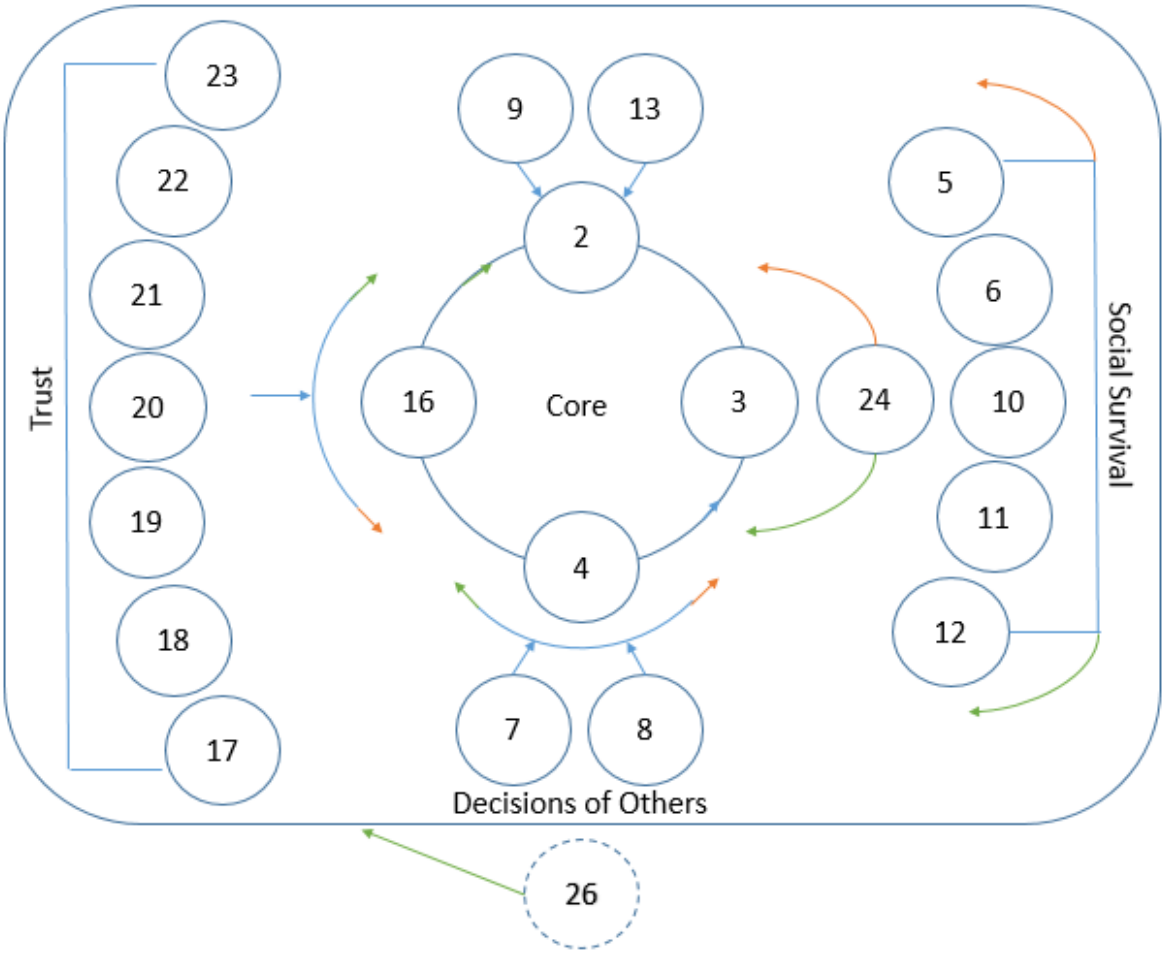

Figure 8: Interactions of elements in behavioural expectations and ideas category, Stage Three.

Stage Three summary

None of these categories or elements are independent of one another, solely influencing uptake, they interact together to produce an effect (categories work together to inform outcome of stage, and elements inform and reinforce each other within, and sometime between, the categories resulting in their support or opposition to biomedical care). Change in this stage can occur with a single element change only if other elements in each category are in support of this change. Understanding the interactions between the elements and categories can help one to see how change may occur in the outcome if a single, or group of elements is targeted for development.

Stage Four ‘Arrange Travel’: Element Interactions

Table 6: Elements in Stage Four

#	Element Name	Moved*	Effect on Biomedical Uptake When Element is	
			Present	Absent
15	Socially connected/Socially not connected		Support (Socially connected)	Support/Oppose (Socially not connected)
25	Where to seek care (not knowing)		Oppose	.
34	Transportation unaffordable		Oppose	.
35	Lack of confidence to arrange travel	*	Oppose	.
36	Physical barriers, remote, environment, distance	*	Oppose	.
37	Transportation not reliable, not functioning		Oppose	.
38	Transportation unavailable		Oppose	.
39	Night, do not want to travel at night		Oppose	.
40	Planned/Not planned, communicated to access care		Support (Planned)	Oppose (Not planned)

* : Moved column indicates when an element has been placed in this stage due to Author’s knowledge, ‘.’ : no evidence, Support/Oppose: the evidence shows that effect can either support or oppose uptake.

In stage four, nine elements interact to support or oppose if a woman/her decision-making group is able to arrange travel to seek biomedical or other care for treatment of PPH. In stage four the model divides into two pathways, one where people move towards biomedical care and one towards other care. Each of these elements influence arranging travel for both types of care, though potentially in different ways.

Whether this stage is completed successfully depends upon all of the nine elements being satisfied (i.e. either the elements are absent meaning they have no effect on arranging travel, or they are supportive of arranging travel). If the stage is not successfully completed, the woman will rest in stage four, or return to stage three and potentially choose another type of care.

All of the elements in this stage are in the previous stage, but can differ in this stage, as what a person supposes/thinks in stage three, can be different from what is actually true in stage four. Also, as time moves forward in this stage elements can change (e.g. day can change to night making previously absent elements present).

The majority of these elements can singularly alter the outcome of the stage. These include elements 25 ‘where to seek care (not knowing)’, 34 ‘transportation unaffordable’, 35 ‘lack of confidence to arrange travel’, 36 ‘physical barriers, remote, environment, distance’, 37 ‘transportation not reliable, not functioning', 38 ‘transportation unavailable’,

39 ‘night, do not want to travel at night’, and 40, ‘planned/Not planned, communicated to access care’. There are also two elements that can alter the other elements: element 15 ‘socially connected/socially not connected’ and element 36 ‘physical barriers, remote, environment, distance’. Element 15 can change some of the other elements (25, 34, 35, 38, 40). Element 36 can interact with (34, 37, 38, 39): if 36 is absent, then (34, 37, 38, 39) may be minimized or also absent. These elements are not the only elements that contribute to one’s ability to arrange travel, they are only those collected in this research.

Given the need in this stage for all elements to be absent or supportive for travel to be arranged successfully, a change in one element would not produce change in the stage unless other elements were in support of this change. Even element 15 ‘socially connected/socially not connected’ could only change the stage if travel at night time was not an issue. Any one element being in opposition to successfully arranging travel (besides social connection) will result in a person being unable to arrange travel. To have more certainty about how to change the result of this stage, one would need to change the majority of the elements in this stage, with recognition that there are other elements not included here that may need to be identified and/or altered to support a different outcome of the stage.

Stage Five ‘Travel’

Table 7: Elements in Stage Five

#	Element Name	Effect on Biomedical Uptake When Element is	
		Present	Absent
36	Physical barriers, remote, environment, distance	Oppose	.
37	Transportation not reliable, not functioning	Oppose	.
41	Increasing severity	Oppose	.

‘.’ : no evidence, Support/Oppose: the evidence shows that effect can either support or oppose uptake.

In stage five, three elements interact to support or oppose if one is able to successfully complete travel to their destination to biomedical or other care. Whether this stage is complete depends on the absence of physical barriers and no issues arising in regards to the reliability of the transportation en route. Physical barriers include flooding, un-passable roadways, and un-passable bridges and other physical infrastructure or terrain disturbing travel. Transportation can become unreliable en route: it can cease to work (e.g. break down) or run away (e.g. if an animal issued to move a woman). Severity as

an influencing element (element 41 'increasing severity') in this stage is likely to increase with time and may result in the journey being stopped as the woman is too ill to continue. This stage is where 'increasing severity' opposes uptake of care, whereas it usually supports uptake of care. During a potential stop in travel, physical barriers may arise and/or transportation can become unreliable. All elements can become present at any point, and at multiple times, during the course of the trip towards care. Failure to complete travel in this stage can result in resting in this stage, or re-entering the process at stage three.

Given the relationship between elements and the exclusion of potentially important elements (e.g. civil unrest or war inhibiting movement through areas), change to this stage is unlikely to occur with a change to only one element identified here. However, if we consider a setting that includes the few elements identified for this stage, then change to one element may contribute greatly to the success of travel. For example, if physical barriers such as remoteness are eliminated, and therefore care is only a very short distance, this changes the type of transportation necessary and may allow for carrying the woman, therefore leading to successful travel.

Stage Six 'Result of Care'

Table 8: Elements in Stage Six

#	Element Name	Moved*	Effect on Biomedical Uptake When Element is	
			Present	Absent
27	Night, no staff at night		Oppose	.
28	Care available/Care not available	*	Support (Care available)	Oppose (Care not available)
30	Have a referral (between levels of care)/ No referral needed		Support (Have a referral)/ No referral needed	Oppose (No referral)
31	Delay in bureaucratic process		Support/Oppose	.
42	What quality effect BM provides		Good quality = Support *(effect on care success, not uptake)*	Poor quality = Oppose *(effect on care success, not uptake)*

* : Moved column indicates when an element has been placed in this stage due to Author's knowledge, '.' : no evidence, Support/Oppose: the evidence shows that effect can either support or oppose uptake.

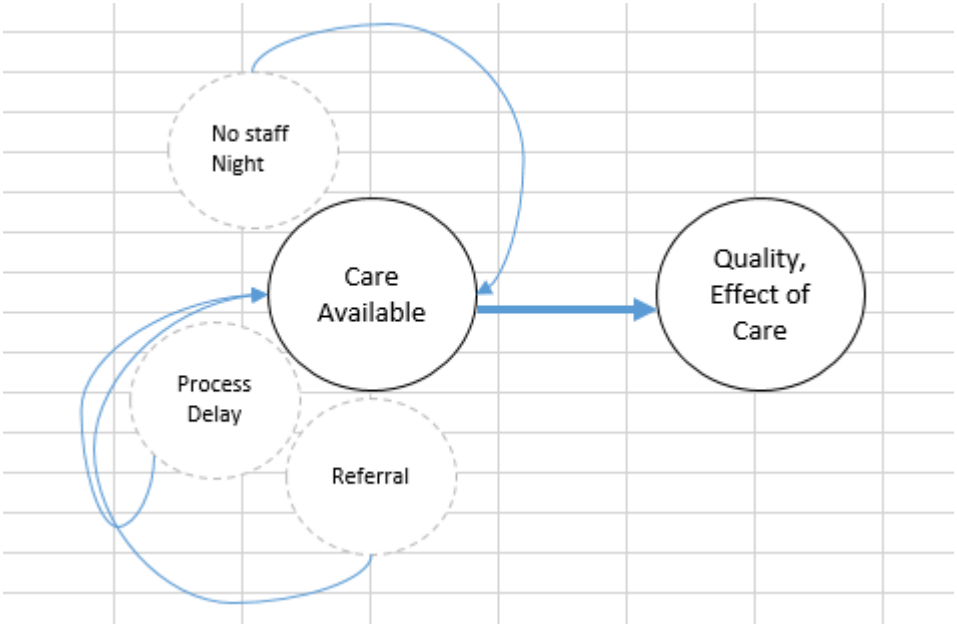

Figure 9: Interactions of elements in Stage Six.

In stage six, five elements interact to result in care being successful or unsuccessful in treating PPH. If care is unsuccessful in this stage, then it results in re-entry to the model, returning women to stage three. Whether this stage is complete (care received successfully treating PPH) depends on the availability of care and then the quality of the care received. There are elements that contribute to the availability of care upon arrival that must be satisfied (supportive or absent) for treatment to occur (elements 27 'night, no staff at night', 30 'have a referral (between levels of care)/no referral', 31 'delay in bureaucratic process'). These elements are related/reflective of care availability, so if one is in opposition to availability, care availability will not occur. Even when care is available, quality of care must be present or the stage will be unsuccessful.

These elements are not the only elements that contribute to successful care, they are only those collected in this research, there are certainly others. The elements collected for this model were about patient uptake, and not about provider side elements and therefore explains the low number of elements included here. The results of care (element 42 'what quality effect BM provides'), is included as an element in this stage as it is pivotal in the care pathway/process: biomedical care is not always successful and may result in re-entry to the model at stage three.

Given the relationship between elements and the exclusion of potentially important elements, change to the outcome of this stage is unlikely to occur with a change to only one element, including effective care. To have more certainty about how to change the results of this stage, one would need to address all elements in this stage, with

recognition that there are others not present that may need to be identified and/or altered to support a different outcome of the stage.

Discussion

This *de novo* process model is informed by complex systems theory and explains treatment seeking for PPH by women who give birth at home in Nigeria. The creation of this model takes an important step towards improving our understanding of treatment seeking behaviour for PPH by proposing interactions between numerous elements and describing the possible effects of these through the various stages a woman passes through in the process towards care and recovery.

There are three key findings and results produced through the creation of this model that can impact and potentially improve how treatment seeking behaviour is understood. The first is the multi-directional effect of a number of elements, second, is the identification of six stages in the model, and third, is the proposed interactions in each stage.

Multi-directional effect of a number of elements

It was discovered through the collection of elements that 16 elements had a multi-directional effect on uptake, likely due to interactions (i.e. the presence of a certain element, or elements, modifies/changes the effect of other elements). Multi-directional effect demonstrates that elements do not always have a fixed directional effect, which is a typical viewpoint when one categorizes elements into barriers and facilitators. When element direction is viewed in a fixed way, efforts that aim to build facilitators to care and/or diminish barriers to care can produce undesirable and ineffective results. Though it is accepted that interactions are occurring and integral to understanding behaviour, model and theories of behaviour do not typically describe these interactions in detail. Identifying details of the effects of interactions helps to advance our understanding of how interactions effect behaviour.

The identification of six stages in the model

The identification of six stages in the process of treatment seeking for PPH is an important outcome, and particularly the inclusion of the first two stages. Typically, ‘decision to seek care’ is designated as a single stage in a treatment seeking model. After reviewing the evidence body on what influences treatment seeking behaviour, it is evident that there are at least two distinct decisions being taken that warrant separation

as they possess significant differences in how elements interact and effect movement in relation to themselves.

Previously grouping these decisions together in a model excluded pivotal information that we must give attention to if we hope to encourage treatment use (biomedical or other care), and address some important causes of care seeking that are not typically targeted for change. For instance, the first stage addresses what is considered to be a life-threatening emergency which is shown not be driven by 'education' but different beliefs about childbirth and blood loss. The second stage, addresses the judgment made of whether a woman in a life-threatening bleed deserves care. This important decision has not previously been set apart in other models of maternal care seeking, despite it being pivotal to the process of care seeking, responsible for mortality, and caused by something not typically emphasized in examinations of maternal care seeking: misogyny.

These beginning stages emphasise the importance of beliefs at the beginning of the process of treatment seeking. Though all elements interact, within and between stages, thereby change in care quality and respectful care will change beliefs, beliefs can also be changed more directly with the inclusion of thought leaders, collective action, and recognition and attention to the issue.

Proposed interactions in each stage

The third key outcome from this model is the proposed interactions between all the elements within each stage. These interactions demonstrate that all elements collectively contribute to how a woman moves through the process of treatment seeking behaviour. Elements are not individual entities, which means change to one element is unlikely to change behaviour, unless all other elements are in support of this change. For example, belief elements are informed by numerous sources, not just experience with biomedical care. This means improving biomedical care to be effective, available, accessible and respectful will only change parts of the belief construction. For more efficient (quicker and effective) change one would need to target the other sources of beliefs. The only element that can alter the effect of all elements within a stage is desperation and severity (in stages 1 and 3). Though these elements would never be targeted to change behaviour, they do indicate that behaviour is fluid and susceptible to quick change given certain conditions.

Investigation into interactions also uncovered some interesting results about how elements interact that have previously been designated as singularly essential to health

and development, namely ‘affordability of care (can/cannot afford care)’ and ‘education’. According to this model, affordability of care is not always influential in care seeking, decisions about care choice rely more so on beliefs about care effect, status, and desperation for effective treatment. Education was also not identified as influential in treatment seeking, showing community beliefs about care to supersede biomedical ‘knowledge’ about disease and treatment. In fact, education was not included as an element in the model as it was not identified in the systematic review (mainly because regression models were excluded from the review due to how variables are identified and the non-causal results of regression), and the key informants explicitly indicated that education was not influential in treatment seeking.

Using the Model

Understanding collective interactions can inform health strategies that consider these relationships and move away from targeting single (or a few) elements for development. With more effective strategies that better understand and can therefore better support treatment seeking behaviours, mortality and morbidity from PPH can be reduced. As many different institutions and groups are contributing to improving the different elements included in this model, using this model to understand the interconnectedness of behaviour can help organize a coordinated effort to create and evaluate systems change. Users of this model, whether they be health researchers, development policy makers, or community organizers, can use this model to understand the complexity of treatment seeking behaviour by comparing and contrasting the structure, elements, interactions, and effects in this model against their own populations of interests. This model can be used as a template to describe the structure of complexity in any population, while adjusting element inclusion, interactions, and effects to specific contexts.

Limitations and considerations

There are a number of limitations and considerations that should be kept in mind when reviewing or using this model. One should consider the assumptions that were taken when reflecting upon the results and their possible application. The main assumptions that should be considered are related to the boundaries created in the model. Boundaries must be drawn in the model to give clarity to the aim of the model: to describe treatment seeking behaviour for PPH by women who give birth at home in Nigeria and seek care outside of the home. These boundaries are multiple, and certain exclusions from the model have been made to support clarity in the process. One important exclusion is when care is brought into the home or when a phone call is made to receive care remotely (i.e.

calling a religious or spiritual leader to pray or do other tasks on their end that are believed to help the woman recover). These both occur and would affect the process if included, perhaps resulting in a delay to biomedical care. Including both in future work can bring awareness to model users of potential places to influence the system. For example, bringing care to the home could provide community distributed misoprostol: though it is currently disputed in many communities due to its potential use in abortion. Also calling for remote support could be an opportunity for religious and spiritual leaders to also help organize other/biomedical care. Another boundary of the model was the focus on patient-side elements that influence uptake, and therefore the multiple elements known to influence provider-side care were not included, even though provider-side care was included in stage 6 of the model. Every system is connected to multiple other systems, and boundaries need to be drawn for focus on the topic of interest. Though this was a deliberate exclusion to focus on patient-side elements, it is important to remind the reader that patient and provider elements are interconnected and only separated here because patient-side elements were the decided focus of the model.

Another consideration one should take of the model is how interactions were proposed. These collective interactions were in part proposed from the experience of the author (as well as from the systematic review and key informants). No matter how interactions are described in a system of behaviour, they will always be subjective judgments that are challenged at capturing the true variation and uncertainty in the interactions. The reader is reminded that these interactions are informed hypothesis and that variation will likely always exist in behavioural interactions, as will uncertainty of their combined effects. This means that intervening in a system, even when ‘all’ elements and interactions are known, may not have intended results. This is in part due to the elements and interactions, as connected to other elements and systems, that are in constant states of change. The proposed interactions in this model bring awareness to the multiple elements that effect treatment uptake, and likely possibilities of how these interactions occur and effect uptake.

A possible limit to the model is how behaviour is generalized. Behaviour is demonstrated to be context specific and not typically generalizable. Thematic sorting of data from the systematic review and key informants may have created unique elements that are actually comprised of some different experiences and ideas. The reader should keep this in mind when interpreting the model. Also, as this model attempted to capture ‘all’ the elements influencing treatment seeking behaviour, including their variations, one may consider if these multiple elements capture the possible contexts of behaviour. This idea that the inclusion of many elements being able to express context, supports the decision

to include elements in the model that were not specific to Nigeria, but to similar contexts. This decision captured more elements and variation of effect, that may exist through a country as large as Nigeria. With the guidance above on how to use the model, it could possibly be used in any country (even high-income countries have lower resource communities, sometimes remote and with lack of trust of biomedicine), following the steps of assessing one's own geographic setting and elements against those of this model.

Conclusion

This is a novel venture into how complex systems theory can be used to inform a process model and take steps towards a better representation of the phenomenon of treatment seeking behaviour for PPH. Even with the above considerations and limitations, the model can provide insight into the importance of beliefs in the process of care, how collective interactions can influence the process of treatment seeking, and how policy to develop uptake can be organized. This model can also support thinking about complex systems theory and behaviour and inform future research in the area.

Chapter 7: Further results

Chapter 7 introduction

This chapter presents a development scenario applied to the Uptake Model, followed by two extensions of the model. These three further results are presented in three parts. Part 1 is a development scenario that demonstrates how change may occur in the model representation when an example of a development policy is applied to the setting. The development scenario is a health strategy that targets the improvement of access and availability. Part 2 and Part 3 are two extensions of the model. Part 2 includes mathematical abstractions (logic expressions) of interactions and effects that can be considered alongside Paper 2. Part 3 is the creation of a decision tree model with multiple pathways stemming from possible initial element combinations (presence, effect, interactions) at stage one and through the process of treatment seeking. These extensions contribute to clearer communication of aspects of complexity (interactions, effect, and variation) and build foundations for possible future computer simulation modelling of the system.

Part 1: Development scenario, a practical example of change to the system

Let us imagine a policy goal, to increase the use biomedical care to treat PPH and thereby reduce maternal mortality. One can use the Uptake Model to estimate the possible impact of this policy goal that aims to increase healthcare use, by altering certain elements within the model. This can be proposed as a question: if access and availability elements are changed to be supportive of biomedical care seeking, how does this impact the process of uptake?

To address this question, three groupings of elements will be altered: access elements, availability elements, and then together access and availability elements. These element groupings have been chosen as they have been identified as essential to improving the use of healthcare and are included in health development strategies. The Uptake Model includes 10 access elements that are present in four stages, and three availability elements that are present in four stages (please see Tables 13, 14, 15).

Table 13: List of access elements included in the Uptake Model

Element count	Element number	Element name
1	30	Have a referral (between levels of care)/No referral
2	31	Delay in bureaucratic process
3	32	Can afford care
4	33	Cannot afford care
5	34	Transportation unaffordable
6	36	Physical barriers, remote, environment, distance
7	37	Transportation not reliable, not functioning
8	38	Transportation unavailable
9	39	Night, do not want to travel at night
10	40	Planned/not planned, communicated to access care

Table 14: Availability elements included in the Uptake Model

Element count	Element number	Element name
1	27	Night, no staff at night
2	28	Care available/care not available
3	36*	Physical barriers, remote, environment, distance (distance to BM)

*In addition to being an access element, element 36 is also listed here as an availability element because availably is provisional, and distance partially designates whom it is provisional to, BM: biomedical

Table 15: Access and Availability elements in Uptake Model stages

	Stage 3	Stage 4	Stage 5	Stage 6
Number Access Elements	8	6*	2*	2
Number Availability Elements	3	1	1	2
Number Access and Availability Elements	11	6	2	4

*Denotes that element is listed twice as an access and availability element, though it is not counted twice in the sum row at the bottom of the table.

First, let us consider stage three, where the most access and availability elements are present. As seen in the previous chapter (Paper 2) results section, stage three elements interact within three categories: availability, access, and behavioural expectations and ideas. These three categories need to be in a collectively supportive direction for biomedical care to be chosen as the outcome of this stage. As presented in the paper a single change to one element, or multiple changes to multiple elements, can only result

in biomedical care being chosen if all other elements support this outcome. Therefore, change to all availability and access elements will only result in a change from other care to biomedical care if behavioural expectations and ideas are in support of biomedical care. If behavioural expectations and ideas are in opposition to biomedical care, changing access and availability elements will not change uptake. However, if all access and availability elements support biomedical care, and behavioural expectations and ideas are in opposition, but severity increases substantially and/or other care has been used and desperation occurs (element 26 'desperate, no other option'), then biomedical care is more likely to be used. Additionally, when element 41 'increasing severity' and/or 'desperate, no other option' influence biomedical care in this scenario, a woman's likelihood of death increased as does her inability to recover even when appropriate care is received. If one is unable to alter the uptake of biomedical care with changes to all access and availability elements in stage three, then changing access and availability elements in later stages is not likely to support the completion of the process towards biomedical care (as earlier stages must be complete to move forward in the model).

Stages four, five, and six also include access, availability, and other elements that must be satisfied to successfully complete each stage and the process towards recovery. For instance, stage four has nine elements, in which six are access and one is availability. If two of these other elements (element 25 'where to seek care [not knowing]', or element 35 'lack of confidence to arrange travel') are present, then having supportive access and availability elements is not enough to support the successful arrangement of travel.

In stage five there are three elements, of which one is increasing severity. This is the only stage where if access and availability elements are altered to support biomedical care that the stage will be successful.

In stage six there are five elements: four are access and availability elements, and one is 'what quality effect BM provides'. Quality of care is essential to help a woman recover from PPH, and a change in all access and availability elements is not enough to change the outcome of the stage if the quality of care is not appropriate. The goal of the process is to recover from PPH with the use of appropriate biomedical care, if this is not achieved women will continue in the process until this care is provided or she succumbs to PPH.

This example illustrates that while it is essential to develop access and availability to support the use of biomedical care and the recovery of women, it is equally essential to develop the other elements within the process. The first two stages included no access and availability elements, yet they are pivotal in the process of reaching biomedical care

and recovery. Policies that aim to improve access and availability of care should be set alongside policies to engage communities about social and cultural beliefs about childbirth, with recognition that these beliefs exist in response to the lack of access and availability of quality care.

Part 2: Logic Expressions

Boolean logic expressions were created to describe the most likely collections of interactions and their impact on each stage outcome. Truth tables were created and used to inform the Boolean expressions. First presented below is a main list of all logic expression symbols used in the expressions. Next, presented by stage, are the facts and assumptions for the expressions followed by the logic expressions. The value of creating logic expressions and presenting them in this section is that they provide a supplementary medium to communicate interactions and their effect. Additionally, these expressions could be useful as a foundation for the construction of a computational model of this system.

Logic Expression Symbols

Let P be ‘present’
Let A be ‘absent’
Let O be ‘oppose’
Let S be ‘support'
Let 1 be ‘valuation of women (low)’
Let 2 be ‘birth traditions’
Let 3 be ‘religion, fate, faith’
Let 4 be 'supernatural cause/biological cause’
Let 5 be ‘community expectations about uptake’
Let 6 be ‘social cohesion (cooperate)’
Let 7 be ‘control of women (mother in law makes decision)’
Let 8 be ‘control of women (male to accompany or permission)’
Let 9 be ‘perception about female strength’
Let 10 be ‘status, reputation, fashionable, wealthy’
Let 11 be ‘status, reputation, reference for biomedicine/Other’
Let 12 be ‘status, reputation, female strength’
Let 13 be ‘blood perceived dangerous’
Let 15 be ‘social connected/socially not connected’
Let 16 be 'quality, effect, biomedicine, Other’
Let 17 be ‘comfortable with procedures’
Let 18 be ‘fear of procedures (to biomedicine)’
Let 19 be ‘fear of biomedicine location’
Let 20 be ‘protected (place)’
Let 21 be ‘relationship health care worker (good)’
Let 22 be ‘relationship traditional birth attendant (good)’
Let 23 be ‘no one trusts care: biomedicine’
Let 24 be ‘quality and effect general (recommendations references) biomedicine, Other’
Let 25 be ‘where to seek care (not knowing)’

Let 26 be ‘desperate, no other option’
Let 27 be ‘night, no staff at night’
Let 28 be ‘care available/care not available’
Let 29 be ‘unable to access biomedicine’
Let 30 be ‘have a referral (between levels of care)/No referral'
Let 31 be ‘delay bureaucratic process’
Let 32 be ‘can afford care’
Let 33 be ‘cannot afford care'
Let 34 be ‘transport unaffordable’
Let 35 be ‘lack of confidence to arrange travel’
Let 36 be ‘physical barriers, remote, environment, distance’
Let 37 be ‘transportation not reliable, not functioning’
Let 38 be ‘transportation unavailable’
Let 39 be ‘night, do not want to travel at night’
Let 40 be ‘planned/Not planned, communicated to access care’
Let 41 be ‘Increasing severity’
Let 42 be “what quality effect biomedicine provides’
Let 43 be ‘category for how to act:
AVAILABILITY’
Let 44 be ‘category for how to act:
ACCESS’
Let 45 be ‘category for how to act:
BEHAVIORAL EXPECTATIONS AND IDEAS’
Let 46 be ‘subcategory of behavioural expectations and ideas:
related to care’
Let 47 be ‘subcategory of behavioural expectations and ideas:
related to power and control’
Let 48 be ‘subcategory of behavioural expectations and ideas:
related to social survival’

Stage 1

Stage 1: Facts & Assumptions

There are 9 elements in stage 1: elements 1-6, 9, and 41

(1, 3, 9) can be P or A. (2, 4, 5, 6, 41) can only be P.

O gets stronger with more elements resulting in O, and S gets stronger with more elements resulting in S.

IF 1P, THEN 1 will always be O.

IF 1P, AND (2-6, 9)PO, THEN O for the stage will be strengthened. IF 1A, THEN 1 may lessen the collaborative reinforcement of (2-6)

2 and 3 are assumed to be linked. IF one is O, THEN the other is O, AND, IF one is S, THEN the other is S.

That 3 can be S is an assumption. The evidence shows 3 can be O, but there was no evidence collected that 3 can be S.

2 and 4 are linked. IF 4 is supernatural, THEN it is O. IF 4O, THEN 2O. IF 4 is biomedical, THEN it is S. IF 4S, THEN 2S.

4 is linked to 2 and 3. IF 4PO, THEN it will inform (2, 3).

5 is informed by (2-4). IF (2-4)O, THEN 5O. IF (2-5)S, THEN 5S.

5 and 6 are linked.

6 is dependent on 5.

IF 5PO, THEN 6PO, AND IF 5PS, THEN 6PS.

2 and 9 are linked. IF 2PO, THEN 9PO. IF 2PS THEN 9PS.

It is possible that A of elements will strengthen O or S depending on the P and direction of other elements, but there is no certainty due to lack of evidence about A, multiple directionality of elements, and possible missing elements.

In conclusion, (2-6, 9)cluster to the same result, either O or S.

IF (1-6, 9) are O, and 41P, THEN the results can change to S.

Stage 1: Logic Expression

IF (((1-6, 9)PO) AND (3A AND/OR 1A)), THEN recognition is not likely. IF (1 is 1PO OR 1A), AND ((2-6, 9)PS), then recognition is likely. IF (1-6, 9) are O, and 41P, THEN the results is likely.

Stage 2

Stage 2: Facts & Assumptions

There are 8 elements in stage 2: elements 1-8.

(1, 3, 7,8) can be P or A. (2, 4-6) can only be P.

O gets stronger with more elements resulting in O, and S gets stronger with more elements resulting in S.

IF 1P, THEN 1 will always be O.

IF 1P, AND (2-8)PO, THEN O for the stage will be strengthened. IF 1A, THEN 1 may lessen the collaborative reinforcement of (2-8).

2 and 3 are assumed to be linked. IF one is O, THEN the other is O, AND, IF one is S, THEN the other is S.

That 3 can be S is an assumption. The evidence shows 3 can be O, but there is no evidence 3 can be S.

2 and 4 are linked. IF 4 is supernatural, THEN it is O. IF 4O, THEN 2O. IF 4 is biomedical, THEN it is S. IF 4S, THEN 2S.

4 is linked to 2 and 3. IF 4PO, THEN it will inform (2, 3).

4 also informs 5.

5 is informed by 2-4.

IF (2-4)O, THEN 5O. IF (2-5)S, THEN 5S.

5 and 6 are linked.

6 is dependent on 5.

IF 5PO, THEN 6PO, AND IF 5PS, THEN 6PS.

The direction of 7 (i.e. S/O) depends on the mother in law, and is likely in line with 5. 7 is not always present.

The direction of 8 depends on the male decision maker, and is likely in line with (5, 7). 8 is not always present.

There are examples where care may not be sought: an unmarried woman being pregnant in a community that this is not acceptable behaviour may be ignored when giving birth, and in an emergency bleed, possibly she herself believes this is correct. However, dead women cannot talk. Another example is where a woman's life is not valued, e.g. if she is older and there are other wives, and/or if she is a trouble maker. These examples were used when considering how elements in this stage interact and whether or not care is sought.

Stage 2: Logic Expression

IF ((1-8)PO) OR (ANY 1, 3, 7, 8 are absent), THEN decision to act is less likely. IF((1-8)PS) OR (1,3,7,8 absent)), THEN decision to act is more likely. In circumstances where there is a mix of P and A, and/or S and O, the result can be either way.

IF (1-8)PO, THEN it is possible that care will be sought, but not biomedical care, as the evidence is about uptake of biomedical care not other care.

Stage 3

Stage 3: Facts & Assumptions ALL CATEGORIES

3 Categories include: Availability (category number 43), Access (category number 44), Behavioural expectations and ideas (category number 45).

43, 44, and 45 are independent of one another, i.e. the result of one category (S or O) does not result in another category being S or O. However, there are element interactions between

categories (e.g. some of the elements in the access category inform the element of 'acceptable distance' in the availability category). If any single category is O, it is enough to result in O for the entire stage.

Stage 3: Logic Expression ALL CATEGORIES

IF (43, 44, 45)PS, THEN biomedical care is chosen.

IF ANY OR ALL (43, 44, 45)PO OR AO, THEN other care is chosen.

Stage 3: Facts & Assumptions by CATEGORY AVAILABILITY (43)

There are 2 elements influencing category Availability (43): elements 27, 36.

27 and 36 can be PO or A. If A assumed to be S.

Stage 3: Logic Expression by CATEGORY AVAILABILITY (43)

IF 27 AND 36 A, THEN 43 is S. IF 27 OR 36 O, THEN 43 is O.

Stage 3: Facts & Assumptions by CATEGORY ACCESS (44)

There are 12 elements influencing category Access (44): elements 15, 25, 30-39.

There are 7 core elements (25, 34, 35, 36, 37, 38, 39) that are independent from one another. The PO of any one of these elements means the result of this category (ACCESS) is O. These are considered core elements because they do not interact with or through other elements, as seen below with the other elements in this category, and they are also possible in any context/population, though not always present.

The 7 elements (25, 34, 35, 36, 37, 38, 39) can be either PO or A (no impact).

IF ALL (25, 34, 35, 36, 37, 38, 39)A, THEN 44 is likely to be S. IF ANY (25, 34, 35, 36, 37, 38, 39)PO, THEN 44O.

32 and 33 can influence 44 (ACCESS) in any direction. For example: each can be PS AND PO. Direction depends on elements in category 'behavioural expectations and ideas', for example, status, beliefs about quality of care and trust, and severity/desperation.

IF 32P AND (behavioural expectations and ideas about status, quality and trust of care are S), THEN 32PS.

IF 33P AND ((26 'desperate, no other option'PS) AND (43PS)), THEN 33PS (actually it ceases to impact the category).

IF 32P AND (behavioural expectations and ideas about status, quality and trust of care are O or A), THEN it is likely that 32PO (actually it ceases to impact the category), and therefore, 44O.

15 can strengthen or change the core elements (25, 34, 35, 38), AND 32, and 33. 15 cannot change the core elements (36, 37, 39). Therefore, IF 15PS, it can strengthen(25, 32, 33, 34, 35, 38) A or S, OR it may be responsible for/contribute to (25, 32, 33, 34, 35, 38) A or S. IF 15PO, it can strengthen (25, 32, 33, 34, 35, 38) PO, OR it may be responsible for/contribute to (25, 32, 33, 34, 35, 38) PO.

Stage 3: Logic Expression by CATEGORY ACCESS (44)

IF ALL core elements (25, 34, 35, 36, 37, 38, 39)A, AND 32PS, THEN 44S.

IF ALL core elements (25, 34, 35, 36, 37, 38, 39)A, AND 32PO, THEN 44O.

IF ALL core elements (25, 34, 35, 36, 37, 38, 39)A, AND 33PS THEN 44S.

IF ALL core elements (25, 34, 35, 36, 37, 38, 39)A, AND 33PO, THEN 44O.

IF ANY core elements (25, 34, 35, 36, 37, 38, 39)O, THEN 44O, the direction of (32, 33) does not matter.

Sometimes the procedures of accessing care (30,31) can influence 44. IF 30 is needed, AND 30PS, THEN 44S. IF 30 is needed and 30AO, THEN 44O. IF 31 is PO, THEN it is possible that 44O. IF 31A, THEN it is possible 44S.

Stage 3: Facts & Assumptions by CATEGORY BEHAVIORAL EXPECTATIONS & IDEAS (45)

There are 22 elements influencing category Behavioural Expectations and Ideas (45): elements 2-13, 16-24, 26.

There are 4 core elements (2, 3, 4, 16). These core elements are always in line with one another: IF one is O all are O, and IF one is S all are S. These are core elements because all other elements either strengthen/reinforce the result of the core, according to the evidence collected.

IF ALL (2, 3, 4, 16)PS OR A, THEN 45S. IF ALL (2, 3, 4, 16)PO, THEN 45O.

(9, 13) are part of element 2 and can be P OR A, and therefore I assume: IF 2 is S, THEN (9, 13)PS OR A. IF 2 is O, THEN (9, 13)PO OR A.

7, 8, are elements that indicate the decision of where to seek care is influenced by the Mother in Law, or a man in the family. I have assumed that in this category, 7, 8 would be in line with the core elements. Therefore: IF (2, 3, 4, 16) S, AND 7P, THEN 7S. IF (2, 3, 4, 16) O, AND 7P, THEN 7PO. IF (2, 3, 4, 16) S, AND 8P, THEN 8S. IF (2, 3, 4, 16) O, AND 8P, THEN 8PO. 7 AND 8 may not be present. It is assumed that their absence does not effect the direction of the core elements.

Elements (17, 18, 19, 20, 21, 22, 23) are partially informed by the core elements, and also reinforce or can redirect the direction of the core elements, as is true for the above elements (9, 13, 7, 8).

17 is part of 16. IF 16PS, THEN 17PS. IF 16PO, THEN 17A.

18, 19 are likely to be superseded by 16. For example: even IF 18PO, THEN it is possible 16 can be S, and therefore (2, 3, 4, 16) S. IF 18, 19 are in disagreement with (2, 3, 4, 16), THEN (2, 3, 4, 16) may weaken.

20 is linked to 16 and 2. And can be in line with these, but depends on a person's situation (where they can access for a protected birth). It is assumed here that if 2, 16 are PS THEN, 20PS. IF 2, 16 are PO, THEN 20PO. There will be exceptions to this, as seen in the evidence.

21, 22 are important but would not supersede the core (2, 3, 4, 16). If 21, 22 are in disagreement with the core (2, 3, 4, 16), THEN the core (2, 3, 4, 16) will be weakened. IF 21, 22 are in agreement with the core (2, 3, 4, 16), then the core (2, 3, 4, 16) is strengthened.

23 is part of 16. I assume IF 16PS, THEN 23A. IF 16PO, THEN 23PO.

IF 24 is P, then it is a reflection of the core elements (2, 3, 4, 16), meaning that it is informed by the core elements direction. IF core (2, 3, 4, 16) S, THEN 24PS. IF core (2, 3, 4, 16) O, THEN 24PO

There are 5 elements that represent social survival (5, 6, 10, 11, 12). I assume they would be in line with the core elements (2, 3, 4, 16). 5, 6 are always present. IF (2, 3, 4, 16) S, THEN 5PS, 6PS. IF (2, 3, 4, 16) O, THEN 5PO, 6PO. 5 and 6 strengthen the core (2, 3, 4, 16).

10, 11, 12, can be present or absent. IF 10P it is S. IF 11P it can be S/O. IF 12P it is O. ANY combination in line with the core (2, 3, 4, 16) will strengthen the core results (strengthening opposition or support).

26 (desperate, no other option) can override the entire category of 45 (BEHAVIORAL EXPECTATIONS). Therefore, if core (2, 3, 4, 16) O, AND 26PS, THEN 45S.

Stage 3: Logic Expression by CATEGORY BEHAVIORAL EXPECTATIONS & IDEAS (45)

IF ALL (2, 3, 4, 16)PS OR A, THEN 45S. IF ALL (2, 3, 4, 16)PO, THEN 45O.

IF (core (2, 3, 4, 16) PO), AND (all other elements in category are O/A,) AND 26PS, THEN 45S.

Stage 4

Stage 4: Facts & Assumptions

There are 9 elements in stage 4: elements 15, 25, 34-40.

15 is linked to (25, 34, 35, 38, 40).

IF 15PS, it can strengthen (ANY OR ALL(((25, 34, 35, 38)A,) AND OR 40PS)).

15PS may be responsible for/contribute to (ANY OR ALL((25, 34, 35, 38)A AND OR 40PS)).

IF 15PO, it can strengthen ANY OR ALL (25, 34, 35, 38)PO AND OR 40A.

15PS OR 15PO, can therefore alter the entire stage.

36 can be linked to (34, 37, 38, 39).

IF 36A, THEN ANY OR ALL (34, 37, 38, 39) could be minimized (move towards being A, from PO).

Stage 4: Logic Expression

IF ANY ((PO (25, 34, 35, 36, 37, 38, 39))40A), THEN Travel will not be Arranged.

Additionally, IF ALL ((A (25, 34, 35, 36, 37, 38, 39))40PS),THEN Travel will be Arranged.

Stage 5

Stage 5: Facts & Assumptions

There are 3 elements in stage 5: elements 36, 37, 41.

Stage 5: Logic Expression

IF (36, 37)A, AND 41PS, THEN Travel will be Successful.

IF ANY OR ALL (36, 37)PO, THEN Travel will be Unsuccessful.

IF 41PO, THEN Travel can be paused, or stopped (Travel will be Unsuccessful).

When Travel is paused, 37A can become PO, AND OR 36A can become PO.

Stage 6

Stage 6: Facts & Assumptions

There are 5 elements in stage 6: elements 27, 28, 30, 31, 42.

Care success requires care availability, followed by the reception of quality care.

27, 30, 31 may be present or absent. 28, 42 are only present.

IF 28PO, THEN (27, 30, 31) are nullified.

IF 27PO, THEN 28PO.

IF 28PS, THEN 27A.

IF 30 is needed AND 30AO, AND/OR 31PO, THEN care may not be received in a time or not at all.

Even if (27, 28, 30, 31) support care success, or support through absence, care success ultimately depends on ‘what quality effect BM actually has’ (42).

Stage 6: Logic Expression

IF (27, 31) are A, AND (28, 30) are PS, AND 42PS, THEN care success/recovery is likely.

IF ANY OR ALL (27, 28, 30, 31, 42) are P/AO, THEN Care will be unsuccessful.

The results of these expressions are likelihoods, not certain, as we can never be certain of the effect of collective interactions due to uncertainty (nonlinear relationships between elements and the stage outcomes, missing/limited elements and interactions), and variation (element, direction and interaction differences between people or groups and over time). Though some variation is described in the presentation of multiple possible logic expressions. Written as logic expressions the mathematical abstractions of these interactions and relationships with stage outcomes follow a main rule: that the outcome is a fixed binary outcome (e.g. true or false)(219). In reality the outcome of collective interactions fluctuates and the logic expressions above do not capture these fluctuations.

Additionally, the logic expressions do not demonstrate how elements are multi-faceted: they express different aspects depending on the stage (as each stage represents a different decision or situation). This means that an element can be supportive in one stage and in opposition in another stage. An example of this is in stage 1 and stage 2. These stages can occur simultaneously and each stage contains most of the same elements, however the elements and collective interactions are representing different decisions (recognition of PPH and decide to act) which reflect different aspects of the elements. Stage 1 represents how elements influence if PPH is present, and stage 2 represents when one knows PPH is present and a life-threatening emergency, and they decide if they should act. Therefore, it is possible in stage 1 for the collection of elements to be supportive of seeking care, and in stage 2 they can be in opposition.

Simplification of a phenomenon is a necessity of modelling, but choices for simplification can alter the correctness of a representation. The above simplifications made by describing the phenomenon using logic expressions could limit understanding of the complexity of uptake. It was therefore decided to create a decision tree model that captures the variation in the system (different combinations and possible outcomes of interactions within and between stages). The decision tree is presented in the next section of this chapter.

Part 3: Decision Tree Model

The decision tree model illustrates the pathways a woman can take through the behavioural system of uptake, as a result of increasing severity of PPH (time), and possible combinations of elements and the effects of these combinations. The severity of PPH is represented by the passage of time (as time passes the severity of PPH increases), which is assumed to increase every one hour and ten minutes. Six hours is the maximum amount of time a woman is estimated to live after her entrance into the model at a stage-three haemorrhage (two hours is the minimum time) (181). The upper time estimate was chosen for the timeline of the decision tree. Therefore, if a woman does not receive successful care within six hours, she is assumed to die. The possibility of death is also included throughout the model, initially at ten minutes into the model, then at every one hour and ten minutes. This is to capture variation due to difference in refill rate, and severity increase of bleed due to cause, movement, and possibly other treatments. If the lower time to death estimate was chosen (two hours) for the model timeline, then the urgency to reach care would be heightened, and more women would exit the model earlier due to exsanguination.

Women enter the model at a stage-three haemorrhage: this is point when a life threatening bleed is assumed to be recognized due to visual loss of vital signs. The construction of the model follows a five-step pattern: event, element combination, result of element combination, action, and natural outcome. The first event in the model is PPH (stage-three haemorrhage) at 00:00 minutes. All following events (at increments of one hour and ten minutes later) occur as severity increases. Element combinations within each stage are taken from the truth tables mentioned in the previous sections, and included in Appendix H. The results of the combinations are either likely/unlikely or variations of these. The outcomes are not certain, but they are expressed in this model as producing only two results (yes/no). For example, ‘likely’ becomes ‘yes’, and ‘unlikely’ becomes ‘no’. Element combinations and results are placed within the same time point as the event.

Five minutes after the event the action step occurs. The action step reflects the results of the element combinations, and indicates whether a woman stays in the stage (no action taken), or moves to the next stage in the model. Later model stages also allow for a movement back to earlier model stages. Another five minutes later the natural outcome step occurs. This step indicates at this point in time if a woman lives or dies. One hour after the natural outcome step, an event occurs, representing an increase in severity. Here the five-step process repeats itself through the stages for a six-hour timeline.

Change in model elements (presence and therefore interactions and effect) can also occur over the model timeline for individuals who are moving through the process. This individual change over the six-hour timeline is called quick-change. Quick-change is change that can occur during an individual timeline of experiencing PPH (through this six-hour process). There are also long-change elements, that take longer to change than an individual's movement through the model (greater than six hours). Please see Table 16 and 17 below for details of quick and long-change elements by stage.

Table 16: Elements that possibly change in each stage during an individual's movement through the model, "quick-change" elements

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
-Severity of bleed (This change, has the potential to change all other elements)	None	-Night (availability of care and travel) -Referral -Delay bureaucratic process -Environmental barriers -Transportation reliability, functionality -Transportation unavailable -Desperate no other care option	-Environmental barriers -Transportation reliability, functionality -Transportation unavailable, -Night, do not want to travel	-Environmental barriers -Transportation reliability, functionality -Severity of bleed	-Time of day -Care availability -Referral -Delay bureaucratic process

Table 17:Elements by change type and stage

Change Type	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Quick	1	0	7	4	3	4
Long	7	8	32	9	0	5

Stage 1

When entering the model, there are seven different pathways a woman can enter the model in, and these are reflective of her socio-cultural environment (see Figure 7). Three pathways allow her to move forward immediately (recognizing PPH as a life-threatening bleed), and the other four pathways split into 44 pathways over six hours, where a woman stays in stage one, and either the severity of the bleed increases and the bleed is recognized as life-threatening (moves to stage two), or she succumbs to PPH. Not recognizing a stage-three haemorrhage is possible for a number of reasons, including that a large loss of blood in PPH may not be visible and when visible it is difficult to

estimate the amount. Other beliefs about childbirth also slow the recognition of a life-treating bleed. For example, there are beliefs that women are meant to suffer during childbirth (220), and therefore the interpretation of emergency is different from those who do not believe this. Whether lack of recognition has to do with not being able to diagnose a life-treating bleed, or beliefs that allow for suffering, the increase in severity of the bleed (element 41) can supersede the other elements so that recognition occurs. Element 41 is the only element in this stage that can change quickly for an individual, over the six-hour timeline of the model. All other elements in Stage 1 are long-change elements (for example ‘behavioural expectations and ideas’ elements take more than six hours to change).

TIME 24hr	00:00			00:05	00:10	01:10		01:15	01:20	02:20		02:25	02:30	03:30		03:35	03:40	04:40		04:45	04:50	05:50		05:55	06:00
Pathway #	Event	Element Combin-ation	Result Combin-ation	Action	Natural Outcome	Event	Result Combin-ation	Action	Natural Outcome	Event	Result Combin-ation	Action	Natural Outcome	Event	Result Combin-ation	Action	Natural Outcome	Event	Result Combi-nation	Action	Natural Outcome	Event	Result Combin-ation	Action	Natural Outcome
1	PPH	1.A	Unlikely	None	Live	Severity+	Not Likely	None	Live	Severity+	Not Likely	None	Live	Severity+	Not Likely	None	Live	Severity+	Not Likely	None	Live	Severity+	Not Likely	None	Die
1.1				None	Die																				
1.2							Likely	Move S2																	
1.3									Die																
1.4											Likely	Move S2													
1.5													Die												
1.6															Likely	Move S2									
1.7																	Die								
1.8																			Likely	Move S2					
1.9																					Die				
1.10																							Likely	Move S2	
2	PPH	1.B	Likely	Move S2																					
3	PPH	1.C	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Die
3.1				None	Die																				
3.2							Likely	Move S2																	
3.3									Die																
3.4											Likely	Move S2													
3.5													Die												
3.6															Likely	Move S2									
3.7																	Die								
3.8																			Likely	Move S2					
3.9																					Die				
3.10																							Likely	Move S2	
4	PPH	1.D	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Die
4.1				None	Die																				
4.2							Likely	Move S2																	
4.3									Die																
4.4											Likely	Move S2													
4.5													Die												
4.6															Likely	Move S2									
4.7																	Die								
4.8																			Likely	Move S2					
4.9																					Die				
4.10																							Likely	Move S2	
5	PPH	1.E	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Live	Severity+	Unlikely	None	Die
5.1				None	Die																				
5.2							Likely	Move S2																	
5.3									Die																
5.4											Likely	Move S2													
5.5													Die												
5.6															Likely	Move S2									
5.7																	Die								
5.8																			Likely	Move S2					
5.9																					Die				
5.10																							Likely	Move S2	
6	PPH	1.F	Likely	Move S2																					
7	PPH	1.G	Likely	Move S2																					

Figure 8: The seven pathways in Stage 1 of the Uptake Model.

Severity+=increasing severity; S2=Stage 2.

Stage 2

As a woman moves into the second stage of the model, she is in a decision stage where there are seven elements present (these seven elements were also in Stage 1). Though these elements are named the same in each stage, they take on a different direction and collective effect, as the context of the stage is different (these elements are contributing to a different decision).

Stage 2 is about deciding if a woman deserves care, when it has already been recognized that the woman will die from her bleed if untreated. The decision in this stage is based on beliefs about conduct, and how conduct is related to deserving care. All of the elements in this stage contribute to these beliefs about conduct, if they exist.

All of the elements in Stage 2 are long-change elements. Therefore, if a woman is judged in this stage to have acted inappropriately, and this act results in denial of care, then this decision will not change in the woman's individual timeline, and she will stay in Stage 2 until her death. In Stage 2, the three immediate entry pathways from Stage 1 spilt into 24 pathways, in which three pathways move into Stage 3, and 21 stay in Stage 2. It is assumed here that regardless of beliefs in support of treating PPH with biomedicine, it is possible to have beliefs that also result denial in care. Later entry pathways from Stage 1 (in 20 pathways women enter at different time points into Stage 2), spit into 84 pathways where women, either move to Stage 3 (16 pathways), or over time succumb to PPH (68 pathways).

TIME	00:05	00:10			00:15	01:15						02:15						03:15						04:15	
Pathway	**Enter Stage**	**Natural Outcome**	**Element Combin-ation**	**Combin-ation Result**	**Action**	**Natural Outcome**						**Natural Outcome**						**Natural Outcome**						**Natural Outcome**	
2.0		Live	2.B	More Likely	Move to S3																				
2.1		Die																							
2.2			2.A/2.C-2.T	Less Likely	Stay in S2	Live						Live						Live						Live	
2.3						Die																			
2.4												Die													
2.5																		Die							
2.6																								Die	
2.7																									
6.0		Live	2.B	More Likely	Move to S3																				
6.1		Die																							
6.2			2.A/2.C-2.T	Less Likely	Stay in S2	Live						Live						Live						Live	
6.3						Die																			
6.4												Die													
6.5																		Die							
6.6																								Die	
6.7																									
7.0		Live	2.B	More Likely	Move to S3																				
7.1		Die																							
7.2			2.A/2.C-2.T	Less Likely	Stay in S2	Live						Live						Live						Live	
7.3						Die																			
7.4												Die													
7.5																		Die							
7.6																								Die	
7.7																									

Figure 9: Stage 2 immediate entry pathways.

These pathways continue through two more natural outcome time points (05:15 and 06:00). At 05:15 the three ‘live’ pathways split into ‘live’ or ‘die’, and at 06:00 all women remaining would die from exsanguination. S2=Stage 2; S3=Stage 3.

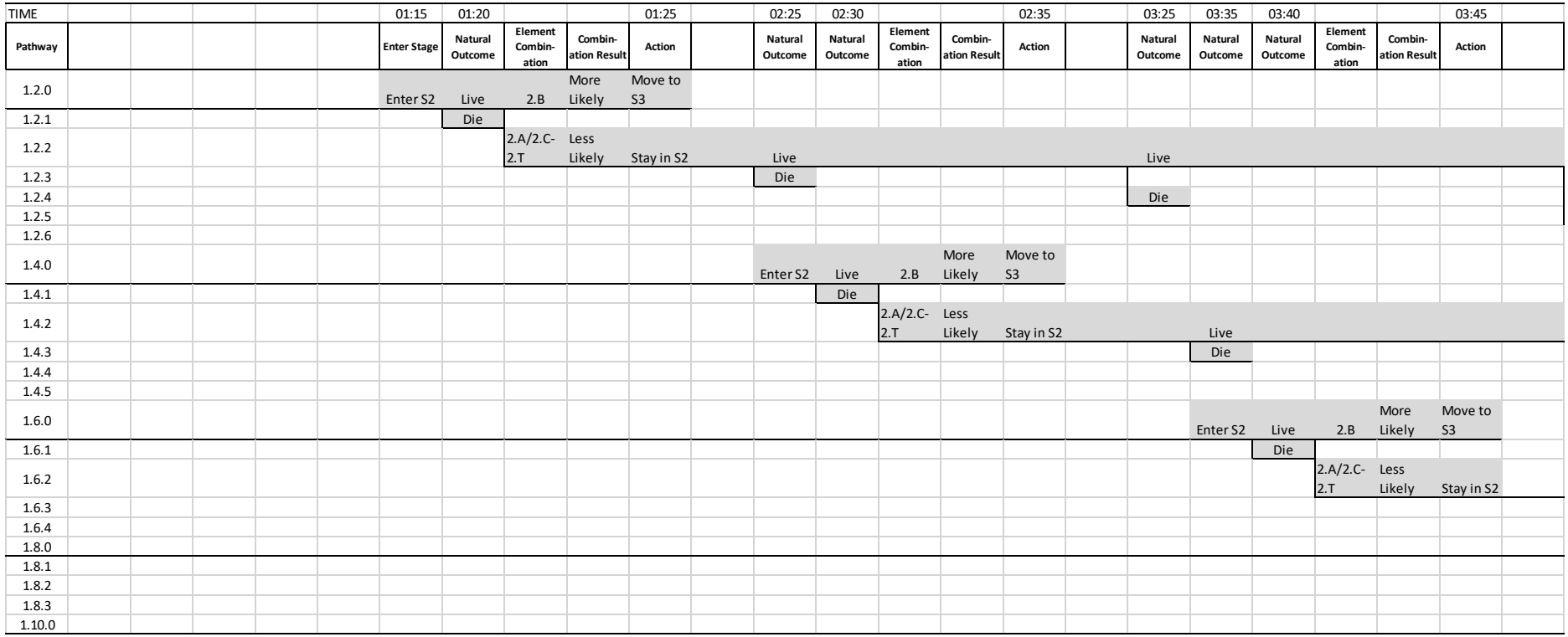

Figure 10: Stage 2 late entry pathways.

This figure shows the pathways stemming from element combination 1 in Stage 1. Pathways numbers include three separate numbers. The first number designates Stage 1 element combination. The second number designates where the pathway has split during Stage 1 due to different life and death outcomes or to a different decision based on the result combination over time (severity). The third number designates in Stage 2 where the pathway has split again in Stage 2 due to different life and death outcomes or to a different decision based on the result combination over time (severity). There are two more late entry points in pathway 1 branches at 04:45 and 05:55 (not shown). Those remaining in this stage at 06:00 are assumed to die from exsanguination. For all pathways entering Stage 2 there is one combination of Stage 2 elements that result in movement to Stage 3 (element combination 2.B). All others stay in Stage 2, either living or dying at natural outcome timepoints (until all remining women die at 06:00). S3=Stage 3; S4=Stage 4.

Stage 3

When entering Stage 3, the three immediate entry pathways from Stage 1 and 2 split into nine pathways, representing whether element groupings support biomedical, other care, or if a woman succumbs to PPH at this time point. Those pathways that have later entry from Stage 2 into Stage 3, split in the same ways as immediate entry pathways, the only difference is they appear at a later time in the timeline (and therefore severity has increased more for these women). In Stage 3, the pathways that move immediately towards biomedical care have all Stage 3 categories in support of biomedical care, all other element combinations move towards other care.

There are seven quick-change elements in this stage, and 32 long-change elements. Change in these quick-change elements will only occur after re-entry to stage three from later stages. People may wait for elements to change in Stage 3, but it does not change their decision on care type. It is assumed that they wait because they have made a decision about care type and are trying to see this decision through. The only exception is that increasing severity (element 41) can change a decision from other care to biomedical; and only if biomedical care is believed in, is available, and is possible to reach.

The seven elements that are present in Stage 3, are also present in Stage 1 and Stage 2, and again they are within a different decision context (here the decision is what type of care to seek). However, Stage 1 elements and Stage 3 elements interact and influence stage decisions in a similar way. If in Stage 1, a woman is on a pathway that has elements in opposition to recognition, it is likely those elements will act in opposition to biomedical care in Stage 3. And if a woman follows a pathway that has elements in support of recognition in Stage 1, it is likely those elements will act in support to biomedical care in Stage 3. However, it is possible that these elements can also result in different directionality from Stage 1 to Stage 3, because in Stage 3 they are within a different decision context and interconnected to a large number of other elements.

The result of Stage 3 is where the process model spits towards biomedical care or other care, therefore no-one stays in Stage 3, though they may succumb to PPH during this stage.

TIME	00:15	00:20			00:50
Pathway	**Enter Stage**	**Natural Outcome**	**Element Combin-ation**	**Combina-tion Result**	**Action**
2.0.0		Live	3.A	Likely	Move S4 BM
2.0.1		Die			
2.0.2				Unlikely	Move S4 OC
6.0.0		Live	3.A	Likely	Move S4 BM
6.0.1		Die			
6.0.2				Unlikely	Move S4 OC
7.0.0		Live	3.A	Likely	Move S4 BM
7.0.1		Die			
7.0.2				Unlikely	Move S4 OC

Figure 11: Immediate entry pathways into Stage 3.

The 30-minute time difference between the natural outcome and the action is assumed. It may be shorter or longer. S4=Stage 4; BM=biomedical care; OC=Other care.

TIME							01:25	01:30			02:00	02:35	02:40			03:10	03:45	03:50			04:20	04:55
Pathway							**Enter Stage**	**Natural Outcome**	**Element Combina-tion**	**Combina-tion Result**	**Action**		**Natural Outcome**	**Element Combina-tion**	**Combina-tion Result**	**Action**		**Natural Outcome**	**Element Combina-tion**	**Combina-tion Result**	**Action**	
1.2.0.0							Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC											
1.2.0.1								Die														
3.2.0.0							Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC											
3.2.0.1								Die														
4.2.0.0							Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC											
4.2.0.1								Die														
5.2.0.0							Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC											
5.2.0.1								Die														
1.4.0.0												Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC						
1.4.0.1													Die									
3.4.0.0												Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC						
3.4.0.1													Die									
4.4.0.0												Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC						
4.4.0.1													Die									
5.4.0.0												Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC						
5.4.0.1													Die									
1.6.0.0																	Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC	
1.6.0.1																		Die				
3.6.0.0																	Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC	
3.6.0.1																		Die				
4.6.0.0																	Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC	
4.6.0.1																		Die				
5.6.0.0																	Enter S3	Live	3.B/3.G	Not Likely	Move S4 OC	
5.6.0.1																		Die				

Figure 12: Stage 3 late entry pathways.

There is one more late entry time at 04:45 (not shown) where four more branches enter. In Stage 3 it is assumed all people exit the stage to either biomedical or other care. S3=Stage 3; S4=Stage 4; OC=Other care.

Stage 4

Stage 3 and Stage 4 are very close in time, if not simultaneous in terms of the time that they occur. Stage 4 is a distinct stage as it considers if travel is arranged or not, and even though the majority of the elements in Stage 4 are also included in Stage 3 (8/9), they are not necessarily the same in terms of their presence and therefore effect. This is due to the difference between what one expects or has previously arranged (in Stage 3), versus what actually occurs (in Stage 4).

When entering Stage 4 with immediate entry, the three biomedical pathways from Stage 3 spit into nine pathways, and the three other care pathways also split into nine pathways. These 18 pathways can either result in the successful arrangement of travel, of staying in Stage 4 to wait for quick-change elements to change, or the unsuccessful arrangement of travel which can result in re-entry into the model at Stage 3. There are four quick-change elements and nine long-change elements in Stage 4. If arranging travel is unsuccessful for other care, and the woman returns to Stage 3, it is unlikely the choice will be made to seek care at a biomedical facility as it is usually further away. Though the choice after unsuccessfully arranging travel is likely to be for a closer care facility, not dependent on care type but on ability to get there.

POSSIBLE PATHWAYS DIRECT ENTRY FROM STAGE 1, 2 & 3 TO BM CHOICE

TIME	00:50	00:55			01:25
Pathway	**Enter Stage**	**Natural Outcome**	**Element Combin-ation**	**Combin-ation Result**	**Action**
2.0.0.0	Enter S4	Live	4.A	Likely able to arrange travel	Move S5 BM
2.0.0.1		Die			
2.0.0.2			"Not 4.A"	Cannot arrange travel	Stay in S4
6.0.0.0	Enter S4	Live	4.A	Likely able to arrange travel	Move S5 BM
6.0.0.1		Die			
6.0.0.2			"Not 4.A"	Cannot arrange travel	Stay in S4
7.0.0.0	Enter S4	Live	4.A	Likely able to arrange travel	Move S5 BM
7.0.0.1		Die			
7.0.0.2			"Not 4.A"	Cannot arrange travel	Stay in S4

POSSIBLE PATHWAYS DIRECT ENTRY FROM STAGE 1, 2 & 3 TO OTHER CHOICE

TIME	01:00			01:30
Pathway	**Natural Outcome**	**Combina tion**	**Decision**	**Action**
2	Live	4.A	Likely able to arrange travel	Move S5 OC
2.5		"Not 4.A"	Cannot arrange travel	Stay S4
2.6	Die			
6	Live	4.A	Likely able to arrange travel	Move S5 OC
6.5		"Not 4.A"	Cannot arrange travel	Stay S4
6.6	Die			
7	Live	4.A	Likely able to arrange travel	Move S5 OC
7.5		"Not 4.A"	Cannot arrange travel	Stay S4
7.6	Die			

Figure 13: Immediate entry pathways into Stage 4, biomedical and other care.

When element combination 4.A is present, it is likely to result in transportation being arranged, and the woman moves to travel to BM (biomedical) or other care. When all other element combinations occur “Not 4.A” then transportation cannot be arranged and the woman stays in Stage 4 and either waits for change or returns to Stage 3 and makes a different care choice. If there is no other care choice or travel cannot be arranged and a change does not occur in the elements influencing ability to arrange travel then a woman will stay in Stage 4 until she dies from exsanguination. S4=Stage 4; S5=Stage 5; BM=biomedical care OC=Other care.

Stage 5

When entering Stage 5 immediately from Stage 4, three biomedical pathways split into five pathways, and three other care pathways also split into five possible pathways. The three elements in Stage 5 are all quick-change elements. Each can change at any point over the course of travel and may change multiple times. As they are all quick-change elements, it is probable that they can change over the course of travel. If travel is unsuccessful it will result in a return to Stage 3, and perhaps staying in Stage 5. Staying in stage five would occur if severity has increased to a point where it is felt unsafe for the woman to travel. In these cases she would succumb to PPH. Later entry into this stage results in a more severe case of PPH, increasing the probability of her death in this stage, especially as travel can further exacerbate the health of a women with PPH.

POSSIBLE PATHWAYS DIRECT ENTRY FROM STAGE 1, 2, 3 & 4							
TIME	02:00			03:00			06:00
Pathway	Natural Outcome	Combin-ation	Decision	Action	Natural Outcome		
2	Live	5.A	Likely successful	Move S6			
2.7		5.B-5.H	Not successful/ Likely not successful	Stay S5	Live		Die
2.8				Go home no care options	Die		
2.9				Move S3			
2.10	Die						
6	Live	5.A	Likely successful	Move S6			
6.7		5.B-5.H	Not successful/ Likely not successful	Stay S5	Live		Die
6.8				Go home no other care options	Die		
6.9				Move S3			
6.10	Die						
7	Live	5.A	Likely successful	Move S6			
7.7		5.B-5.H	Not successful/ Likely not successful	Stay S5	Live		Die
7.8				Go home no other care options	Die		
7.9				Move S3			
7.10	Die						

Figure 14: Immediate entry pathways into Stage 5, biomedical care.

It is assumed that travel takes one hour. If element combination 5.A is present, then travel to care is successful and the woman moves to Stage 6. If other element combinations occur than travel is not successful. A woman either stays in Stage 5 (she may be stranded or too weak to be moved) and will eventually die from exsanguination, assumed to occur at 06:00. If she returns home as travel is unsuccessful but has no alternative place to seek care, she is assumed to die. If travel is unsuccessful but there are other care options, she moves to Stage 3. Later entries into Stage 5 are not shown, but they follow the same pattern as above, just at later time points. S3=Stage 3; S5=Stage 5; S6=Stage 6.

Stage 6

With immediately entry into Stage 6, three biomedical pathways split into 18 pathways, and three other care pathways also split into 18 pathways. Later entry into this stage results in a higher probability of death, including the inability of appropriate care to recover a woman. There are four quick-change and five long-change elements in Stage 6. The results of this stage are successful treatment (recovery), unsuccessful treatment

(resulting in death or re-entry to the model in Stage 3), or staying in Stage 6 until the quick-change elements change. In this model previous stage elements have no direct interactions with elements in this stage.

POSSIBLE PATHWAYS DIRECT ENTRY FROM STAGE 1, 2, 3, 4 & 5							
TIME	04:00			05:00			
Pathway	**Natural Outcome**	**Combin-ation**	**Outcome**	**Action**	**Natural Outcome**		
2	Live	6.A	Care Successful	Complete Process	Live		
2.11		6.B-6.H	Care Not Successful	Stay S6 can wait and recover			
2.12		6.J-6.P	Care Not Successful	Stay S6 can wait but care not good			
2.13		6.I	Care Not Successful	Move S3			
2.14				Go home no other care options	Die		
2.15	Die						
6	Live	6.A	Care Successful	Complete Process	Live		
6.11		6.B-6.H	Care Not Successful	Stay S6 can wait and recover			
6.12		6.J-6.P	Care Not Successful	Stay S6 can wait but care not good			
6.13		6.I	Care Not Successful	Move to S3			
6.14				Go home no other care options	Die		
6.15	Die						
7	Live	6.A	Care Successful	Complete Process	Live		
7.11		6.B-6.H	Care Not Successful	Stay S6 can wait and recover			
7.12		6.J-6.P	Care Not Successful	Stay S6 can wait but care not good			
7.13		6.I	Care Not Successful	Move S3			
7.14				Go home no other care options	Die		
7.15	Die						

Figure 15: Immediate entry pathways into Stage 6, biomedical care.

When element combination 6.A occurs then care is successful and the woman recovers from PPH. If combinations 6.B-6.H occur then care can help a woman recover but other elements are not supportive. These elements can change over time, therefore a woman is assumed to wait. In element combinations 6.J-6.P care cannot help a woman recover (care is not good quality or appropriate) and the other elements are not supportive but can change over time. Due to the time of these direct entry pathway (05:00) it is assumed that a woman is very weak, and she will wait for elements to change instead of seeking care elsewhere. She will then die as even if elements support her being cared for, the care will not be sufficient and due to the 06:00 timeline she will die. In element combination 6.I elements are supportive of care but care is not successful due to poor quality or inappropriate care. The woman at this point may decide to seek care elsewhere (move to Stage 3) or may go home. If she goes home without proper treatment she will die. S3=Stage 3; S6=Stage 6.

Chapter 8: Discussion

Chapter 8 introduction

The aim of this thesis is to demonstrate the value of using complexity theory, to describe the process of the behaviour of uptake, for the treatment of PPH, by women who give birth at home in Nigeria. This aim was achieved through the building of a *de novo* process stage model. Several important results and findings were estimated from the Uptake Model, and through its construction and extensions. In this chapter the interpretation and significance of these important results and findings are discussed, followed by a discussion of the limitations of the work. The chapter concludes with proposals for future work on this topic, including modelling, and how these may support a larger understanding of treatment seeking behaviour for PPH.

Main results and findings

Creation of the Uptake Model

The main result of this thesis is the creation of the Uptake Model (Chapter 6, Paper 2) and its extensions (Chapter 7: development scenario, logic expressions, and decision tree model). Truth tables informing logic expressions can be found in Appendix H. The Uptake Model and its extensions help to advance how treatment seeking behaviour for PPH is understood, by describing aspects of complexity that have not previously been detailed in the literature on this topic. These aspects of complexity include: explaining behaviour as a system of interconnected elements, that recognizes the uncertainty of collective interaction effects, and incorporates variations of the composition of interactions and their effects into the description of the system.

In health research, complex systems theory is often used to describe biological systems, though it is beginning to be used more in the field of public health. Public health use of complex systems theory has investigated a variety of areas including the complexity of infectious disease emergence and transmission(221), policy development(222), and the process of care delivery(223). Specifically, to public health and behaviour, areas such as dietary behaviours and drug use behaviours have been examined with ABMs(224, 225).

Though these two examples of public health behaviours examined with complexity theory and ABMs are different from the foundational works built in this PhD, they raise some interesting points about the value of first creating foundational work before creating a computational ABM. It is imperative to first understand the fundamental components

and dynamics of a system before creating a simulation, otherwise the construction of a model (conceptual or computational) can be flawed and will therefore produce misleading results. As models of systems are in part shaped by the elements included, it is essential to make efforts to ensure that elements inclusion is as correct and comprehensive as possible.

Auchinclos et al 2011(224) examines dietary behaviours with an ABM, providing only three references for two of the elements included in the model (frequency of food purchasing, and what store is shopped at), and no discussion is made of comprehensiveness of the inputs. The authors do not explain how the other inputs (including interactions) and elements in the model are identified, and to mitigate this perhaps, they introduce randomness into the model. Galea, Hall, and Kaplan 2009(225) examine drug use behaviours with an ABM, and provides little referencing (only references general literature on social network graphing), and makes no mention of effort to comprehensively capture the elements in the system. The value of the Uptake Model and its extensions is that they attempt to include all known influencing elements in the system, and provide details of the interactions: these give some clarity and sense to patterns in behaviour. Without this, an explanation of a system will be limited and probably misleading. The exception is, if a more comprehensive and detailed conceptual model is first built and then selected parts of it are focussed on for examination (e.g. future modelling).

To the point of randomness: behaviour is not random, it has causes and meaning(45). To add randomness to a systems behavioural model for how elements interact and their effect will produce incorrect results. The Uptake Model and extensions, by attempting to be comprehensive, explain the multiple interacting causes of behaviour in the context of decision/action stages, and thereby reflect some meaning in the behaviour. This comprehensive and detailed description of interactions and effects eliminates the need to insert randomness as a substitution for missing information.

In regard to maternal public health, complex systems theory is rarely used. One article was identified in a recent search I conducted: Stylios & Georgopoulos 2010(226), who create a fuzzy cognitive map (FCM) that graphically represents causal relationships of the decision process of obstetricians when evaluating labour (deciding between a caesarean section and natural labour). The authors use expert opinion to map the decision making process. FCMs illustrate causal feedback loops(227), typically in one space, where the modelling in this thesis shows interactions (collective ways in which elements relate and alter each other) over stages in a process (multiple spaces). FCM

is a technique used in future studies(227), and are similar to causal loop diagrams (CLD), which is a technique in systems thinking(228).

A main aspect of complex systems theory is feedback (positive and negative), which can be produced by interactions and can be an interaction(48). Feedback is present in the Uptake Model: the presence of an element(s) informs the effect of another element(s). But the Uptake Model takes a different approach from FCMs and CLD: it recognises feedback, and it also considers how elements are related to each other (when they work together/cluster), and how they collectively influence each stage.

Another difference between these two conceptual models (FCM and CLD) and the Uptake Model, is that the Uptake Model presents variation of collective element interactions and their effects. The other models present one version of the system, which at least for CLD follows systems thinking of modelling the most probable pathway. One more difference is that in the examples of Stylios & Georgopoulos 2010(226) (FCM) and Arizona State University 2013(228) (CLD) is these models are of task systems that are stable, as opposed to a behavioural system that is fluid. The goal of a task system is the completion of a process correctly, and the system is considered to be malfunctioning if the process is not complete in the correct way. However, the goal of the behavioural system in the Uptake Model is not the uptake of biomedical care: uptake is the outcome I am interested in which informs the scope of the model.

The goal of the behavioural system is survival (both individual and group). Most often, what drives behaviour is survival of self or group. Variation in the effect of collective interactions can be explained by this goal, as is demonstrated in the Uptake Model: for example, whether group or individual survival is chosen. For example, group survival can be chosen when adherence to group held beliefs supersedes choices to protect an individual's survival.

All of these model types are useful and depend on the question asked, the stability of the system, and the information the creator of the model is aiming to describe. For the purposes of the thesis aim, the Uptake Model and its extensions explain well the process of treatment seeking behaviour for PPH, by women who give birth at home in Nigeria, with aspects of complexity (systems view, collections of interactions, and uncertainty and variation in regard to the composition of element interactions and their effects).

Elements are not fixed

As highlighted in the discussions of Paper 1 and Paper 2, it is of considerable importance that the effects of single elements are not fixed: their effect is not consistent. I have called this multi-directional effect, where an element can at the same time support or oppose uptake of biomedical care. This curious finding is due to interactions between elements. This can clearly be demonstrated with affordability elements ('can afford care', 'cannot afford care'), elements that one may assume, that if a person can afford care this would be supportive of biomedical care use and if one cannot afford care, this would be in opposition to biomedical care use. However, affordability of care is not always influential in care seeking in these ways due to interaction with other elements. The model shows that decisions about care choice rely more on beliefs about care effect, status, and desperation for effective treatment, thereby sometimes nullifying the influence of affordability.

There were 16 multi-directional elements incorporated into the Uptake Model, that were identified from the systematic review and from the key informants. It is likely that there are more multi-directional elements, and that a small number were identified because of the predominance of current research is designed to capture either barriers or facilitators to care(229, 230). The evidence collected from the systematic review was from studies designed to capture single-directional elements approaches: they were not aiming to identify multiple-effects but to simply categorize elements into barrier and facilitator type categories. Multi-directional elements were identified in the systematic review due to multiple studies demonstrating different effects of elements.

The multi-directionality of elements supports the presence and impact of interactions and contrasts with the barrier and facilitator approach typically taken in maternal health development(231, 232). Interactions also mean that targeting singular elements for development is not very likely to produce desirable results. This finding highlights the need to approach treatment seeking behaviour in a different way, with the consideration of interactions and the effect these interactions have on uptake.

Proof of interactions

Interactions are present and collectively contribute to effect as evidenced in the systematic review, and by key informants, and described in the model. In line with complex systems theory, it is proposed that interactions occur between all elements and therefore all elements contribute to effect. This subsequently means that for change to

occur, all contributing elements must be considered as elements working collectively together. The non-linearity of these interactions emphasizes that change may produce unpredictable and inconsistent effects on the system. Estimating the potential effect of a change to the system can be informed by reviewing the Uptake Model, with the consideration that uncertainty exists in change to a complex system, and that this uncertainty is due to non-linear interactions. All elements interacting means that any change in the system can change the whole system, and since the relationships in the model are non-linear and somewhat unpredictable, deliberate change should be considered and with these caveats in mind.

This interconnectedness of elements also highlights that unbalanced development efforts are unlikely to produce desired change. This was demonstrated in the scenario analysis at the beginning of Chapter 7. Considering the interconnectedness of the elements, a potential plan to change the system is attempting to influence all the elements in the system. However, this may seem unrealistic, and because of non-linearity it might even produce undesirable results. If changing single elements or only a few elements can produce undesirable results, and changing all elements might produce undesirable results, then how can we use this work to ameliorate development efforts?

Perhaps the awareness of “all” elements that influence a system, and how these elements collectively may influence a system, can inform a monitoring and evaluation framework that recognizes the system and observes how it is evolving. This can present some challenges as some smaller change may not be observable until a large change occurs (a tipping point), where it might be too late to intervene(48).

Though there is no seemingly perfect approach, it is important not to ignore what we know about behaviour and choose a simplified approach that we know to be limited. An attempt at a comprehensive approach is perhaps possible with a coordinated effort of many stakeholders. This approach is in line with some international goal setting that takes a multi-pronged and collaborative approach to develop health, safety and prosperity (183), and multi-level approaches are suggested for behavioural interventions by experts in social sciences and behavioural research in public health(233).

The inclusion of Stage 2 in the 6-stage process model

The second stage in the process model describes the possible judgment made of whether a woman in a life-threatening bleed deserves care(187). This important decision has not previously been set apart in other models of maternal care seeking(36, 234).

This stage is pivotal to the process of care seeking, as it must be satisfied for a woman to move through the process of care seeking (represented in the model). It is also a stage that the elements do not change over a woman's individual PPH experience. If a woman enters this stage, and is judged to not deserve care, then this decision about her is not likely to change. What then happens to the women who do not die when this decision is made, and what happens to her new-born child if it lives and she does not? These questions were not addressed in the model or captured in the research to inform the model, but they are highlighted here to bring attention to these women's lives and the absence of work in this area. How a society regards women directly and substantially effects women's health, including the successful recovery from PPH. This stage requires equal balance in development efforts, not just due to the interconnectedness of the elements and stages in the model, but to support human dignity for all persons.

Key informants significantly improved systematic review results and model

The systematic review resulted in 41 elements, and confidence in the results was judged to be low or moderate. The systematic review results were validated and contributed to by two key informants, validating 10 elements, and contributing nine additional elements, and showing that 11 additional elements had multi-directional effects. These two women significantly contributed to raising the quality of the model inputs, though validation and new inputs. These were surprising results, as two people may be considered too few to make such a substantial contribution. As the study was not meant to be representative, concerns of sample size can be quelled, also other methods for collecting expert opinion (e.g. Delphi panels) have no minimum number to be considered correct methodologically, as long as experts are indeed experts and have the right conditions to share expertise(235). This also raises the question of how much more information could have been collected if more women were interviewed. Possibly more, and this is something that future research could explore.

Limitations

There are numerous limitations to this work that should be considered. In order to not repeat what was written in Paper 1 and Paper 2, this section will focus on overall limitations that have not previously been discussed. These are mainly around quality of the data used to inform the model. Previously discussed limits include: assumptions relating to the boundary of the model (not including care brought to home, or extensive

inclusion of delivery side elements influencing uptake), my subjectivity in putting elements interactions togethers, and how behaviour is generalised.

The value and limits of quality assessment on elements and effects

It is important to assess the quality of others' research when it is used to build a model, to help build the validity of the model, so that it comes closer to a true representation of a phenomenon. However, there are challenges to quality assessment that should be considered. It perhaps goes without saying that simply following a checklist of questions to assess quality is not going to yield helpful results. One needs to think deeply about how the evidence was generated, and how this might affect assessment results and in the case of this thesis, model results. It is also difficult to make consistent judgments across larger numbers of article and outcomes.

In the systematic review elements, interactions, and the effects on these were extracted for use in developing the Uptake Model. Qualitative articles were judged to have low or moderate confidence in the evidence quality, and the quantitative studies also were judged to have bias that affected the results that were extracted for the model (quantitative studies were not included in GRADE-CERQual as they were not qualitative and the NOS only allows for descriptive judgements not level or grades of judgement).

The main reasons that extracted results were judged to be of low or moderate quality, was lack of reporting, no ethical consideration, no consideration of the dynamic between researchers and participants, and poor study design (including offering elements to participants and recording whether or not they were present). Does this mean that the data collected from the systematic review was not useful? Low and moderate confidence in the results means that we suspect that some of the data extracted from the studies is not a balanced representation of the phenomenon of treatment seeking behaviour for PPH.

There are elements typically targeted in treatment seeking behaviour research, that one may question: is this simply a replication of elements and not necessarily correct. This was demonstrated with the element 'education'. Perhaps it could be the case with others. It is difficult to know with this type of study as 'truth' has a way of creating itself when an idea becomes the favourite of research and development strategy. This challenge is demonstrated in the review results, where certain elements in the primary extraction list were mentioned numerous times (e.g. transportation), where others less so (e.g. status). It is not necessarily that transportation problems are occurring more than status affecting

behaviour, but that it is talked about more, presented as an option to participants in surveys more, and given as a response more due to power dynamics.

Responses due to power dynamics are another challenge to the review results. If power dynamics were not considered (e.g. race and income), then women may have agreed to elements that were not true, agreeing or disagreeing in line with what they believed would be seen as correct or perceived well. The idea that the 'white man' has his/her own ideas of what is right and wrong and how this differs from their own, impacts how a participant with less power responds. Though this 'white man' concept is taken from discussion with the key informants, it has been demonstrated in every country I have lived and worked in social and health development. This is why it is important to create an environment for research where participants feel they can respond freely. In the discussions with key informants that contributed to this thesis I made many efforts to create this type of environment for the expert women who attended. I attempted to minimize power difference by letting them know that I needed their help, that they were the experts. When I shared the aims of the larger modelling research I chose different words, but I did not simplify the work I was doing and what I hoped to achieve. I stressed the value of including them in the process of germinating and validating evidence for the model. I created a design voice component that followed the discussions (design voice is similar to photo voices but uses design to express thoughts and ideas). An accomplished British-Ghanaian multimedia textile designer collaborated with me to present what design voice was to the women and teach them how to design a textile based on their responses and thoughts about the research and the discussion. Later the textiles were printed on fabric and sent to the women. The aim was to try to offer something of value back to the women for their participation as key informants, and also to perhaps elicit some new data from their drawings. The latter proved difficult, mainly due to time constraints, but the effect on those women and the textile designer was profound. We were actually all teary at the end of the evening and this was not due to the content, it was bringing women together and creating a space where African women have a voice and it is then used to create change. I believe because of these efforts to balance power and give back to the women, the workshop and interviews were a success even though only two women participated.

In summary I believe the data collected from the systematic review is useful though it may be limited, overemphasizing certain elements over others, and perhaps including and excluding some elements due to researcher selection and not addressing power dynamics. The key informants made a good contribution to improving the confidence one can have in the elements and effect results included in the Uptake Model.

Validity of interactions collected and proposed

The interactions collected from the systematic review and they key informants were all unique (no similar or same interactions were collected). All interactions contained two to three elements. This is an interesting finding, that may be because I am only able to conceive of two to three interactions occurring at once, and not more. The interactions extracted from the systematic review were not explicitly called interactions and were extracted based on my perception and judgement, therefore certainly some interactions were unknowingly excluded. It is likely that since I was looking for interactions with the key informants (and the systematic review articles included were not) that I found so many. Again, some bias would be introduced as only myself analysed the results from the key informants. This means the interactions collected in the systematic review and from the key informants should be viewed as subjective.

It is typical in systems modelling to use author/researcher knowledge and ideas to propose how multiple elements interact and what effect this produces. Nonetheless, the reader may call into question the validity of this approach. It is important to highlight that the aim of the model is a novel foray into using complex systems theory to explain treatment seeking behaviour for PPH, and that part of a model's purpose is to mlexplore hypotheses. Future work can explore the validity of these interactions, though as they are not linear, linear analyses would not be supportive. I would suggest ethnographic studies in communities and together women who live in Nigeria and either have knowledge or interest in anthropological theory and methods. Building research capacity in collaborations assists in strengthening the validity of research and balancing power.

Future Work

As the Uptake Model and extensions are foundational works to help build complex systems modelling describing behaviour, therefore, there are many ways in which these can be used to support future research and modelling.

Firstly, the limits can be addressed pertaining to the evidence and interactions supporting the construction of the model. For example, further validation of the model elements, interactions, and effect, in multiple-locations in Nigeria would be beneficial to the model. Of particular use would be ethnographic studies, as people are not typically able to identify and explain their behaviour, and though they may be able to speak to some/many elements, it would be beneficial to have a broader collection of elements that included

hidden elements (those elements that are unknown to people). Also, ethnographic studies can capture the ways in which people speak about their behaviour versus what they do. Conducing multiple ethnographic studies across Nigeria would be time consuming and expensive, but also they would strongly build the next phase of the model.

Secondly, I envision that after these studies and conclusion of this phase of model building that the model is tested in different countries with similar circumstances (e.g. places with low trust in biomedicine and biomedical providers, lower income communities). Though behaviour is often contextual and specific to a culture, there are also similarities in how elements cluster and operate collectively. If the model could demonstrate this in multiple countries, then an interactive tool could be created where users could select element presence, interactions, and effects. The tool would present estimates from these selections, and it could be of good use to health and development policy planners and researchers.

There are three other areas the Uptake Model and extensions could contribute to future work: building a model that explains the feedback of individual movement through the model to future individuals and groups; populating the decision tree model; and building an ABM. Though models are abstractions and not meant to be exact replicas of phenomenon, I believe that the quality/correctness of the evidence used to construct a behavioural model must be of good quality. The key informants interviewed for the model substantially raised the quality of the evidence used in this model. However, as noted above, some models of systems do not approach evidence in this way. In my opinion, to develop the decision tree further or create an ABM, so that they are useful, good quality evidence must inform their construction and/or population. The decision tree model and the ABM each require extensive data collection for models that may be outdated by the time they are published. Behaviour is constantly changing: strengthening, dissipating, slowly and quickly and unpredictably. More so with the exponentially increasing development of technology, and increase in communication. The Uptake Model, and the ethnographic Nigerian research and worldwide assessment, take a more general view of behaviour, that could be refined continually over time. The decision tree model and ABM (if quality evidence informed) are data heavy, and the additional information they might provide would not be worth the investment in their creation.

I hope that the Uptake Model and extensions contribute to future research and policy that improves development efforts to support the reduction of deaths and disabilities from PPH. I also hope that the inclusion of women in the development of this research is seen

as essential and valuable, not just to creating correct representations of women's lives, but to empower women as contributors in efforts to improve their lives.

Conclusion

The Uptake Model and the extensions presented in this thesis fulfil the aim of the thesis: to demonstrate the value of using complexity theory, to describe the process of the behaviour of uptake, for the treatment of PPH, by women who give birth at home in Nigeria. The Uptake Model and the extensions explain well some of the key aspects of complex system theory and provides a novel examination of treatment seeking behaviour for PPH.

Complex systems theory is new to public health and researchers are still creating and navigating how this theory can be used. There were many challenges and limitations in the creation of this model, including unsuccessful efforts to spend time in Nigeria to validate the model. Despite these limitations, the Uptake Model and extensions provide a strong foundation of work that elucidates our understanding of behaviour, and that future research and policy can benefit from. This work not only serves as a starting point, for others to further model PPH and maternal health service uptake, but also in thinking about how other conditions can be modelled with a complex systems approach.

Health behavioural theories and public health have long recognized the importance of interactions and complexity, and gone about exploring them in a variety of ways. This recognition and previous investigations allowed for complex system theory to be welcomed into public health, and as we experiment and develop its use, we contribute to our shared goal of improving people's lives.

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Appendix A: WHO recommendations for the prevention and treatment of postpartum haemorrhage

From WHO Guidelines Approved by the Guidelines Review Committee. WHO Recommendations for the Prevention and Treatment of Postpartum Haemorrhage. Geneva: World Health Organization, 2012

WHO recommendations for the prevention of postpartum haemorrhage

- The use of uterotonics for the prevention of PPH during the third stage of labour is recommended for all births. (Strong recommendation, moderate-quality evidence)
- Oxytocin (10 IU, IV/IM) is the recommended uterotonic drug for the prevention of PPH. (Strong recommendation, moderate-quality evidence)
- In settings where oxytocin is unavailable, the use of other injectable uterotonics (if appropriate ergometrine/methylergometrine or the fixed drug combination of oxytocin and ergometrine) or oral misoprostol (600 µg) is recommended. (Strong recommendation, moderate quality evidence)
- In settings where skilled birth attendants are not present and oxytocin is unavailable, the administration of misoprostol (600 µg PO) by community health care workers and lay health workers is recommended for the prevention of PPH. (Strong recommendation, moderate quality evidence)
- In settings where skilled birth attendants are available, CCT is recommended for vaginal births if the care provider and the parturient woman regard a small reduction in blood loss and a small reduction in the duration of the third stage of labour as important (Weak recommendation, high-quality evidence)
- In settings where skilled birth attendants are unavailable, CCT is not recommended. (Strong recommendation, moderate-quality evidence)
- Late cord clamping (performed after 1 to 3 minutes after birth) is recommended for all births while initiating simultaneous essential newborn care. (Strong recommendation, moderate quality evidence)
- Early cord clamping (<1 minute after birth) is not recommended unless the neonate is asphyxiated and needs to be moved immediately for resuscitation. (Strong recommendation, moderate-quality evidence)
- Sustained uterine massage is not recommended as an intervention to prevent PPH in women who have received prophylactic oxytocin. (Weak recommendation, low-quality evidence)
- Postpartum abdominal uterine tonus assessment for early identification of uterine atony is recommended for all women. (Strong recommendation, very-low-quality evidence)
- Oxytocin (IV or IM) is the recommended uterotonic drug for the prevention of PPH in caesarean section. (Strong recommendation, moderate-quality evidence)
- Controlled cord traction is the recommended method for removal of the placenta in caesarean section. (Strong recommendation, moderate-quality evidence)

WHO recommendations for the treatment of postpartum haemorrhage

- Intravenous oxytocin alone is the recommended uterotonic drug for the treatment of PPH. (Strong recommendation, moderate-quality evidence)
- If intravenous oxytocin is unavailable, or if the bleeding does not respond to oxytocin, the use of intravenous ergometrine, oxytocin-ergometrine fixed dose, or a prostaglandin drug (including sublingual misoprostol, 800 µg) is recommended. (Strong recommendation, low-quality evidence)
- The use of isotonic crystalloids is recommended in preference to the use of colloids for the initial intravenous fluid resuscitation of women with PPH. (Strong recommendation, low-quality evidence)
- The use of tranexamic acid is recommended for the treatment of PPH if oxytocin and other uterotonics fail to stop bleeding or if it is thought that the bleeding may be partly due to trauma. (Weak recommendation, moderate-quality evidence)
- Uterine massage is recommended for the treatment of PPH. (Strong recommendation, very low-quality evidence)

- If women do not respond to treatment using uterotonics, or if uterotonics are unavailable, the use of intrauterine balloon tamponade is recommended for the treatment of PPH due to uterine atony. (Weak recommendation, very-low-quality evidence)
- If other measures have failed and if the necessary resources are available, the use of uterine artery embolization is recommended as a treatment for PPH due to uterine atony. (Weak recommendation, very-low-quality evidence)
- If bleeding does not stop in spite of treatment using uterotonics and other available conservative interventions (e.g. uterine massage, balloon tamponade), the use of surgical interventions is recommended. (Strong recommendation, very-low-quality evidence)
- The use of bimanual uterine compression is recommended as a temporizing measure until appropriate care is available for the treatment of PPH due to uterine atony after vaginal delivery. (Weak recommendation, very-low-quality evidence)
- The use of external aortic compression for the treatment of PPH due to uterine atony after vaginal birth is recommended as a temporizing measure until appropriate care is available. (Weak recommendation, very-low-quality evidence)
- The use of non-pneumatic anti-shock garments is recommended as a temporizing measure until appropriate care is available. (Weak recommendation, low-quality evidence)
- The use of uterine packing is not recommended for the treatment of PPH due to uterine atony after vaginal birth. (Weak recommendation, very-low-quality evidence)
- If the placenta is not expelled spontaneously, the use of IV/IM oxytocin (10 IU) in combination with controlled cord traction is recommended. (Weak recommendation, very-low-quality evidence)
- The use of ergometrine for the management of retained placenta is not recommended as this may cause tetanic uterine contractions which may delay the expulsion of the placenta. (Weak recommendation, very-low-quality evidence)
- The use of prostaglandin E2 alpha (dinoprostone or sulprostone) for the management of retained placenta is not recommended. (Weak recommendation, very-low-quality evidence)
- A single dose of antibiotics (ampicillin or first-generation cephalosporin) is recommended if manual removal of the placenta is practised. (Weak recommendation, very-low-quality evidence)

Appendix B: Protocol Literature Review Models of Uptake of Postpartum Haemorrhage Interventions by Patients

TITLE

A Literature Review of Models of Uptake of Postpartum Haemorrhage Interventions by Patients

Author
Meghann Gregg

Protocol written
October 2, 2017

Original search date: October 2, 2017
Updated search date: December 31, 2019

BACKGROUND

Before commencing the building of the Uptake Model it is important to first identify if other similar models exist.

Aim

The aim of this literature review is to identify published models that examine (explain, identify, predict) how elements (factors, determinants) influence the uptake of postpartum haemorrhage (PPH) interventions by patients, in a clinic or hospital setting.

METHODS

The format of this protocol was adapted from the Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0, Chapter 2 Preparing a Cochrane Systematic Review, Box 2.2.a: Sections of a protocol for a Cochrane review.

Criteria for Selecting Studies

Any study type can be included in this review, provided the main aim of the study is to describe a model that examine how elements influence the uptake of postpartum haemorrhage (PPH) interventions by patients, in a clinic or hospital setting. If the aim of the article is to examine an element (factors, determinants) that could influence uptake, but the examination is not within the question of uptake (e.g. estimating the affordability of a service), the article would be excluded. Models that examine elements that influence uptake include:

- Conceptual models. Models that explain or hypothesis how elements interact and/or influence uptake. These are not mathematical models, they describe the components and interaction of a process/system/idea.
- Statistical models. With statistics, these models estimate if a relationship exists between elements and uptake (e.g. regression models, structured equation models).
- Process simulation models. These mathematical models explain or predict how elements are interconnected, and their influence on uptake using nonlinear equations and/or logic equations.
- Spatial models. Models that explain or predict interaction between physical locations and uptake (e.g. gravity model).

Models of care, which describe procedures of how care should be undertaken are not included as models in this review. Also, models as ideals not included.
Participants included in the search are patients seeking prevention or treatment for PPH. Typically this is a woman who is pregnant or has just given birth. However she herself may not have made this decision, therefore the review will include persons who have made the decision for her to use prevention or treatment (i.e. husband, partner, parent, relative, community member, or other). For studies of this population to be included it must be explicitly stated in the article that this other person has made the decision for prevention/treatment to be used.

Interventions included in the search are those included in the World Health Organizations (WHO) Recommendations for the Prevention and Treatment of Postpartum Haemorrhage (1). These interventions are given for prevention of PPH (at the time of birth) or in the case of PPH (in the 24 hours after birth). WHO recommendations predominantly require a clinic or hospital setting, therefore included studies will be those that consider uptake in a clinic or hospital setting.

It should be noted that prevention and treatment for PPH may not be modelled specifically as uptake of PPH interventions. PPH interventions can be included within other maternal care services during the perinatal (intrapartum) period. Therefore, to ensure the capture of all relevant studies, a wider search will be conducted including maternal health services uptake. Articles will be included that examine delivery location as PPH prevention, as it is encompassed in this choice (even if it is unknown). Please see table 1 for eligibility criteria.

Table 1: Eligibility Criteria

Study Type	Any, with the aim to describe a model of elements influencing uptake of PPH interventions by patients
Participants	Women seeking prevention or treatment, or those taking the decision for her
Interventions	WHO recommendations for prevention and treatment of PPH
Setting	Clinic or hospital

Search Methods for Identifying Studies

Search

Three terms and their variations will be searched in 2 databases (MEDLINE PubMED and Web of Science). Please see table 2 for search terms and variations.

Table 2: Search Terms and Variations
MEDLINE PubMED

TERM	VARIATIONS
model	Modelling OR modelling
patient acceptance of health care[MeSH Terms]	
maternal health services [MeSH Terms]	

Web of Science

TERM	VARIATIONS
model	Modelling OR modelling
uptake	accept OR acceptance OR acceptability OR adopt OR adoption
maternal	(obstetric OR postpartum) AND (healthcare, OR clinic OR hospital OR centre OR health care OR surgery)

Each article in the MEDLINE PubMED database are indexed by medical subject headings (MeSH) terms, that describe the content of the articles (2). It is appropriate to use MeSH terms in a MEDLINE PubMED search. The MeSH terms ‘patient acceptance

of health care' will include all articles that focus on uptake, and the MeSH term 'maternal health services' will include all articles that focus on maternal health services (prevention and treatment for PPH).

All years will be searched and the search will be restricted to studies on/about humans, and the English language. To make the search more specific, the search in MEDLINE (PubMED) will be of title and abstracts only. It is reasonable to assume that an article about a model of uptake on PPH interventions would state this in the title/abstract. PPH interventions can occur alongside other maternal health services, therefore the search will include PPH and maternal health as keywords. This will increase the sensitivity of the search.

Searches in the Web of Science will be made more specific by refining the results by Web of Science categories. Web of Science categorises citations by subject categories. These categories will be selected after the search results, as the list of categories is generated from the search. For example, as we are interested here in patient uptake, we can exclude the category Occupational Health.

Results will be moved to endnote 8.1 and duplicates will be removed.

Table 3: Search Strings for Databases

DATABASE	SEARCH STRING
MEDLINE (PubMED)	((((modeling[Title/Abstract]) OR modelling[Title/Abstract]) OR model[Title/Abstract])) AND ((patient acceptance of health care[MeSH Terms]) AND maternal health services[MeSH Terms])
Web of Science	(model OR modelling OR modeling) AND (maternal OR obstetric OR postpartum) AND (healthcare OR clinic OR hospital OR centre OR health care OR surgery) AND (uptake OR accept OR acceptance OR acceptability OR adopt OR adoption) Timespan: All years. Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI.

Identifying Studies: Screening for Inclusion

One reviewer (M.G.) will assess articles for inclusion over two screening stages. In primary screening the title and abstract will be reviewed to determine inclusion. See table 3 for primary screening questions. If all answers are yes/unsure the article will move to secondary screening (full-text review) to confirm whether the article will be included or not. If the answer is no in primary screening, the article will be excluded from the review.

Table 4: Primary Screening Question, Title and Abstract

Question 1	Is the main aim of the article to describe a model of elements that influence uptake of PPH interventions (as defined by WHO Recommendations for the Prevention and Treatment of Postpartum Haemorrhage) by patients in a clinic/hospital setting?	yes/unsure	no

Secondary screening will be conducted on the full text of articles. Articles that meet the inclusion criteria will be included in the review. The question for secondary screening will be the same as primary screening. The exception is that the responses to the inclusion question after full text screening can only be yes or no. If the answer is no in secondary screening, the article will be excluded from the review and the reason for exclusion recorded.

Data Collection and Analysis

Extraction

Information will be extracted from included articles using an extraction form (table 4), and input into Excel. Information will be extracted by one reviewer (M.G.).

Table 4: Extraction Form

PUBLICATION
Author(s)
Title
Study type
Study aim
Year published
POPULATION
Country
Population
MODEL
What type of model is used to examine/explain uptake?
RESULTS
What are the results of the model and pertaining to PPH?

Quality Assessment

Quality assessment will be done on the included articles. Assessment will be guided by methodological checklists/tools to assess quality of articles (varies by study type), and the authors discussion on limitations.

Results

Results of the search will be communicated in a PRISMA flow diagram. All included articles will be placed in a table that indicates the study details (see example table 5). A written description of each model will produced, reflecting the extraction results. The quality, strengths and weakness of each model type will be discussed.

Table 5: Example: Included Articles

Number	Author (s)	Title	Year	Journal
1	Abdul-Mumin KH	Village midwives and their changing roles in Brunei Darussalam: A qualitative study	2016	Women and Birth
2	Ahmed J, Ur Rehman S, Shahab M	Community midwives' acceptability in their communities: A qualitative study from two provinces of Pakistan	2017	Midwifery

Limitations

There are a number of limitations to this review. First, article selection and categorisation of extracted data will be done by one reviewer: these are both subjective tasks and the results will reflect this. This limitation will be minimised with clear inclusion criteria and extraction questions. Second, it is possible that some articles were not captured in the search due to searching two databases, language limitations. The results should be considered with these limitations in mind.

REFERENCES

1. World Health Organization. WHO Recommendations for the Prevention and Treatment of Postpartum Haemorrhage. Geneva: World Health Organization
2. Georgia State University. PubMed - Searching Medical Literature: Using Medical Subject Headings (MeSH) 2017. Available from: http://research.library.gsu.edu/pubmed.

Appendix C: Ethics approval letter

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Observational / Interventions Research Ethics Committee

Ms Meghann Gregg LSHTM

11 July 2018

Dear Meghann,

Study Title: Modelling the uptake of biomedical health care services and the impact on intervention outcomes for postpartum haemorrhage in Nigeria

LSHTM Ethics Ref: 14532

Thank you for responding to the Observational Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval having been received, where relevant. Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Investigator CV	MEGHANN GREGG CV ARPIL2018	16/04/2018	1
Protocol / Proposal	ProtocolDelphiStudyMay29	29/05/2018	1
Protocol / Proposal	Focus Group and Design Voice Protocol to Validate Behavioural Maps	29/05/2018	1
Information Sheet	ParticipantInformationSheetDelphi	29/05/2018	1
Information Sheet	ConsentDelphi	29/05/2018	1
Information Sheet	ParticipantInformationSheetDesignvoice	29/05/2018	1
Information Sheet	ConsentDesignvoice	29/05/2018	1
Advertisements	RecruitmentPoster	29/05/2018	1
Information Sheet	ParticipantInformationSheetDelphiV2	03/07/2018	2
Information Sheet	ParticipantInformationSheetDesignvoiceV2	03/07/2018	2
Covering Letter	EthicsResponseJuly32018	03/07/2018	1

After ethical review

The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

An annual report should be submitted to the committee using an Annual Report form on the anniversary of the approval of the study during the lifetime of the study.

At the end of the study, the CI or delegate must notify the committee using an End of Study form.

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: http://leo.lshtm.ac.uk

Additional information is available at: www.lshtm.ac.uk/ethics

Yours sincerely,

[redacted]

Professor John DH Porter Chair

ethics@lshtm.ac.uk http://www.lshtm.ac.uk/ethics/

Improving health worldwide

Appendix D: Systematic review protocol

Protocol date: September 22, 2017

Title

Systematic Review and Synthesis of Elements, and their Interactions, that Influence the Uptake of Postpartum Haemorrhage Interventions in Clinical Facility Settings by Patients

Author Gregg M

Introduction

Postpartum haemorrhage (PPH) is reported to be the leading cause of maternal death worldwide, with the majority of these deaths occurring in lower income countries (1,2). Efforts to reduce the burden of PPH typically centre on the development of interventions and health services to deliver these interventions (3). However, without the uptake of health services, the efforts to reduce the burden of PPH through this approach cannot be realized.

There exists many challenges to our understanding of the uptake of health care services. Part of the reason is that current approaches take linear views of determinants that influence uptake, or focus on one area of uptake (or level) and do not consider a wider, dynamic, and interconnected view of determinants. While more narrow approaches can be useful, they should be placed within a wider understanding otherwise results and conclusions drawn about uptake will be misleading.

The aim of this review is to collect a list of elements and element interactions the influence the uptake of PPH interventions (prevention and treatment) by patients and delivered in clinical facility settings. This list will help to inform a conceptual map that will broadly illustrate uptake and the influencing and interacting elements. The map will inform a subsequent mathematical model that will help to realize patterns and drivers of uptake.

Aims and Objective of Literature Review

AIMS

1. To identify elements that can influence the uptake of biomedical PPH interventions by patients in a clinical facility setting
2. To identify interactions between the elements identified in the first aim (i.e. how an element behaves in the presence or absence of another element, the relationship between elements, sequentially, conditionality)
3. To identify the effect of the elements and element interactions upon uptake

OBJECTIVE

To conduct a review of the published literature to identify articles that the main aim is to identify, discuss, or examine elements that are explicitly linked to influencing the uptake of biomedical PPH interventions by patients in a clinical facility setting

Notes on Terminology

Element influence over uptake can be supportive, obstructive, or delaying. The terms facilitators and barriers are not used because they denote directionality. As context influences directionality

and directionality is not consistent across contexts the term *element* is used instead as it conveys no directionality. Examples of elements are: transportation, perceived quality of care, disposable income, cost of care, religious beliefs, social culture, women's rights etc.

Patients include women of reproductive age, and other decision makers that can have power over whether or not a woman seeks biomedical prevention or treatment for PPH. Other decision makers include a husband, parent, relative, community member, or other. To be included other decision makers must clearly influence the decision of a woman or her movement. This must be explicitly stated by the author. These different decision makers will be noted in extraction. Other persons (e.g. health care workers, politicians etc.) may be included if they make commentary about why a woman uses or does not use healthcare. This may be the case when the women had died and others are making commentary through survey about why the women had died and the reasons why (e.g. elements influencing uptake).

Biomedical PPH interventions include procedures and pharmaceuticals recommended by the WHO for the prevention and treatment of postpartum haemorrhage (see Appendix I). Please note that PPH interventions may not always be known to respondents/participants in studies, they may seek care to have a safe birth or to stop bleeding. Biomedical PPH interventions do not include the choice to have a caesarean section, as this is a specific type of delivery in a clinical facility setting, not a PPH intervention.

Methods

Search Strategy

The bibliographic databases MEDLINE (PubMed) and Web of Science will be searched for studies that aim to identify, discuss, or examine elements that influence the uptake of biomedical PPH interventions by patients in clinic or hospital settings. Two search term sets will be searched. Each term set is a variation of one of the two terms (uptake and postpartum haemorrhage). Please see table 1 below for search terms and variations. All years and study types, will be included in the search. The search will be conducted on the full text of each study. Please see table 2 for the search strings for MEDLINE (PubMed) and Web of Science. Please note that MESH terms are assigned to each study after review of the abstract by MEDLINE (PubMed), they are not assigned by the author.

Table 1: Search Term Sets, Literature Review of Elements

Database	Search Term Sets
MEDLINE (PubMed)	patient acceptance of health care [MeSH Terms]
	AND
	(Maternal OR Obstetric OR Postpartum OR "Post partum" OR "Post-partum") AND (Haemorrhage OR Hemorrhage)
Web of Science	(use OR utlise OR utilize OR utilisation OR utilization OR accept OR acceptance OR acceptable OR access OR accessing OR participate OR choosing OR choose OR choice OR seek OR seeking OR demand OR decline OR refuse OR refusal OR prefer OR preference OR preferred)
	AND
	((health OR delivery) AND (care OR service OR services OR facility)) OR (hospital OR clinic OR centre OR center OR post)
	AND
	(reason* OR facilitator* OR barrier* OR impediment* OR component* OR factor* OR motive* OR motivation* OR cause* OR element*)
	AND
	(maternal OR obstetric OR postpartum OR "post partum" OR "post-partum") AND (haemorrhage OR hemorrhage)

Table 2: Search Strings for Databases

Database	Search String
MEDLINE (PubMed)	Search ((((Maternal OR Obstetric OR Postpartum OR "Post partum" OR "Post-partum")) AND (Haemorrhage OR Hemorrhage))) AND patient acceptance of health care [MeSH Terms] Sort by: Author
Web of Science	
#9	#7 AND #5 AND #2 AND #1 Refined by: [excluding] WEB OF SCIENCE CATEGORIES: (ENVIRONMENTAL SCIENCES OR UROLOGY NEPHROLOGY OR ACOUSTICS OR VETERINARY SCIENCES OR PLANT SCIENCES OR AGRICULTURE DAIRY ANIMAL SCIENCE OR PARASITOLOGY OR TRANSPLANTATION OR FOOD SCIENCE TECHNOLOGY OR OPHTHALMOLOGY OR CLINICAL NEUROLOGY OR ENGINEERING INDUSTRIAL OR DENTISTRY ORAL SURGERY MEDICINE OR GENETICS HEREDITY OR COMPUTER SCIENCE INFORMATION SYSTEMS OR CHEMISTRY MULTIDISCIPLINARY OR NEUROSCIENCES OR BIOTECHNOLOGY APPLIED MICROBIOLOGY OR CARDIAC CARDIOVASCULAR SYSTEMS OR BIOCHEMISTRY MOLECULAR BIOLOGY OR CHEMISTRY MEDICINAL OR BIOLOGY OR ALLERGY) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#8	#7 AND #5 AND #2 AND #1 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#7	#6 OR #4 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#6	TS=(hospital OR clinic OR centre OR center OR post) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#5	TS=(reason* OR facilitator* OR barrier* OR impediment* OR component* OR factor* OR motive* OR motivation* OR cause* OR element*) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#4	TS=(health OR delivery) AND TS=(care OR service OR services OR facility) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#3	#2 AND #1 Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#2	TS=(maternal OR obstetric OR postpartum OR "post partum" OR "post-partum") AND TS=(haemorrhage OR hemorrhage) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years
#1	TS=(use OR utlise OR utilize OR utilisation OR utilization OR accept OR acceptance OR acceptable OR access OR accessing OR participate OR choosing OR choose OR choice OR seek OR seeking OR demand OR decline OR refuse OR refusal OR prefer OR preference OR preferred) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years

Database search results will be exported to Endnote X8.1 and duplicates will be deleted.

Screening

Search results will be screened for inclusion by two independent reviewers in two stages. The primary screening stage will be of title and abstract only. If inclusion criteria are confirmed/unknown during primary screening, then the study will move to secondary screening (full-text screening).

Inclusion criteria

- English language
- Participants: women of reproductive age who have given birth or may in the future give birth, those who have power in the decision of whether a woman uptakes healthcare services (e.g. husband, mother, mother-in-law, other relative, traditional birth attendant etc), persons commenting on elements that influence the uptake of

healthcare services by women (e.g. health care workers, community members, politicians etc.).

- Types of Studies: qualitative, quantitative, mixed method, literature review
- Study aims explicitly to identify, discuss, or examine an element(s) that influences the uptake of biomedical PPH interventions by patients. This may include studies on the delay in seeking/accessing care, if elements are identified, discussed or examined that influence a delay in uptake. Women may seek care for safe birth (PPH prevention) or to stop bleeding (PPH treatment), and may not be able to identify the clinical name PPH or the interventions. Where studies aim to identify the causes of PPH mortality, near-miss, or morbidity, words such as remote causes, environmental factors, cultural contexts, avoidable factors, socio-cultural factors, and associated factors indicate elements may be identified that influence uptake of services.
- Clinical facility setting: a facility where biomedical interventions for prevention and treatment of PPH are administered by health care professionals. For example a clinic or hospital, but not a community based program where care is administered in the community.
- Outcome of interest: study reports or concludes in findings/results section an element(s) influencing uptake of PPH interventions (prevention or treatment) concluded from the analysis of the study (original research). Not influencing if from regression, x2, or percent change.

Exclusion Criteria

- Is not English language
- Study only identifies elements in reference to other published studies, opinion, unknown source, and not from author's original research. References in articles to elements from other studies will be reviewed for inclusion.
- Commentaries, editorials, case studies
- Literature reviews that do not contribute new data/information or new analysis
- Literature reviews that are superseded by an updated literature review

Extraction

An extraction form will be built in Excel to collect and analyse results from the review. Data to be extracted will include:

- Study Information
- Title of study
- Author(s)
- Year of publication
- Study type
- Theory study is based on or analysis based on
- Timeline of the study
- Study population (age, sex, location, city/rural, country, marital status, income level, education)
- Healthcare setting (clinic, hospital)
- Where has birth occurred?
- Uptake of which intervention or service (treatment, prevention, both)
- Type of service (pay-per-use, government insurance, private insurance, charity)
- Aim 1: Elements
- Element name
- Element definition
- Element category name
- Element category definition

- How is element measured (method)
- How is element analysed (method)
- Is the identification of the elements based on past experience or a future (preferred, imagined)?
- What is the level of element (individual/group/population/structural)?
- If author does not indicate level of element, what is my assessment of level?

Aim 2 & 3: Context and Interactions

- Does the presence of the element support or oppose uptake?
- Are any conditions noted for the present element to support/oppose uptake?
- Does the absence of the element support or oppose uptake?
- Are any conditions noted for the absent element to support/oppose uptake?
- Is there a sequential placement?
- Is the sequential placement conditional?
- If yes, what is it conditional on?
- Does the element interact with other elements?
- If yes, which elements?
- Describe the interaction (held constant, duration of hold, changes, changes how, further supports or opposes uptake, duration of change)
- Are there any conditions for the interaction to occur?
- Are there any conditions for the interaction to cease?
- Does the interaction produce feedback? (Result in an interaction occurring back to the element identified as causing the interaction)
- If yes, describe the feedback

Additional extraction items may be added to the list during the extraction process. If this occurs, extraction will begin again with the first study to ensure consistency of data extracted. Extraction data will be conducted by one reviewer and checked by another reviewer.

Analysis

The goal of this literature review is to identify from the published literature, elements, element interactions, and their effect upon the uptake of biomedical PPH interventions by patients in clinical facility settings. After data extraction is complete, the included studies will be tabulated as and outcomes will be summarized. Subsequently, a unique list will be developed through thematic sorting of the elements and element interactions. Quality assessment of individual studies (by outcome) and across studies (by outcome) will be conducted. There will be three steps to the analysis of the results: please see below.

Step 1: Create a unique list of elements and element interactions by thematically sorting all the extracted elements and interactions. Sorting will be conducted by two reviewers independently, then one list will be finalised by the lead author.

There will likely be multiple elements with the same name. Element names will only appear once on the unique list, and the count of how many times the name appeared will be noted. It may occur that studies will contain some of the same elements or interactions, but use different terminology for identification. When this occurs one encompassing name will be chosen, and the rational for the choice will be recorded. It will also be appreciated that when elements or interactions have the same name, they may not be defined or behave in the same way.

Care will be given when grouping elements under the same name in consideration of the characteristics across all studies that contribute to the new element name. It may be that even

when definitions are the same and elements names are slightly different, that characteristics and interactions are different. In this case it will be assessed whether or not elements can be grouped under the same name, and aggregating characteristics and interactions, or if elements should be kept separate. This will depend on the context and interactions of the elements and the quality of the research and extracted data determined in the analysis.

Step 2: The outcomes extracted from each study will be assessed in quality assessment of individual studies. As all data is qualitative being extracted, studies will be assessed for qualitative methods. This adds a layer of complication as studies may be quantitative yet qualitative data is being extracted from them. Study types will be noted in quality assessment for review readers to clearly identify when a qualitative assessment is being done on a quantitative study. As recommended by the Cochrane Collaboration, the review authors take responsibility to choose the most appropriate assessment tool for the study being reviewed.

Step 3: The quality of outcomes extracted will also be assessed across studies using GRADE CERQual.

A note on the analysis: It is possible that elements can fit together in multiple ways to create a comprehensive whole, or some variation of this. The analysis may be adjusted after viewing all extracted data, or through the identifying and categorisation process, depending on what the data and analysis reveals.

Results

Search and screening results will be presented in a flow diagram (PRISMA). A table will be created of all included studies summarising the study characteristics and outcomes. The unique list of elements, and interactions will be presented, and an explanation of sorting and naming will be described in written text. Quality of the evidence will be presented for individual study outcomes and across studies by outcome.

Limitations

There are a number of limitations to this literature review. First, not all relevant studies will have been captured with this search. This review only searchers publications in the English language, and only includes two large databases. It is possible that some studies that would have met inclusion criteria were missed. The language limitation should be noted. In regards to the databases, given the coverage of the two databases chosen it is likely that most relevant publications will be captured. Please note that no literature review can capture all relevant studies due to time lag between search and analysis. The aim is to minimize this limit. Second, there is subjectivity in assessing the quality of the study outcomes, individually and across studies, even when more than one reviewer is involved. This limitation should be noted when considering the results.

References

1. GBD 2013 Mortality and Causes of Death Collaborators. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2015;385(9963):117-71.
2. Say L, Chou D, Gemmill A, Tuncalp O, Moller AB, Daniels J, et al. Global causes of maternal death: a WHO systematic analysis. Lancet Glob Health. 2014;2(6):e323-33.
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Appendix E: Focus group protocol

Focus Group and Design Voice Protocol to Validate Behavioural Maps

Protocol Date: May 29, 2018
Version 2 Date: July 26, 2018
Author: Meghann Gregg, LSH1512517

BACKGROUND

A mathematical model is being built to describe and simulate the possible elements that influence uptake of facility based health care services for postpartum haemorrhage (PPH) prevention and treatment in a global setting. Nigeria has been selected as an example country to determine applicability of the Global Model to a national setting. There are multiple steps in creating the model, one of which is the development of conceptual maps to inform the model framework, inputs, and relationships between inputs to inform the mathematics to estimate the outcomes.

It is essential to include Nigerian women in the validation of the model, as it is their lives and behaviours that are reflected in the model, and as this model may impact their lives through policy change. The aim of this study is to validate the model through engagement with Nigerian women. Validation with Nigerian women is to ensure that the model represents uptake (inclusion of possible elements, interactions, and effects, and arrangement of elements) from a Nigerian perspective.

METHODS

Designvoice

Designvoice, is similar to Photovoice (1) but it uses drawing and design instead of photographs. Designvoice requests participants to create drawings and designs (in this study textile design) to express their opinions and ideas about research. Collecting information on behaviour requires appropriate methodology, which are not possible to implement over a short time period, as behaviour is not a topic that people can speak to easily (due to taboos, and the hidden nature of most behaviour as it is not readily recognizable). To overcome this challenge I will use Designvoice.

Art has been used throughout history to comment on life, document events, and share ideas. Art can invoke subconscious thoughts that can be brought into physical representations, for example in art therapy (2). It is the access to different parts of the mind through creativity that can contribute to a richer exchange of ideas about behaviour. As artistic expression is not an easy form of communication for all persons, those with artistic aspirations or experience will be invited to participate.

The purpose of transforming drawings into textile design is primarily to create a genuine reciprocal relationship between the researcher and the participants. Participating women will be provided with an opportunity to explore and develop skill in textile design. Additionally, the designs will be printed onto scarves, and women will receive a scarf of their design, and if agreed another copy of the scarf will be showcased for the general public to view (see below in results section for more details). The showcasing of the textiles (scarves) will give women a venue to share their skill and ideas with the general public, which not only gives them potential future opportunities, but helps to create stronger and wider relationships between researchers and

communities. Participating women can truly gain from this workshop while helping to strengthen the conceptual models and therefore the mathematical models. Please note that textile design was chosen as Nigeria is world renowned for textile design (3), and scarfs are multi-functional and can be used by women in many ways, including covering, presenting, and protecting. These actions hold a deeper meaning in expressing the behaviour and lives of women.

Recruitment and Sampling

I have been unable to secure funding to travel to Nigeria to conduct this research. As it is essential to include Nigerian women, I propose to conduct the study in London, United Kingdom, with new immigrants and refugees from Nigeria. Recruitment will be conducted through London based organizations that support Nigerian immigrants and refugees, including the Nigerian Organization of Women, Refugee Women's Association, and various churches and mosques (to be identified through my personal network). Organizations will be asked to communicate to members about the study, verbally and with recruitment posters that I will provide.

A purposeful sample of 20 women of childbearing age (18 to 45 years of age), who have recently relocated to the United Kingdom from Nigeria in the past five years, or Nigerian born women who currently live in London and have spent a significant amount of time in Nigeria in the past five years (6 months continuously), will be recruited. Refugee women as well as immigrant women will be invited to ensure equal opportunity to participate, and also as these two groups of women will likely come from different income groups, thereby strengthening the conceptual map. As the study solicits opinion to inform the conceptual model in relation to participant knowledge of the health system and cultures in Nigeria, and not specific person experience of PPH in Nigeria, a representative sample is not necessary.

Location and Workshop Environment

The location of the workshop will be held at the London School of Hygiene and Tropical Medicine (LSHTM). LSHTM is a neutral location away from community or community organization politics. As participants will be recruited from different areas and through different organizations in London there may exist prejudices or favouritism if the location of the workshop is at a community organization. I do recognize that there is a power dynamic in place between participating Nigerian women and a UK institution, researchers, and what these represent. This dynamic will be present when holding the workshop at LSHTM. In order to minimize any negative effects from this dynamic there will be other study staff present, including the design facilitator who will be of African origin. Also, all study staff present will be women. I will ensure the workshop is a respectful and informal environment by communicating to women that their participation is very appreciated, and any ideas or thoughts they have are very welcome and will be accepted. I will also allow the workshop space to be one that people can speak whenever they wish to the entire group, and not restrict talk or movement. All participants will be encouraged to speak and given the opportunity to speak afterwards in private if they wish (in person or by email).

Workshop and Data Collection

The workshop will take place over one evening on August 21st 2018, at LSHTM Tavistock Place. The workshop will run for 3 hours, from 6:00 pm to 9:00 pm. The workshop will produce qualitative lists and descriptions from group work and discussions, and drawings and textile designs reflecting upon the research. The workshop will include a presentation of the purpose of the workshop and how it will progress and consent will be collected. Then the research aims and objectives will be presented, followed by a discussion about the research, then a free-listing exercise to collect opinion about what should be included in the model. The preliminary model

results will not be presented to the participants so as not to influence their responses. Discussions will be prompted from the free listing around two questions: why go to a doctor for postpartum haemorrhage and who not go to a doctor for postpartum haemorrhage. Participants will be encouraged to draw throughout the first evening workshop, and an artist facilitator will be present to encourage and support women in drawing their thoughts. The women will then transfer their drawings into textile designs.

Participants will be asked to explain their resulting textile prints at the end of the workshop. With the consent of all participants the workshop will be audio recorded and anonymous pictures will be taken of the drawings. Participants will have the choice of whether or not they want to be identified as the artist of the drawings and textiles. If participants do not want to be recorded a researcher will be present to take notes. Findings will be summarised at the end of each workshop to ensure participants feedback was captured properly.

Analysis

Qualitative summaries will be produced of the discussions, free-listing, drawing descriptions, textile descriptions, and closing discussions. If the workshops are audio recorded, they will be reviewed against written qualitative summaries for correctness.

Ethics

Consent will be sought at the beginning of the workshop to give women the opportunity to ask questions. It will be made clear that consent can be withdrawn at any time. Though the research does not solicit person experience about health seeking behaviours, it is likely that women will draw from their own experiences as well as others that they are aware of. The topic of PPH could be difficult if a woman has suffered from it or knows someone who has. Also, it may be difficult for refugees to speak about Nigeria given the circumstances of their departure.

RESULTS

The results from the workshop will be used to improve the conceptual maps in terms of inclusion of elements, interactions, element and interaction effect and model framing.

Textile Production and Exhibit

After the workshop, textile designs will be printed onto scarves. Two scarves will be printed for each design, one for the woman to keep, and one to be displayed at an exhibit for the general public at LSHTM Kepple Street. I will try to arrange a launch evening for the exhibit of the scarfs and for the women to speak and be recognised. The exhibit will only occur if women consent to showing their scarves. The exhibit will take place in December 2018.

REFERENCES

1. Nykiforuk CI, Vallianatos H, Nieuwendyk LM. Photovoice as a Method for Revealing Community Perceptions of the Built and Social Environment. . Int J Qual Methods. 2011;10(2).
2. Haeyen S, van Hooren S, Hutschemaekers G. Perceived effects of art therapy in the treatment of personality disorders, cluster B/C: A qualitative study. The Arts in Psychotherapy. 2015;45:1-10.
3. Metropolitan Museum of Art. The Essential Art of African Textiles: Design Without End 2018 [cited 2018 May 29]. Available from: https://www.metmuseum.org/exhibitions/listings/2008/african-textiles.

PARTICIPANT CONSENT FORM

Title of Project: Focus Group and Design Voice to Validate Behavioural Maps Name of Researcher responsible for project: Meghann Gregg

Statement	**Please initial or thumbprint* each box**
I confirm that I have read the information sheet dated May 29 2018(version1) for the above named study. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily. **OR** I have had the information explained to by study personnel in a language that I understand. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected.	
I understand that data about/from me/the participant may be shared via a public data repository or by sharing directly with other researchers, and that I will not be identifiable from this information	
I agree to take part in the above named study	

Printed name of participant	Signature of participant	Date

I attest that I have explained the study information accurately in the participant information sheet and at the workshop on August 1st 2018, and was understood to the best of my knowledge by, the participant and that he/she has freely given their consent to participate.

Printed name of person obtaining consent	Signature of person obtaining consent	Date

Participant Information Sheet

Title of Project: *Focus Group and Design Voice to Validate Behavioural Maps*

Introduction

I would like to invite you to take part in a research study. Joining the study is entirely up to you. Before you decide, you need to understand why the research is being done and what it would involve. Ask questions if anything you read is not clear or you would like more information. Please feel free to talk to others about the study if you wish. Take time to decide whether or not to take part.

What is the purpose of the study?

For my Ph.D. at the London School of Hygiene and Tropical Medicine (LSHTM) I am doing research to improve women's health during childbirth in Nigeria. My research explains the many reasons why women go the doctor or hospital to get help for bleeding after childbirth (called postpartum haemorrhage). Though Nigeria is a very diverse country, health plans are made at the federal level, so it is important to look broadly at experiences across Nigeria for similarities and differences.

Currently my research uses previous work and expert opinion to explain women's behaviour, and now I would like to include the voices of Nigerian women. I am inviting Nigerian women who have recently moved to London to a workshop to watch a presentation of my research and share thoughts and ideas about it.

During the workshop you will sit with other Nigerian women and I will share with you my results so far. You will be invited to share what you think about my research. Your opinion will help to shape the next stage of this research.

In addition to speaking you are invited to share your opinions through drawing and design. Drawing can help to express ideas without the restriction of language. An artist will help guide you to express your ideas through drawing and to transform your drawings into a scarf design. The scarf design will be printed and you will be given a copy. With your consent an additional copy will be made to display at a special exhibit at the London School of Hygiene and Tropical Medicine, Kepple Street. You will be invited to attend and speak if you wish on the first day of the exhibit. The exhibit will be held August 15th 2018.

Why have I been asked to take part?

You have been invited because of you are a Nigerian woman of childbearing age, recently moved from Nigeria (within the past year), with an interest in creating art.

Do I have to take part?

No. It is up to you to decide to take part or not. If you don't want to take part, that's ok. Please let me know if you want to arrange a phone call to discuss the study further or send me an email if you have any questions. If you agree to take part, then I will ask you to sign a consent form individually in a separate room at the workshop in case you have any concerns or questions.

What will happen if I take part?

You will attend two evening workshops that will take place over two evenings from 6:30 pm to 9:00 pm on August 1st and August 2nd at (a location in the recruitment neighbourhood-currently being negotiated). You will take part in discussions about the research and share what you think. You will make drawings about your thoughts and ideas, and on the second evening you will transform your drawings into textile designs that will be printed (with the help of a professional artist). You will receive a print of your design, and if you wish another print will be made to be displayed at an exhibit for the public.

What are the possible risks and disadvantages?
You can choose to be anonymous if you wish or you can have your name associated with your drawings and textile design. It is up to you to decide. Remaining anonymous will not exclude you from the Worksop or receiving a print of your design. If you choose to be anonymous your name will be kept in a separate electronic file in a password protected document, on a password protected computer and network. Your name will only be kept on your consent form.

The workshop asks for your opinion, not your personal experiences with postpartum haemorrhage or care seeking. However I understand that your opinion may be based from your experience. There is a possibility that you may become upset by the conversation at the workshop.

What are the possible benefits?
I cannot promise the study will help you but the information I get from the study will help knowledge and understanding of health seeking behaviour by patients for postpartum haemorrhage in health facilities in Nigeria.

What if something goes wrong?
If you have a concern about any aspect of this study, you should ask to speak to myself and I will do my best to answer your questions at Meghann.Gregg@lshtm.ac.uk +44 (0) 77 6378 8879. If you remain unhappy and wish to complain formally, you can do this by contacting my supervisor Simon Cohn at Simon.Cohn@lshtm.ac.uk +44 (0) 20 7927 2848. The London School of Hygiene and Tropical Medicine holds insurance policies which apply to this study. If you experience harm or injury as a result of taking part in this study, you may be eligible to claim compensation.

Can I change my mind about taking part?
Yes. You can withdraw from the study at any time. You just need to contact me and say that you don't want to be in the study anymore. If you withdraw from the study after the first workshop I will keep your results from the first workshop, unless you tell me not to. It may not be possible to destroy your results from group discussion as these will be collectively presented.

What will happen to information collected about me?
All information collected about you will be kept private. At the end of the project, the study data will be archived for ten years on a protected computer, and in a locker in a locked room at LSHTM.

What will happen to the results of this study?
The study results will be used to improve conceptual models which will be revised after your participation. These models will be published in a peer-reviewed journal. The models will be used to create a mathematical model. Your personal information will not be included in the study report and there is no way that you can be identified from it.

If you choose to be a part of the exhibit on August 15th you can choose to do so anonymously or with your name known. The exhibit will run for one month, and, with your consent, the scarves will be archived and used in future exhibits.

Who is organising and funding this study?
London School of Hygiene & Tropical Medicine, Clinical Trials Unit, is the sponsor for my Ph.D. research.

Who has checked this study?
All research involving human participants is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by The London School of Hygiene and Tropical Medicine Research Ethics Committee (LSHTM Ethics Ref: 14532).

Further information and contact details
Thank you for taking time to read this information leaflet. If you think you will take part in the study please read and sign the consent form.

Appendix F: Individual quality assessment by study ID

Study ID 1: Chiwuzie et al 1995 (CASP)

Results Valid:

There is minimal information reported on the study design, and it is unclear if researcher or participant bias was considered and minimised. The authors do not qualify in their data analysis how common or predominant the elements influencing uptake were, making it difficult to determine to what extent these elements influenced uptake. Results are from self-reports in a group setting (focus group), which may influence responses.

There was a somewhat clear statement about the aim of the research and the methodology was appropriate. There is limited reporting of the research design, no reporting of the recruitment strategy, and no justification for the choice of method or number of focus groups. The data was collected in a way that addressed the research issue. It is not clear if the relationship between the researchers and participants had been adequately considered, as it was not reported. Authors do mention women were interviewed by women, and that men were interviewed by men.

What are Results?:

There is no ethical statement or description of ethics being considered. There is no description of how data was analysed so we cannot comment on the rigor. There is a clear statement of findings.

Results Local:

The results could perhaps help locally (e.g. providing transportation) but it is clear that the study results are not fully reflective of the situation. For example, the authors mention in the introduction that issues of sexism are present but this was not collected in the focus groups. Perhaps participants did not feel comfortable to discuss or are taught/told not to discuss sexism, however this was not discussed in the article (why the authors' state sexism is present yet it is not captured in the focus groups). The results should be applied with consideration of limited study reporting, design, and potential researcher and participant bias.

Generalizable beyond Local:

It is possible that these elements are be important in other settings, with the consideration of contextual influences and limitations mentioned above. The authors do not discuss these results in relation to findings from other studies.

Study ID 2: Etuk, Itam, Asuquo 1999 (CASP)

Results Valid:

This is a mixed method study. Our outcomes of interest were captured in the qualitative part (open-ended questions) of the study. Women were asked "why they preferred the church" for delivery. The aim is clearly stated. The methodology is perhaps appropriate, as well as the design to address the research questions, but it is difficult to have confidence as little detail is reported. The recruitment strategy was likely appropriate (attempted to capture all defaulting women who booked to deliver at the study hospital, tracing 67.36%, of which 43.5% delivered outside of an orthodox health facility). We cannot make an assessment on if data was collected to address the research issue as no description of the study was given (simply stated interviews, open-ended questions, and verbal autopsy were conducted). Additionally, we cannot comment on if the

relationship between the researchers and participants had been adequately assessed as this was not reported.

What are Results?:

There is no ethical statement or description of ethics being considered. There is no description of how data was analysed so we cannot comment on the rigor. There is a somewhat clear statement of findings, however results are presented together with other diagnoses and therefore not possible to separate out PPH. Results are partially unclear as some are grouped into an “other” category and never described further.

Results Local:

It is unclear if the results could help locally as not enough information was reported about the study design, implementation, or analysis. Results should be assessed in consideration of limited study reporting and potential researcher and participant bias.

Generalizable beyond Local:

It is possible that these elements are important in other settings, with the consideration of contextual influences and limitations mentioned above. The poor reporting on study design, implementation, and analysis make it difficult to have confidence in applicability to other settings.

Study ID 3: Kalim et al 2009 (CASP)

Results Valid:

There were clear statements about the aim of the research and the qualitative method was appropriate (in-depth interviews), and the method is appropriate to address the aims of the research. It is unclear if the recruitment strategy was appropriate to the aims of the research as authors do not explain why they selected the number of participants or how they were selected. It is unclear if the data was collected in a way that addressed the research issue as there is no explanation of how the interviews were designed and implemented. There is no description of the tools and techniques used, for example what was the thematic scope of the questions. It is unclear if the relationship between the participants and the researchers was adequately considered, as there is no reporting of this in the text, other than to say that interviewers were trained.

What are Results?:

There is no ethical statement or description of ethics being considered. Data may have been analysed with rigor but there is little detail around it, simply stating that content analysis was used. There are clear statements of the findings.

Results Local:

We are somewhat confident that results could be useful in this local setting. The method was appropriate, and results were likely analysed well. However, there is no information on the design of the interviews, the selection of participants, ethical consideration, or the relationship between participants and researchers, all of which could introduce serious bias into the study. Results should be considered with these potential limitations.

Generalizable beyond Local:

It is possible that these elements are important in other settings, with the consideration of contextual influences and of the limitations mentioned above. The limitations of the reporting (and perhaps of the study) make it difficult to have confidence in applicability to other settings.

Study ID 4: Okong et al 2006 (CASP)

Results Valid:

There was a somewhat clear statement of the aims of the research: aims are vague. The method was appropriate, however the design leads participants' answers. The elements in the questionnaire were pre-defined before administration, and consequently participants could only answer within the pre-defined elements. Therefore it is likely that not all elements of importance to the participants were captured. This also lessens our confidence that all the elements identified by this study were occurring in this setting, as when participants are given answers to choose from, they may choose an answer even if it is not applicable to them simply because it was presented (response bias). We do not have good confidence that the research design was appropriate to address the aims of the research, as there are no details of the questions in the questionnaire and given the concerns above about pre-defining elements. The study design was in line with other aims, for example filling the gaps in patient records, but not our outcome of interest (delays in seeking care).

We have concerns about the recruitment strategy. It attempted to capture all women who fulfilled the criteria for near miss at four hospitals, however it is very possible that a number of records were not correct in identifying near miss as "less than half" of the records were incomplete (loose and lost pagers, undated, no time recorded, brief notes). Authors simply state that incomplete records were followed up with interviews, but there is details about the number followed up, and with whom. It is reasonable to assume that due to poor records not all near miss women were captured. We do not know if those women not recorded correctly were significantly different from those who were correctly coded (e.g. perhaps those with poor coding were due to poverty, ethnic discrimination etc.). Though the authors aimed to collect data in a way that addressed the research issue (delays in seeking care), this should be considered with reference to the limitations. Efforts were made to address the relationship between the researchers and the participants, (plain clothes health care workers to interviewer, use of local vernacular, interviewers empathetic not blaming). There are other issues that could effect this relationship that were not reported/discussed in this paper.

What are Results?:

This study received ethics approval and verbal consent was obtained. It is difficult to assess if data analysis was significantly rigorous. It is simple stated that "narrative data were…cleaned, read and abstracted". There was a clear statement of findings, however results are presented together with other diagnoses and therefore not possible to separate out PPH.

Results Local:

The results could perhaps help locally but we have concerns with the study design and implementation that could affect applicability (pre-defined answers and leading questions, other researcher participant relationship bias, potential for important missing cases). Given this we feel that the study results may not be fully reflective of the local situation.

Generalizable beyond Local:

It is possible these results could apply to other settings but the above concerns with local applicability should be considered.

Study ID 5: Orji, Ogunlola, Onwudiegwu 2002 (CASP)

Results Valid:

The method to identify elements is qualitative but the effect (presence impacting delay) is reported quantitatively. Please note that no elements were reported to be present 100% of the time, all were below 50%, and of the seven results reporting percentages, five were 25% or lower. These elements occurred less often than not.

It is difficult for us to comment on the validity of the results as there was no reporting of the details of the study design, just that people were interviewed (relatives of women who died). There was a clear statement of the aim of the research and interviews would be an appropriate method, but no details were given on the design of the interviews. This also disables us to comment on if the design of the study appropriately addressed the aim of the research. There are no details reported on recruitment for us to comment on if the recruitment strategy was appropriate. Additionally, there is no comment by authors about adequacy addressing the relationship between researchers and participants: this could introduce serious bias into the study.

What are Results?:

There is no ethical statement or description of ethics being considered. There is very little description of how data was analysed so it is difficult to comment on the rigor ("The data were fed into an IBM-compatible personal computer and analysed accordingly"). There was a clear statement of findings, however results are presented together with other obstetric problems and therefore not possible to separate out PPH.

Results Local:

The results could perhaps help locally but we cannot be confident as very little was reported about the study design and analysis. Additionally, the percentage given for the occurrence of elements was always under 50% and often 25% or lower. Given this, it is likely that the study results do not fully reflect the local situation.

Generalizable beyond Local:
It is very difficult to comment on applicability of results to another setting given the uncertainty about the results due poor reporting of the study design and analysis.

Study ID 6: Osubor, Fatusi, Chiwuzie 2006
Results Valid:

There is a clear aim of the study, and an appropriate method (focus groups) is used to address the aim. The participant recruitment however is randomised which in our opinion is not appropriate for a study on behaviour given the complexity of behaviour (in particular variation and patterns). Randomisation does not equal representativeness when behaviour is the topic. Additionally, there is not sufficient detail about the sampling or number of participants included. There is mention of a previous study but no reference which is suspicious.

Some of the results were from focus groups and some from questionnaires. In seven cases it is not clear which method was used to determine the element. For this qualitative assessment we have assumed that all elements were collected in the focus group. This may not be correct so for those seven elements with unknown methodology please review the extraction sheet and consider during element specific across study

assessment (CERQual). There is no comment by authors about adequacy addressing the relationship between researchers and participants: this could introduce serious bias into the study.

What are Results?:

Ethics was considered as authors report ethics approval from a teaching hospital and that standard operating procedures were followed. Data may have been analysed with rigour, as authors state they have identified patterns and themes, but they do not give more detail. There was a clear statement of findings, however review findings are presented together with other causes of death and therefore not possible to separate out PPH.

Results Local:
The results could perhaps help locally, if the sample reflects the entire local context, but we cannot determine this from the article. If results are considered within the limitations of the study they could be useful.

Generalizable beyond Local:

With consideration of the study limitations and contextual nature of behaviour these results could be generalised cautiously to other similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Study ID 7: Sibley et al 2005 (NOS)

Results Valid:

This is a quantitative study using a "structured survey questionnaire" via face to face oral interviews. I have designated it as a cross-sectional, descriptive study. The authors report that they captured all women in the study area who reported symptoms or signs of excessive and who had planned to give birth at home and whose pregnancy resulted in birth or abortion in 1998. Women were identified through a survey questionnaire and this was administered to all households about household demographics. The reader can assume all women were identified, however there is no discussion of this nor how many households were in the study area. An internet search reveal that the population is 181,591. The article reports a sub-study of women between 15 and 49 years of age, who reported excessive bleeding, but it is possible that not all women who experienced excessive bleeding reported it. It is also possible that not all women were identified in the larger demographic study. Neither of these potential limits are discussed in the article.

I am unsure if the method used to address the aim is appropriate, as asking participants a set questionnaire with pre-defined answers limits their ability to respond in a way reflecting their experience. It is also not clear how the questionnaire was asked (e.g. were they given responses to choose from?). Authors state that local terms were incorporated into the questionnaire. There was no discussion of the relationship between the participants and the researchers. Ethics approval for the study was obtained as was verbal consent from participants. Outcomes were self-reported.

What are Results?:

It is difficult to assess our review finding that was extracted from the study, as results from different causes of bleeding (birth and abortion) are grouped together. It is simply stated that 18% “of women sought care outside of the home in response to signs or symptoms suggesting excessive bleeding”.

Results Local:

It is possible that results apply locally, but I cannot be confident considering the limitations of the study and lack of reporting.

Generalizable beyond Local:

Concerns about local application apply to application to other settings.

Study ID 8: Sikder et al 2011 (CASP)

Results Valid:

There was a clear research aim stated, and the methodology was appropriate to address the research aim. Participants were interviewed with semi-structured, in-depth interviews. The recruitment strategy was a purposeful sample of 40 participants (women and families in the case of women's death), and is appropriate to the research aim. There is no comment by authors about adequacy addressing the relationship between researchers and participants: this could introduce serious bias into the study.

What are Results?:

Ethics was considered as authors report obtaining informed consent. The results may have been analysed with rigour as they were analysed by qualitative analysis software and coded and reviewed by a second reviewed for recurring themes. There is however, some issue with the clarity of results as different complications are all grouped together, (cannot separate out elements pertaining specifically to PPH).

Results Local:

The results would likely help locally, if the sample reflects the entire local context, but we cannot tell this. If results are considered within the limitations of the study they could be useful.

Generalizable beyond Local:

With consideration of the study limitations and contextual nature of behaviour these results could be generalised cautiously to other similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Study ID 9: Ashimi and Amole 2015 (NOS)

Results Valid:

Authors report inadequate information on the study design for an assessment on the validity of results. It is not clear if our review findings were collected with a qualitative or quantitative methodology, it is simply said that people were interviewed. The results of the interviews are reported quantitatively. Given the limited reporting we (MG and AWS) have agreed to designate this study quantitative. This study has been designated to be a cross-sectional, descriptive study that uses semi-structured questionnaires for collection and counts, frequencies and logistic regression analysis for analysis. As per the systematic review protocol, regression results are not extracted from this study as it was not a randomised controlled trial, and therefore regression results cannot be viewed as causal.

There is not enough information reported to have confidence in the representativeness of the sample. Every third woman attending the antenatal clinic at two hospitals was sampled. There is no reporting on the size of the population the sample is taken from, nor is there rationale for why every third woman was sampled. Sample size was calculated with Fisher's formula, citing a WHO document about estimating sample size in health studies. However, as behaviour is not evenly distributed within a population it is not appropriate to sample with this method. It is difficult to assess whether those selected with the above sampling method are different from those who were not. From those selected it was reported that 97.1% consented. The women included in the study were from an ante-natal clinic that was paid for by clients, therefore we must consider results in this context (clients have money to pay for care).

The outcomes of this study were self-reported, and this could introduce bias, especially as there was no discussion about the relationship between researchers and participants, except that female nursing students administered questionnaires.

What are Results?:

Ethics was considered: the study approved by the Federal Medical Centre, and informed consent was obtained. Though results are called qualitative in the article, referring to results reflecting reasons for delivering at home, they were reported with frequencies and percentages. No other information was given on how these were summarised or designated into categories to be report quantitatively. Therefore I conclude that these "qualitative variable" were designated beforehand and part of the questionnaire, and therefore actually quantitative, as they were likely collected with counts. Additionally, review findings are presented together with other obstetric problems and therefore not possible to separate out PPH.

Results Local:

It is possible that results apply locally to women who access paid antenatal services. One should consider the limitations of the study and reporting before applying locally, particularly that outcomes are self-reported and that the relationship between researchers and participants has not been discussed, and therefore the questionnaire may not reflect the bias that can be introduced due to power relationships, differing perspectives, and the leading nature of questions.

Generalizable beyond Local:
Concerns about local application should be considered when attempting to apply to other communities.

Study ID 10: Belton, Myers, Ngana 2014 (CASP)

Results Valid:

This paper is reported to be a 'rapid ethnography' but it is in-depth interviews. It is unclear why or how authors determined this to be a rapid ethnography. The research aim was clearly stated, though the method was not clearly stated. If we assess the paper with the method of in-depth interviews we determine the methodology was appropriate to address the research aim. It is difficult to assess the appropriateness of the recruitment strategy. It is a purposeful sample of 11 but there is no rationale for why the number 11 was chosen. Perhaps it was all the women the in the community the female church leader knew of (participants recruited by church leader)?

There is no comment by authors about adequacy addressing the relationship between researchers and participants. This can seriously bias a study. One point of concern for

an “ethnography”, is the way authors disrupted the culture of men speaking to have women speak. It is good to allow women to speak, but it is not a cultural observation.

What are Results?:

Ethics was considered as authors report ethics committee approval from the study university, and teaching study staff about research ethics. The results may have been analysed with rigour (thematic analysis) but it is not possible for us to fully assess as the authors reference a textbook that details their analysis method and we cannot access this textbook. The research findings are clearly stated, however for our review finding it is not clear which cases were haemorrhage (as not captured in this study). One case was determined by the authors as haemorrhage, but there was no medical confirmation. The results are presented for some women where no diagnosis is proposed.

Results Local:

The results could perhaps help locally, if the sample reflects the entire local context, but we cannot tell this from the limited study description and rationale for sample choice. There could be other women who were not selected that differ significantly from those selected. If results are considered within the limitations of the study they could be useful.

Generalizable beyond Local:

With consideration of the study limitations and contextual nature of behaviour these results could be generalised cautiously to other similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Study ID 11: Chiphangwi et al 1992 (CASP)

Results Valid:

There is a clear statement about the aim of the research, though for our review finding it is stated clearly in the abstract, not the full text of the article (i.e. introduction or methods sections). It is likely that in-depth interviews are appropriate to address the research aim, and that the study design is appropriate. There is some description of the questions asked and very little reported about how it was administered. The recruitment strategy was appropriate to the aims of the research. Almost all deaths reported were investigated 140/150. 4124 respondents were asked about maternal deaths in the area of Thyolo (population 431,539). This is less than 1% of the population. There is no explanation of how or why these 4124 persons were chosen to be interviewed, and therefore they could be significantly different from those not interviewed. Authors indicate that participants were randomly selected but there is no description of how this was done. Given the limited reporting on the how interviews were administered, it is unclear if the data was collected in a way that addressed the research issue. It is unclear if the relationship between the researchers and the participants was adequately considered. It was simply stated that midwives administered the interviews but were untrained in interviewing. Also, some data was collected from respondents about deaths that occurred many years in the past, so there may have been recall bias.

What are Results?:

Ethics are not reported as being considered, and there is no description of how results were analysed, therefore it is not possible to comment on the rigour of the analysis. The statement of finding is not clear and the results pertaining to our review finding were not in the results section, but reported in the discussion section. Additionally, the review

finding is presented with other causes of death and it is not possible to separate out those elements specific to PPH.

Results Local:

It is difficult to determine if the results can be transferred locally as it is unclear how the interviews were administered, ethics were not considered, and it was not reported if the relationship between the researchers and the participants was adequately considered. All of these could have introduced serious bias into the results, even given a potentially widespread and random sample.

Generalizable beyond Local:

Concerns about local application should be considered when attempting to apply to other communities.

Study ID 12: Choulagai et al 2013 (NOS)

Results Valid:

The aim of this study is clear however there is insufficient reporting in the article to assess how well the study was designed or implemented. This is a cross-sectional study that uses questionnaires to collect counts, frequencies and analyses correlation with logistic regression. As per the systematic review protocol, regression results were not extracted from this study as it was not a randomised controlled trial, and therefore regression results cannot be viewed as causal. I am not confident that the sampling is representative of the included districts as the authors report. Authors describe a two stage random sampling: first two “Ilaka”, which are three to five village development committees and municipalities which are divided from study districts, were chosen from each of the three included districts. There is no rationale for how or why these Ilaka are grouped in this way, nor how they were randomly selected. Also, these were not uniformly sampled, as authors chose to select a different number of Ilaka based on population size and deliveries, with no descriptive rationale. In the second sampling stage three wards were randomly selected from each village development committee. Given the lack of reporting there is a possibility that the wards selected are very different from those not selected. Also, authors report that all women in the selected wards with a child under one year old were included in the study because district health office records had data on each of them because BCG immunization is 100% and 99% in the districts. Authors also report that to ensure no woman was missed, the study team visited all households. It is difficult to assess these reports as no numbers are given of the households visited, or any discussion of the quality of district health records. The sample size is likely calculated for a relationship between antenatal care service use and delivery care service use. As sampling is done by cluster, the sample size should be calculated considering clustering. There is not enough information reported in the article to determine if this was done correctly. Women were interviewed individually by a female community health worker. There is no reporting of the consideration of the researcher and participant relationship beyond this.

What are Results?:

Dependent and independent variables were self-reported and bias can be introduced because of this. It was not explained why independent variables were chosen. Other review findings extracted were self-reported and it is not possible to determine how they were collected due to lack of description of the study design and implementation. These other findings were not reported as being identified as variables beforehand, and there was no reporting of a qualitative analyses or grouping of responses, so I assume these responses were fixed beforehand and were part of the questionnaire as closed

questions. I cannot be certain though as it could be due to lack of reporting and limited study design. Providing responses for a participant to choose leads the response to fit the researcher view and does not capture participant experience. Additionally, the review finding is reported in aggregate with other obstetric problems, and therefore we cannot separate out PPH.

Results Local:

It is very difficult to determine if the results can be applied locally due to poor reporting of study design, implementation, and analysis. Also, there is limited reporting about the sample, making it difficult to assess who these results could be applied to. Concerns about pre-defining responses also reduce confidence in the results. Results should be interpreted cautiously and with consideration of the limitations of the study.

Generalizable beyond Local:

Above concerns about local application should be considered when attempting to apply to other communities.

Study ID 13: D'Ambruoso et al 2010 (CASP)

Results Valid:

There was a clear research aim stated, and the methodology was somewhat appropriate to address the research aim. All extracted results are evidenced with participant quotes. However it is not clear how the survey was conducted. It is likely the participants were first asked closed-questions and then to elaborate (as is the case with verbal autopsy): this would potentially produce some bias in the results as researchers raised the possible elements first. The participants were not selected to represent the population, but to identify some relevant outcomes. Therefore the recruitment strategy is likely to be appropriate (purposeful and convenience based, 174 deaths).
There is little consideration by authors to adequately address the relationship between researchers and participants. Authors state study staff familiarity with the local area, choosing nurses over doctors to avoid taking a line of inquiry about diagnosis (assumes nurses do not do this), but nothing is said of power relationships and taboos etc. Not considering this relationship can seriously bias a study.

What are Results?:

Ethics was considered as authors report informed consent and study approval, as well as consideration given in training study staff to manage upsetting scenarios with participants. The results were likely analysed with rigour (detailed description of thematic analysis). The research findings are clearly stated, however the review finding is presented with other causes of death and it is not possible to separate out those elements specific to PPH.

Results Local:

The cases were not statistically selected to represent a population, however they are examples from two very different geographic and socio-cultural settings, therefore they could be generalised cautiously to other similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Generalizable beyond Local:
With consideration of the study limitations and contextual nature of behaviour these results could be generalised cautiously to other similar contexts. This would require

understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Study ID 14: Deepak et al 2013 (CASP)

Results Valid:

There is a clear statement about the aims of the research and the methodology was appropriate (in-depth interviews). The research design was appropriate to address the research aims. The recruitment strategy was appropriate to the aims of the research: it was purposeful and used snowballing, and not meant to be representative. The data was collected in a way that addressed the research issue. It is likely that the relationship between the researchers and the participants was adequately considered as authors report on the consideration of social desirability bias, recall bias, use of local experienced researchers, and interviewing in local language.

What are Results?:

Ethics was considered: approved at the research institute, locally, and written informed consent by participants. Data analysis is considered to be rigorous and was well described (thematic coding and content analysis). The results were clearly stated, however for our review finding it is not clear when the results pertain to use of uterotonics for PPH or for augmentation of labour. It is not possible to separate out the results. Also, some of the results are conflicting, which can be illustrative of the varied nature of influencing elements.

Results Local:

This is a well reported, designed and conducted study. It is a purposeful sample and not meant to be representative, which we support as behaviour cannot not be captured in a "representative" way due to its dynamic nature and variation within and between all group levels. With the above considerations the study results could be applied to the local setting.

Generalizable beyond Local:

With consideration of the above local application and the contextual nature of behaviour, these results could be generalised cautiously to other similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Study ID 15: Garner et al 1994 (CASP & NOS)
Results Valid:

There was a clear statement of the aims of the research, and the method is identified by authors as a cross sectional study with key informant interviews (for deaths) and follow up interviews (for deliveries and obstetric hospital and health sub centre service users). This is an appropriate qualitative method, and the design was appropriate to address the aims of the research. However, there was minimal description of how the interviews were conducted as it is not possible to tell from the article if the obstetric service user interviews (our review findings) were qualitative or quantitative (open or closed questions). We therefore used both qualitative and quantitative assessment tools to assess this study.
The recruitment strategy was likely appropriate for our review finding, attempting to interview all births registered at the hospital and health sub centre. 77 women of the 110 births registered (adjusted for duplicates) were interviewed: 16 had moved away, and 17 could not be traced. It is possible that those women who could not be traced are

significantly different from those who were traced. An additional 12 women were added, identified through baptismal records and key informants. It can be assumed that these women gave birth at the sub centre as the authors mention these additional women as identified due to a six-month “deficiency” in records at the sub centre. There is no further information on this deficiency or how likely it is that all missing births were captured. There are user fees for hospital and sub centre health care. Also, there is no reporting of the consideration of the researcher and participant relationship.

What are Results?:

Participant consent is mentioned in regards to a different part of the study, but not in relation to the obstetric service user interviews. Additionally, there is no statement of ethics about the study so it is difficult to assess if ethics has been taken into consideration. There is no reporting of data analysis so we cannot assess the rigour of this. The statement of findings was clear, however review findings are presented together with other obstetric problems and therefore not possible to separate out PPH.

Results Local:

The results can be applied locally if consideration are given to the context of the results (e.g. all women reporting on our review finding who could afford to pay for hospital and/or sub centre delivery), and: possible bias from the researcher participant relationship, that women who could not be located for interview may be significantly different from those located, possible bias from closed questions, and rigour of analysis.

Generalizable beyond Local:

With consideration of the above local application and the contextual nature of behaviour these results could be generalised cautiously to other similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Study ID 16: Mbachu et al 2017 (NOS)

Results Valid:

This is a quantitative, cross sectional study. The sample was somewhat representative: it was non-random from a hospital using an exhaustive sampling approach. Using an exhaustive strategy is appropriate for the aim of the study. Assessing how exhaustive the sample was depends on how complete and correct the hospital records were (i.e. how consistently and correctly severe maternal outcomes were identified, and if they were always reported and subsequently recorded). The potential issues about hospital records was not discussed in the article. The article reports on all recorded maternal near-miss and mortality at the hospital. One can infer that data was collected for all cases.

It is unclear how patient oriented problems of uptake (patient delays) were determined. Patient records were used to determine delays. Authors cite a previous study that was adapted to inform this study. The previous study identifies four items deemed as patient-orientated problems, including “those generated by patient or her family either by way of delay in presentation to the hospital, refusal of intervention, or inability to pay for necessary services as at when due or lack of health insurance for necessary intervention". However it is unlikely that these four patient-orientated problems could be captured in hospital records. This introduces a serious flaw into the design of the study.

What are Results?:

Authors state that participant consent was not obtained as the study collected data from patient records. Ethics for the study was approved by a local hospital. The findings are clearly stated, however, there is a mix of different causes of maternal near-miss and mortality, and the review finding extracted is an aggregate of these women's data. It is therefore not possible to link the review finding specifically to PPH. Additionally, review findings are presented together with other causes of severe maternal outcomes and therefore not possible to separate out PPH.

Results Local:

Given the severe flaw in the study design one cannot be confident in applying the results in the local setting (for our review finding).

Generalizable beyond Local:
The threat to local application can be inferred to application in other settings.

Study ID 17:Mbizvo et al 1993 (CASP & NOS)

Results Valid:

There is a somewhat clear statement of the aims of the research. The method of a cross sectional study within a case control study is appropriate to address the aim, and interviewing is appropriate to address the aim of the research. However, not enough information is reported in the article to determine whether the interview was qualitative or quantitative (open or closed questions). We therefore used both a qualitative and quantitative assessment tool to assess this study.

The recruitment strategy is appropriate for the aims of the research. It attempts to be exhaustive, using registry and facility records (reporting system of all female deaths in Masvingo, Harare health institution records, mortuary records, private and public delivery settings). However, there is no mention of if the authors were able to connect with families for all of the maternal deaths. Therefore it is not possible to be certain if any deaths were excluded from inquiry and if these could have been significantly different from those interviewed. Due to limited reporting, it is not clear how participants were interviewed (open or closed questions) and therefore is not possible to assess the appropriateness of data collection, even after looking into referenced articles about how other aspects of the study were published elsewhere and duplicate articles that were slightly re-written. There is no mention in the article about whether the relationship between the participants and the researchers has been considered.

What are Results?:

There is no reporting of ethics being obtained for the study or consent from participants. There is a description of a statistical analysis for the study, but no explanation of if (or how) data was analysed qualitatively. The findings are clearly stated, however for our review finding the results for the women investigated are grouped together (18% of women had haemorrhage as a cause of death). It is therefore not possible to link the review finding specifically to PPH.

Results Local:

It is likely that the results can be applied to the local setting, however it is also likely that results are limited, in that other elements are occurring and were not identified through the interviews. Limitations are due to uncertainty around how the study was implemented (types of questions, if any women were not investigated, and how different they may be from those deaths investigated), if the relationship between participants and researchers was considered, and how qualitative data was analysed (if it was qualitatively collected).

Generalizable beyond Local:
The results could be applied to other settings cautiously, considering the above limitations.

Study ID 18: Mirzabagi et al 2013 (CASP)

Results Valid:

There is a clear statement of the aims of the research and the qualitative methodology (in-depth interviews) is appropriate. The research design is appropriate to address the aims of the research, however there is no rationale stated for why interviews were held in groups of 20 persons, and how this number is, or is not, representative of entire districts. The recruitment strategy may have been appropriate, it used a snowball process in clinics and with “Dais” (traditional birth attendants) to identify births in rural areas. It is not discussed whether women in urban areas that do not visit health clinics and public health facilities should be considered, as they would likely be very different from those captured. The data was collected in a way that addressed the research issue. There is no discussion of whether the relationship between participants and researchers was considered, other than to say interviews were conducted in the local language.

What are Results?:

Ethics were considered: the study was reviewed and informed consent obtained from participants. The data analyses was well described and we believe it was done in a rigorous way (grounded theory and theme definition). The results are clearly stated, however, for our review finding we are not able to separate out the results we are interested in as they are combined with ideas about uterotonics for labour augmentation. Though PPH treatment and prevention is mentioned as an indication for uterotonics, the majority of the participants are concerned with labour augmentation and our extracted review finding includes all participants.

Results Local:

Results are likely to help locally if considered within the scope of the study (emphasis on labour augmentation) and possible limitations (possible as not reported) such as: why urban women who do not visit health centres were not considered and how different they may be from those included, how 20 persons represents an entire district, and how bias could have been introduced if the relationship between participants and researchers was not adequately considered.

Generalizable beyond Local:

The results could be applied to other settings cautiously, considering the local setting and the above limitations of the study, summarized results, and lack of reporting.

Study ID 19: Okolocha et al 1998 (CASP)

Results Valid:

There is a clear research aim stated, and the methodology was appropriate to address the research aim. However, the focus group participants knew each other and this would influence their responses. Additionally, to add interviews after the focus group is potentially useful but not for what the authors suggest: they suggest it is because focus groups cannot transfer to larger populations, therefore interviews would assist in this. It is not clear how or why this is suggested.

It is difficult to assess if the recruitment strategy was appropriate as there is not enough information reported on why the participants were selected, and out of how many potential participants. It is also unclear what the advantage of having homogeneity in the focus group was (age, sex, education, occupation). Indeed some methodological guidance on focus group suggests homogeneity, but as the aim is to capture community based factors one would think to seek diversity, so as to collect more factors and not search for consensus (which is reported in the case of two elements 100% out of five that report percent agreement [there were nine elements extracted in total]). It is not justified why they chose a focus group size of 7-10 persons and 19 focus groups, when the community of Ekpoma has 70,000 persons. Again they do not report who could be a potential participant. The relationship between researcher and participant was not adequately addressed. The article only reported that focus groups were conducted in the local language. Given this, there could be serious bias in this study.

What are Results?:

There is no reporting of ethical approval or considerations. We are not confident that the results were analysed with rigour, as described in the paper, a report was produced by a sociologist who understood the language but was not present at the session (focus group). Then the tape of the focus group discussion and report were reviewed by another team remember who spoke the language. It was not stated if this reviewing team member was present at the focus group. This is unclear and oddly not discussed. Though authors state there were no issues in the focus groups pertaining to translation, as the report was reviewed by other members of the team in addition to the two mentioned above, but clearly data would be lost unless study staff who were present at the focus group reviewed the report. This was not indicated, and potentially compromises the results. The research findings are clearly stated, however findings are about all types of haemorrhage during maternal period, not specifically PPH.

Results Local:

We have little confidence that the results could help locally as there is a serious issue with how the tapes of the focus groups were transcribed and given there was no ethical consideration or consideration of the relationship between researchers and participants. If results are considered within the potential serious limitations of the study they could be useful.

Generalizable beyond Local:

With consideration of the potentially serious study limitations and contextual nature of behaviour these results could be generalised cautiously to other similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Study ID 20: Olaniran et al 1997 (CASP)

Results Valid:

There are two studies within this paper, one qualitative with a focus group and community survey, the second quantitative, before and after, determining the effect of the interventions on uptake (focus group and mini-survey). There was a clear research aim stated, and the methodology was appropriate to address the research aim. However, the limitations of the methodology was not discussed nor how authors would minimize them. The research design was appropriate to the aims of the research, and the recruitment strategy may have been appropriate though there was no discussion of the justification for the number of focus groups chosen, nor the sample size for the survey. We also do not have knowledge of how many people were in the larger population that this sample

was taken from (should be all those giving birth not those in hospital only). For the survey the sample size is as follows for the two communities over all persons (1069/22151, 780/16475). Every 10th woman on the registry was sampled. If the registry is complete this is adequate sampling, however we do not have knowledge of the completeness of the registry. It is not clear how the data was collected nor do the authors discuss consideration of the relationship between the participants and the researchers. These could introduce serious bias into the study.

What are Results?:

There is no reporting of ethical approval or considerations. We cannot comment on whether the results were analysed with rigour because the authors do not report a description of the analysis method or implementation of focus groups and survey. There is a clear statement of findings, however review findings group together all obstetric complications, cannot separate PPH.

Results Local:

We do not have strong confidence that the results could help locally as the methods of this study are poorly reported, and this could lead to serious bias in the results. Additionally, there was no ethical consideration reported or consideration of the relationship between researchers and participants. If results are considered within the potential serious limitations of the study they could be useful.

Generalizable beyond Local:

With consideration of the potentially serious study limitations and contextual nature of behaviour these results could be generalised cautiously to other similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Study ID 21: Ononge, Okello, Mirembe 2016 (CASP)

Results Valid:

There was a clear research aim stated, and the methodology was appropriate to address the research aim. A phenomenological approach was taken and participants were interviewed with open-ended and clarifying questions. The recruitment strategy was a purposeful sample of 15 participants (6 women who delivered at home and 9 traditional birth attendants) and is appropriate to the research aim. The data was collected in a way that addressed the research issue. The authors adequately addressed the relationships between researcher and participant: all interviewers were female, fluent in the language, had no involvement with district administration, voluntary and confidential participation, and no responses would lead to retribution.

What are Results?:

Ethics was considered: granted from university ethics committee, verbal consent from participants, and consideration when interviewing. We have confidence that the results were analysed with rigour from the detailed description and method of ‘meaning units’. There is a clear statement of findings.

Results Local:

We have confidence that the results could help locally as the study is well designed, implemented, analysed and reported. One should consider the small sample size and the potential variability of behaviour and beliefs in the local community.

Generalizable beyond Local:

Even given the small sample size it is possible that these elements and effects could be generalised beyond this community. This should be done cautiously and to similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Study ID 22: Ramos et al 2007 (CASP)

Results Valid:

This is a study using a verbal autopsy, which is an interview guided by a questionnaire with closed and open questions about a death. There is a clear statement of the aims of the research, and the qualitative methodology was appropriate as participants are asked to “describe the dynamics of factors that impeded timely and efficient contact with the health system”.
The recruitment strategy is a sample of 25 cases, representing at least one death per province. This is perhaps not appropriate to the aim which is broad (to determine factors that impede contact with health services), but this strategy could be interpreted as appropriate if it was simply to capture some factors. The results should be considered with the limitation of this recruitment approach. Given this, the research design could be considered not appropriate to the aim, as the aim is broad and does not explicitly state that the study is to capture some potential factors. This also lowers our confidence in whether the data was collected in a way that addressed the research aim.

The authors do not discuss whether the relationship between the participant and the researcher was adequately considered, they simply state that field staff received training. If the training did not consider this relationship then bias would be introduced to the results.

What are Results?:

There is no statement about ethical approval of the study or participant consent. There is no description of the analysis of qualitative results, so we cannot assess whether data analysis was rigorous. There is a clear statement of findings, with results grouped into the 3 delays, however for our review finding it is not clear if the factors apply to those with PPH or to women with other diagnoses. Vignettes are presented but not connected to diagnoses. Haemorrhage accounted for 22.1% of these maternal deaths.

Results Local:

It is possible that these results could be applied locally but one should consider the possible limitations of the study, in particular the recruitment strategy and the presentation of results. Other limitations should be considered to be possible, but not certain, due to lack of reporting. These include: the relationship between the participant and the researcher, ethics, and rigour of data analysis.

Generalizable beyond Local:

These results could be applied beyond this local context but with consideration to the above limitations.

Study ID 23: Rosenstein, Romero, Ramos 2008 (CASP)

Results Valid:

This is a study using a verbal autopsy, which is an interview guided by a questionnaire with closed and open questions about a maternal death outside of a health care facility. There was a clear statement of the aims of the research and the qualitative method was appropriate. The research design was appropriate to address the aims of the research. The recruitment strategy was appropriate as it was meant to be exhaustive. The study investigated the majority of deaths (252/366) of women 10-49 years of age who died outside of a medical facility in Argentina. Those deaths not investigated were due to flaws in the database and incorrect data entry (address, place of death). Of these deaths investigated, 20 maternal deaths were identified. The data was collected in a way that addressed the research aim. The relationship between participants and researchers was somewhat addressed, as interviewers were social scientists that had a two-day training on how to interview, and participants were allowed to choose the location of the interview: these would help to reduce bias.

What are Results?:

Ethics was considered: the study had local ethics approval and informed consent was obtained from participants. The data analysis may have been rigorous. Results were analysed using the three delays framework, but no other information is given. There is a clear statement of findings, but the narrative results are not reported, only summaries into single factors that are placed under delays. It is not possible to separate out the results of those who were diagnosed with haemorrhage from the other diagnoses (4/20 were diagnosed with haemorrhage). It is also not clear if those with a diagnosis of haemorrhage had postpartum haemorrhage.

Results Local:

The result could be applied locally with consideration of the small sample size and the results may not be specific to post-partum haemorrhage. The study gives insight into some of the factors influencing uptake. It should be considered that some bias may still have been introduced from the participant and researcher relationship and how narratives were grouped into single factors.

Generalizable beyond Local:

These results could be applied beyond this local context but with consideration to the above limitations.

Study ID 24: Supratikto et al 2002 (CASP)

Results Valid:

It is difficult to determine if this study meets the inclusion criteria for CERQual. An audit of this kind does have open-ended questions, but it is not clear if these were used for our outcomes of interest. Results of the study are reported quantitatively, and somewhat qualitatively, but this is unclear. We have decided to include this study in the qualitative assessment due to the uncertainty, however it has resulted in a poor quality assessment.

The aim of the study is somewhat clear, and method of open-ended questions to address this aim is appropriate, though it is not clear how this was done or if it was done for our outcomes of interest. There is not enough description of the study method to determine if our outcomes of interest were from closed or open questions. We do not have confidence in the recruitment strategy, though the size for interviews is moderate (30/130 deaths), it is unknown if those chosen to be interviewed differed substantially and in important ways from those who were not interviewed. It is difficult to assess if the data was collected in a sufficient way to address the research question.

The authors did not report any consideration of the relationship between the participants and the researcher. It was stated that village midwifes conducted the interviews, however the reviewers suggest this could have introduced bias due to the power relationship between midwife and community members. Not considering these relationships between participants and researchers could introduce serious bias into the study.

What are Results?:

There is no reporting of ethical approval or considerations. We cannot comment on whether the results were analysed with rigour because the authors do not report a description of the analysis method or implementation. There is a clear statement of findings, however the review finding is presented with other causes of death and haemorrhage is not possible to separate out (do not specify PPH as a type of haemorrhage, group all haemorrhage together).

Results Local:

We do not have enough information from this study to say with confidence whether the results can be applied to the local setting. If results are considered within the potential serious limitations of the study they could be useful locally.

Generalizable beyond Local:

With consideration of the potentially serious study limitations and contextual nature of behaviour these results could be generalised cautiously to other similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Study ID 25: Thaddeus and Nangalia 2004 (CASP)

Results Valid:

There is no statement of the aim of the research, and it not possible to assess the appropriateness of the qualitative method as it is not described (simply state personal communications, collected anecdotal suggestions, and a literature review with very minimal reporting of the method [authors only state that they reviewed one data base and then “complementing it with electronic searches”] and no other description of the review design, implementation, analysis). Given the minimal reporting it is not possible to assess if the research design was appropriate, if the inclusion criteria for the literature review or personal communications and anecdotal suggestions was appropriate, if the data was collected in a way that addressed the research issue, or if the relationship between the participants and the researchers was adequately considered (for the personal communications and anecdotal suggestions).

What are Results?:

There is no reporting of ethics, for the study or with participants. There is no reporting of how results were analysed so it is not possible to determine if these were done with rigour. The research findings are not presented clearly, and it is difficult to identify what method the results are gathered from as these are not well introduced and interspersed throughout the article.

Results Local:

We are not confident these results can be applied locally as there is too little reporting of the methods (design, implementation, analysis) and poor reporting of results. It may be

possible that the factors identified do influence uptake but this study does not provide good evidence.

Generalizable beyond Local:
Given the limitation of the study and reporting these results should not be applied to other locations.

Study ID 26: Thorsen, Sundby, Malata 2012 (CASP)

Results Valid:

There is a clear statement of the aims of the research, the qualitative method is appropriate (interview within verbal autopsy), and the research design is appropriate to address the aims of the research. The recruitment strategy was appropriate to the aims of the research, as the sample is purposeful (maternal deaths who had delivered in hospital or received care in hospital) and resulted in saturation of contributing factors to maternal deaths. It should be considered that 27 investigated deaths, even though authors state they reached saturation point, may not include the variation of factors across the district of 669,021 persons. It is difficult to assess if data was collected in a way that addressed the research issue, as the authors do not share details about the questions or prompts. There is no discussion of whether the relationship between the participants and researchers was adequately considered.

What are Results?:

Ethical approval of the study was obtained locally and from the authors' research institute (Norway). There is no reporting of informed consent by the participants (families of the deceased). Data analysis was likely rigorous as using content analysis informed by the three delays model. Though it should be considered that the evidence picture can be biased when fitting evidence into an existing framework rather than analysing what the evidence shows without a framework. There is a clear statement of findings.

Results Local:

The results could be valuable locally, with the reflection upon if the sample size (27) could achieve saturation within a large population (669,021). Likely the results could be applied locally with consideration of the potential limitations introduced by the way participants were interviewed (types of questions, prompts, relationship between participants and researchers), and how factors are grouped into single factors within three delays model.

Generalizable beyond Local:

Given the limitation of the study as noted above, these results could be applied to similar settings.

Study ID 27: Weeks et al 2005 (CASP)

Results Valid:

There was a clear research aim stated, the methodology was appropriate to address the research aim. Participants were interviewed with semi-structured interviews with open ended questions. The recruitment strategy was a purposeful sample of 30 participants (women who had narrowly avoided maternal death and a pathological diagnosis including haemorrhage), and is appropriate to the research aim. There is no comment by authors about adequacy addressing the relationships between researcher and participant. This can seriously bias a study.

What are Results?:

Ethics was obtained by a hospital committee, however we question whether the psychological harm to the women was considered given they were interviewed immediately after surviving a near-death experience. We have confidence that the results were analysed with rigour from the description of the software used (winMaxx Pro software) and the method of independent theme assessment and that authors had local experience. The statement of findings could be clearer as results are sometimes reported in aggregate and we cannot identify if the women who suffered postpartum haemorrhage were included in these aggregates. Additionally, only one women suffered from postpartum haemorrhage in the sample, and two from placenta praevia that may lead to postpartum haemorrhage.

Results Local:

It is difficult to have confidence in the results of this study given the sample relevant to our outcome is 1-3 persons. Also, the potential that no consideration was given to the research participant relations is concerning and the vulnerability of the time of the interviews (immediately after near-death). Caution should be taken if applying these results to the local setting.

Generalizable beyond Local:

With consideration of the potentially serious study limitations and contextual nature of behaviour these results could be generalised cautiously to other similar contexts. This would require understanding which contextual elements support behaviour and a wider consideration of how behaviour operates.

Appendix G: Full evidence profile GRADE-CERQual

Summary of review finding	Studies contributing to review finding	Methodological limitations	Coherence	Adequacy	Relevance	CERQual assessment of confidence in evidence
1. Care Affordable influences uptake of facility based HCS for PPH	1, 2, 4, 5, 6, 8, 10, 13, 19, 20, 21, 24, 27	Moderate. There are 13 studies included in this finding. Of concern is that most studies (8) do not indicate that they have considered the PRR, and 2 studies somewhat, but not adequately, addresses PRR (uses nurses who are familiar with local area as opposed to Dr who may diagnose AND use local language). 7 of the studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PR relationship and ethics) help to minimise this. Also, of concern is the limited reporting of methodology in 6 studies, no reporting in 1 study, and limited design in 2 studies (elements pre-defined, poor records to identify cases AND rapid ethnography but intervening in cultural practices to get information [not observing] should be called in-depth interviews). In 5 studies there was no reporting on data analysis, and 1 study limited reporting. Of additional importance, 11 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. Directionality of the elements is consistent if viewed in isolation (with other interaction of other elements directionality changes)	Minor. The data for this finding are adequate from 13 studies and extracting 28 elements. 3 studies give enough description to include interactions. 5 studies describe elements with descriptions in the text, 3 give vignettes, and 5 studies provide a list of elements in text or table. All sample sizes are of good size, except one is low with 8 women deaths investigated in 8 families.	Moderate. Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. One major issue of concern is that 11 of the 13 studies for this finding do not give clear results particularly to PPH.	Moderate confidence

2. Perception Birth Process (perceived normal, perceived complication, perception of blood, perception about (female) strength pain) influences uptake of facility based HCS for PPH	1, 3, 4, 8, 10, 14, 15, 17, 20, 22, 23, 24, 25, 26	Moderate. Half (7) of the studies had no ethics consideration, 8 did not report considering the PRR (two additional studies did consider this somewhat, but not adequately). This relationship is highly influential on the finding as power dynamics and culture influence responses. Of concern is that the majority of studies (9) present results in summary with other diagnoses, which effects our understanding of how our outcome of interest is related to PPH intervention uptake. There are additional concerns as 5 studies do not report how data analysis was done, and 4 do not give enough information about the methods and implementation of the study. It is unclear if these issues have not been addressed or if simply not reported.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. Directionality of the elements varies due to contextual difference, but as influence is defined in the review finding as both support and oppose this presents no issue here.	Very minor concerns. Majority of studies have rich data for our purposes: results are well described in text sometimes with vignettes, and three studies have details on interactions. Most have good sample sizes, and even the small sizes (e.g. 8 families) has descriptive text with vignettes and interactions. These elements are reported in many studies 14/27, and 25 elements were extracted for this finding from 14 studies.	Moderate. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. One major issue of concern is that 9 of the 14 studies for this finding do not give clear results particularly to PPH.	Moderate confidence

3. Cause of Complications (supernatural, biological) influences uptake of facility based HCS for PPH	1, 6, 8, 13, 19	Moderate. There is a concern about the PRR being adequately considered-3 studies do not mention this, and 2 make some minor attempts (use of local language, and using nurses who are familiar with local area as opposed to Dr who may diagnose), and 2 studies do not mention ethics. Both of these concerns, present in all studies, could be due to lack of reporting or that PRR was not well considered. People will alter their responses if power dynamics and culture are not assessed. Additionally, 4 studies do not adequately report on the study design and it is therefore not possible to determine if bias was introduced this way (e.g. were elements offered to P to choose from? or were questions open ended). Another major issue is that for 4 studies the results are mixed, so PPH cannot be separated out. Therefore, this finding may not be specific to PPH but to other diagnoses, which are very different from those concerning blood.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. Directionality of the elements varies due to contextual difference, but as influence is defined in the review finding as both support and oppose this presents no issue here.	Moderate. 3 studies have somewhat rich data for our purpose: described in text with a large sample size. 2 studies only list elements. These elements are reported in 5/27 studies, and 6 elements were extracted for this finding from 5 studies. This finding not being present in studies may have more to do with study design than presence of elements, nonetheless data adequacy is impacted for this finding.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. One major issue of concern is that 4 of the 5 studies for this finding do not give clear results particularly to PPH.	Low

4. Decision about care, treatment (if/when to seek care, what kind of care to seek, where to seek care) influences uptake of facility based HCS for PPH	1, 8, 13, 24, 25, 26	Moderate. Of concern is that all studies do not indicate consideration the PRR (one study somewhat does but not adequately i.e. uses nurses who are familiar with local area as opposed to Dr who may diagnose), and 4/6 studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is poor reporting of methodology (3 studies) and data analysis (3 studies), and one additional study has very poor-quality design. It is therefore possible that significant bias could have been introduced into these studies because of the design and analysis, and lowers our confidence in results. Of additional importance, 3 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This could be important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. Directionality of the elements varies due to contextual difference, but as influence is defined in the review finding as both support and oppose this presents no issue here.	Moderate. 3 studies have somewhat rich data for our purpose, and 1 additional study has rich data: 3 describe in text and 1 described with vignettes. 2 studies only list elements (in text and in a table). These elements are reported in 6/27 studies, and 8 elements were extracted for this finding from 6 studies. This finding not being present in studies may have more to do with study design than presence of elements, nonetheless data adequacy is impacted for this finding.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. One major issue of concern is that 3 of the 6 studies for this finding do not give clear results specific to PPH.	Low

5. Perception of Intervention (preferred (general) effectiveness, quality and effect biomedical, quality and effect traditional) influences uptake of facility based HCS for PPH	1, 3, 6, 8, 14, 18, 19	Moderate. Of concern is that all studies do not indicate consideration the PRR (one study somewhat does but not adequately i.e. uses local language), and 3/7 studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is poor reporting of methodology (3 studies) and data analysis (1 studies). It is therefore possible that significant bias could have been introduced into these studies because of the design and analysis, and lowers our confidence in results. Of additional importance, 4 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. Directionality of the elements varies due to contextual difference, but as influence is defined in the review finding as both support and oppose this presents no issue here.	No/very minor. Majority of studies (6/7) have somewhat rich, and rich data, 4 described in text, and 2 with vignettes. Only 1 study lists elements in text. All studies have a good sample size. Four of the studies give substantial description and include interactions of elements. These elements are reported in 7/27 studies, and 20 elements were extracted for this finding from 7 studies. This finding not being present in studies may have more to do with study design than presence of elements, nonetheless data adequacy is impacted for this finding.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. One major issue of concern is that 4 of the 7 studies for this finding do not give clear results specific to PPH.	Moderate confidence
6. Birth Traditions influences uptake of facility based HCS for PPH	1, 8, 10	Moderate. Of concern is that all studies do not indicate that they have considered the PRR, and 1/3 studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is poor reporting of methodology and data analysis in 1 study. It is therefore possible that significant bias could have been introduced into this study because of the design and analysis, and lowers our confidence in results. Of additional importance, 2 of the studies report results along with other	No/very minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). There is very little difference between the way elements are described under this finding. Directionality is consistent with the elements under this finding.	Minor concern from one of the studies under this finding that only lists elements in the text. One study describes elements in the text, and another study with vignettes. 2 studies have a large sample size, and one is 8 families investigating 8 deaths, but uses vignettes. Two of the studies give good description and include	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. One major issue of concern is that 2 of	Moderate confidence

		diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.		interactions. These elements are reported in 3/27 studies, and 3 elements were extracted for this finding from 3 studies. This finding not being present in studies may have more to do with study design than presence of elements, nonetheless data adequacy is impacted for this finding.	the 3 studies for this finding do not give clear results specific to PPH.	
7. Fear and Comfort (fear of procedures, comfortable with procedures, fear of location, need to be in a protected place, or be protected) influences uptake of facility based HCS for PPH	2, 3, 5, 6, 8, 10, 20, 23	Moderate. Of concern is that almost all studies do not indicate that they have considered the PRR (7), and 1 study somewhat but not adequately addresses PRR (trained staff and let P choose location). Half of the studies (4) do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there is no or limited reporting of methodology in 5 studies, and 1 has a poor study design (rapid ethnography but intervening in cultural practices to get information [not observing] should be called in-depth interviews). In 3 studies there was no reporting on data analysis. It is therefore possible that significant bias could have been introduced into this study because of the design and analysis, and lowers our confidence in results. Of additional importance, 2 of the studies reports results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood	Moderate. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. The directionality is consistent for all but one of the extracted elements.	Minor. Majority of studies (6/8) have somewhat rich, and rich data, 4 described in text, and 2 with vignettes. 2 studies list elements (1 in text 1 in table). Majority of studies have a good sample size. Four of the studies give substantial description and include interactions of elements. These elements are reported in 8/27 studies, and 13 elements were extracted for this finding from 8 studies. This finding not being present in studies may have more to do with study design than presence of elements, nonetheless data adequacy is impacted for this finding.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 7 of the 8 studies under this finding do not give clear results specific to PPH.	Low confidence

		takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.				

8. Perception of healthcare worker/caregiver (relationship, behaviour) influences uptake of facility based HCS for PPH	1, 3, 6, 8, 10, 13, 20, 21, 23	Moderate. Of concern is that most studies do not indicate that they have considered the PRR (6), and 2 studies somewhat but not adequately addresses PRR (trained staff and let P choose location AND uses nurses who are familiar with local area as opposed to Dr who may diagnose). 4 of the studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there is limited reporting of methodology in 5 studies, and 1 has a poor study design (rapid ethnography but intervening in cultural practices to get information [not observing] should be called in-depth interviews). In 2 studies there was no reporting on data analysis. It is therefore possible that significant bias could have been introduced into this study because of the design and analysis, and lowers our confidence in results. Of additional importance, 6 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. Directionality of the elements varies due to contextual difference, but as influence is defined in the review finding as both support and oppose this presents no issue here.	Minor. Most of the studies (6/9) have somewhat rich, and rich data, 4 described in text, and 2 with vignettes. 3 studies list elements (2 in the text 1 in a table). All studies have a good sample size. Four of the studies give substantial description and include interactions of elements. These elements are reported in 9/27 studies, and 12 elements were extracted for this finding from 9 studies. This finding not being present in studies may have more to do with study design than presence of elements, nonetheless data adequacy is impacted for this finding.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 6 of the 9 studies under this finding do not give clear results specific to PPH.	Low confidence

9. Care Access (general) influences uptake of facility based HCS for PPH	1, 6, 8, 19, 27	Moderate. Of concern is that most studies do not indicate that they have considered the PRR (4), and 1 study somewhat, but not adequately, addresses PRR (conducted in local language). 2 of the studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there is limited reporting of methodology in 2 studies. In 2 studies there was no reporting and limited reporting on data analysis. It is therefore possible that significant bias could have been introduced into this study because of the design and analysis, and lowers our confidence in results. Of additional importance, 4 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH (one additional study sometimes give specific results mixed with non-specific, but this study only has 1 woman with PPH). This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Moderate. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). This finding groups elements under care access that too vague to group into more specific categories, therefore their meaning is varied, yet still fit under the general care access finding. The directionality is consistent for all elements.	Minor. Most of the studies (4/5) have somewhat rich, and rich data, 2 described in text, and 2 with vignettes. 1 study lists elements in the text. All studies have a good sample size. 2 of the studies give substantial description and include interactions of elements. These elements are reported in 5/27 studies, and 6 elements were extracted for this finding from 5 studies. This finding not being present in studies may have more to do with study design than presence of elements, nonetheless data adequacy is impacted for this finding.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 4 of the 5 studies under this finding do not give clear results specific to PPH.	Low confidence

10. System Access (health care, insurance) influences uptake of facility based HCS for PPH	1, 10, 13, 27	Moderate. Of concern is that most (3) studies do not indicate that they have considered the PRR, and 1 study somewhat, but not adequately, addresses P R (uses nurses who are familiar with local area as opposed to Dr who may diagnose). 2 of the studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there is limited reporting of methodology in 2 studies and 1 has a poor study design (rapid ethnography but intervening in cultural practices to get information [not observing] should be called in-depth interviews). In 1 study there was no reporting on data analysis. It is therefore possible that significant bias could have been introduced into this study because of the design and analysis, and lowers our confidence in results. Of additional importance, 3 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH (one of these studies sometimes give specific results mixed with non-specific, but this study only has 1 woman with PPH). This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Very slight nuances are lost in the thematic grouping, all bureaucracy some about health insurance others about clinic conduct, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. The directionality is consistent for all elements.	Minor. Few studies and elements, and 2 are simple listing of elements in the text or a table. 2 studies have somewhat rich or rich data, and one describes interactions. These elements are reported in 4/27 studies, and 4 elements were extracted for this finding from 4 studies. This finding not being present in studies may have more to do with study design than presence of elements, and may be due to health insurance being available or not (context). Due to these data adequacy is impacted for this finding.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 3 of the 4 studies under this finding do not give clear results specific to PPH.	Low confidence

11. Transportation influences uptake of facility based HCS for PPH	1, 2, 3, 4, 5, 8, 10, 11, 13, 17, 20, 21, 22, 23, 24, 26, 27	Moderate. There are 17 studies included in this finding. Of concern is that most (12) studies do not indicate that they have considered the PRR, and 2 studies somewhat, but not adequately, addresses PRR (uses nurses who are familiar with local area as opposed to Dr who may diagnose AND training and P can choose location). 11 of the studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there is limited reporting of methodology in 8 studies, no reporting in 1 study, and 1 has a poor study design (rapid ethnography but intervening in cultural practices to get information [not observing] should be called in-depth interviews). In 7 studies there was no reporting on data analysis. It is therefore possible that significant bias could have been introduced into this study because of the design and analysis, and lowers our confidence in results. Of additional importance, 15 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH (one of these studies sometimes give specific results mixed with non-specific, but this study only has 1 woman with PPH). This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are slightly varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. The directionality is consistent for all elements.	No/very minor. Many studies provide data for this finding (17) and contribute many elements (33). 10 studies have good or very good adequacy of data, with 4 describing elements in text and 6 with vignettes. 3 studies give good description and include interactions. 6 studies list elements in tables (2) and in text (4), and 1 notes element in the text. It is possible that this is due to transportation being an "accepted" element influencing health seeking behaviour and it is therefore included in study design and/or expectation of researchers. This is not to say it is not actually present, just that this may be why it is strongly present, not indicating that it has more importance.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 15 of the 17 studies under this finding do not give clear results specific to PPH.	Moderate confidence

12. Planning/Communicating Care Access influences uptake of facility based HCS for PPH	8, 10, 21, 23	Moderate. There are 4 studies included in this finding. Of concern is that most 2 studies do not indicate that they have considered the PRR, and 1 study somewhat, but not adequately, addresses PRR (training and P can choose location). People will alter their responses if power dynamics and culture are not assessed, and consideration PRR helps to minimise this. Also, of concern is there is poor design of 1 study (rapid ethnography but intervening in cultural practices to get information [not observing] should be called in-depth interviews). Of additional importance, 3 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH (one of these studies sometimes give specific results mixed with non-specific, but this study only has 1 woman with PPH). This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. The directionality is consistent for all elements.	Minor. Adequate data overall, though only from 4 studies with 5 elements extracted. 2 studies give enough description to include interactions. 3 studies describe with vignettes and 1 with descriptive text. All sample sized are good, except 1 study is smaller (8 families investigating 8 deaths). Even with moderate concerns around study design (PRR richness depends greatly on how a study is designed (what is included as questions [elements themselves?] and expectation of researchers).	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 3 of the 4 studies under this finding do not give clear results specific to PPH.	Low confidence

13. Physical Barriers (remote, environment, distance) influences uptake of facility based HCS for PPH	2, 3, 10, 11, 13, 20, 23, 24, 26	Serious. There are 9 studies included in this finding. Of concern is that most studies (6) do not indicate that they have considered the PRR, and 2 studies somewhat, but not adequately, addresses PRR (uses nurses who are familiar with local area as opposed to Dr who may diagnose AND training and P can choose location). 7 of the studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there is limited reporting of methodology in 6 studies, also of concern is there is poor design of 1 additional study (rapid ethnography but intervening in cultural practices to get information [not observing] should be called in-depth interviews). In 4 studies there was no reporting on data analysis. Of additional importance, 8 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are varied (distance, remoteness, flooding, and landslides), but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. The directionality is consistent for all elements.	Minor. Somewhat adequate data overall, from 9 studies with 15 elements extracted. 2 studies give enough description to include interactions. 3 studies describe with vignettes and 1 with descriptive text. All sample sized are good, except 1 study is smaller (8 families investigating 8 deaths).	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 6 of the 9 studies under this finding do not give clear results specific to PPH.	Low confidence

14. Referral (between levels/types of care) influences uptake of facility based HCS for PPH	1, 3, 6, 8, 19	Moderate. There are 5 studies included in this finding. Of concern is that most studies (4) do not indicate that they have considered the PRR, and 1 study somewhat, but not adequately, addresses PRR (uses local language). 3 of the studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there is limited reporting of methodology in 3 studies. In 1 study there was no reporting on data analysis, and in 1 additional study there was too little reported about the analysis to assess. Of additional importance, 3 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	No/very minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). All elements are about referral, though from biomedical to biomedical, or non-biomedical to biomedical facility. The included studies report elements in very similar ways. The directionality is consistent for all elements.	Minor. Adequate data overall, though only from 5 studies with 5 elements extracted. 3 studies give enough description to include interactions. 4 studies describe elements with descriptions in the text, and 1 study with a list of elements in the text. All sample sized are good, except 1 study is smaller (8 families investigating 8 deaths).	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 3 of the 5 studies under this finding do not give clear results specific to PPH.	Moderate confidence

15. Night, time of day influences uptake of facility based HCS for PPH	1, 3, 5, 10, 13, 21, 25, 26	Serious. There are 8 studies included in this finding. Of concern is that most studies (6) do not indicate that they have considered the PRR, and 1 study somewhat, but not adequately, addresses PRR (uses nurses who are familiar with local area as opposed to Dr who may diagnose). 6 of the studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there are 3 studies with limited reporting of methods (not enough to make an assessment), 1 study with no reporting and 2 studies with poor design (rapid ethnography but intervening in cultural practices to get information [not observing] should be called in-depth interviews AND anecdotal and literature review with very poor methods). 3 studies give no description of data analysis. Of additional importance, 4 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	No/very minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). All elements are about difficulties travelling at night. The included studies report elements in very similar ways. The directionality is consistent for all elements.	Minor. The data for this element is somewhat adequate from 8 studies and extracting 9 elements. 2 studies give enough description to include interactions. 2 studies describe elements with descriptions in the text, 3 give vignettes, and 3 studies provide a list of elements in text or table. Most sample sizes are good, except 1 study is smaller (8 families investigating 8 deaths), and one does not report.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 4 of the 8 studies under this finding do not give clear results specific to PPH. The serious concerns with methods impact the relevance of the data.	Low confidence

16. Social connectedness influences uptake of facility based HCS for PPH	22, 23	Moderate. There are 2 studies included in this finding. Of concern is that both studies do not indicate that they have considered the PRR: 1 not at and 1 study somewhat (trained staff and P can choose location). 1 study does not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. 1 study does not give a description of data analysis. Of additional importance, both studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). All elements are about inability to obtain childcare in community. The included studies report elements in very similar ways. The directionality is consistent for all elements.	Moderate. The data for this element is not very adequate as only noted in 2 studies and extracting 2 elements. Though the absence of this element from other studies may have more to do with study design than the absence of this element. 2 studies give description through vignettes. Most sample sizes are good (25 and 20) for the types of studies (open ended questions).	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that both studies under this finding do not give clear results specific to PPH. The serious concerns with methods impact the relevance of the data.	Low confidence

17. Valuation of Women influences uptake of facility based HCS for PPH	4, 5, 8, 13, 22, 25	Serious. There are 6 studies included in this finding. Of concern is that most studies (4) do not indicate that they have considered the PRR, and 1 study somewhat, but not adequately, addresses PRR (uses nurses who are familiar with local area as opposed to Dr who may diagnose). 4 of the studies do not report ethics. Together all studies have an issue with PRR and/or ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there is limited reporting of methodology in 1 study, no reporting in 1 study, and poor design in 2 additional studies (elements pre-defined, poor records to identify cases AND anecdotal and literature review with very poor methods). In 3 studies there was no reporting on data analysis. Of additional importance, 5 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). All elements are about deciding not to spend money on care or seek care for women, and why. The included studies report elements in very similar ways. The directionality is consistent for all elements.	Minor. The data for this element is somewhat adequate from 6 studies and extracting 7 elements. 1 study gives enough description to include interactions. 3 studies describe elements with descriptions in the text, 1 gives vignettes, and 2 studies provide a list of elements in text or table. Most sample sizes are good, except one study does not report sample size. Study design influences whether this, or any, elements are collected.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 5 of 6 studies under this finding do not give clear results specific to PPH. The serious concerns with methods impact the relevance of the data.	Low confidence

18. Control of women influences uptake of facility based HCS for PPH	3, 4, 5, 6, 8, 10, 23	Moderate. There are 7 studies included in this finding. Of concern is that most studies (5) do not indicate that they have considered the PRR, and 1 study somewhat, but not adequately, addresses PRR (trained staff and gave P choice of location). 2 of the studies do not report ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there is limited reporting of methodology in 2 studies, no reporting in 1 study, and poor design in 2 additional studies (elements pre-defined, poor records to identify cases AND rapid ethnography but intervening in cultural practices to get information [not observing] should be called in-depth interviews). In 1 study there was no reporting on data analysis. Of additional importance, 6 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). All elements are about control of women's personhood, movement, and reproduction. The included studies report elements in diverse but similar ways: they all fit well despite diversity under this finding. The directionality is consistent for all elements.	Minor. The data for this element is adequate from 7 studies and extracting 15 elements. 4 studies give enough description to include interactions. 4 studies describe elements with descriptions in the text, 2 give vignettes, and 1 study provide a list of elements in text. Most sample sizes are good, except 1 study is smaller (8 families investigating 8 deaths).	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 6 of 7 studies under this finding do not give clear results specific to PPH. The serious concerns with methods impact the relevance of the data.	Moderate confidence

19. Care available influences uptake of facility based HCS for PPH	1, 3, 5, 6, 19, 20, 22, 23, 24	Serious. There are 9 studies included in this finding. Of concern is that most studies (6) do not indicate that they have considered the PRR, and 2 studies somewhat, but not adequately, addresses PRR (trained staff and gave P choice of location AND local language). 7 of the studies do not report ethics. Together all studies have an issue with PRR and/or ethics. People will alter their responses if power dynamics and culture are not assessed, and these considerations (PRR and ethics) help to minimise this. Also, of concern is there is limited reporting of methodology in 5 studies, no reporting in 1 study. In 5 studies there was no reporting on data analysis and 1 study limited reporting. Of additional importance, 7 of the studies report results along with other diagnoses, and it is therefore not possible to determine if these elements pertain specifically to PPH. This is important as blood takes an important meaning in culture (and a varied meaning), and interpretations and therefore reaction are fundamentally different from other complications.	Minor. Extracted data from the papers was not transformed, but extracted as quotes. Thematic groupings were conducted by two experienced anthropologists (Senior and mid-career). Some nuances are lost in the thematic grouping, and the data are slightly varied, but all elements fit well into the review finding thematic category. The included studies do not report the same elements in the same ways, but this may be due to study and reporting differences rather than contextual differences. The directionality is consistent for all elements.	Minor. The data for this element is adequate from 9 studies and extracting 17 elements. 2 studies give enough description to include interactions. 4 studies describe elements with descriptions in the text, 2 give vignettes, and 3 studies provide a list of elements in text. All sample sizes are of good size.	Moderate concerns. There is certainly diversity in contextual factors, but given what the data is expected to do (identify elements and interactions that effect uptake), variation is acceptable. Of major issue of concern is that 7 of 9 studies under this finding do not give clear results specific to PPH. The serious concerns with methods impact the relevance of the data.	Low confidence
20. Social reasons influences uptake of facility based HCS for PPH	27	Moderate concerns as the PRR was not reported as considered, and the results were sometimes presented in aggregate with other diagnoses, therefore we are unable to know when results correspond to PPH. Additionally, only one woman had PPH in the sample (two has placenta praevia which may lead to PPH).	n/a	Moderate. No other studies report this, but may have more to do with study design and research expectations than presence. This 1 included study gives good description with vignettes	Moderate concerns. Of major issue of concern is that this 1 study does not give clear results specific to PPH, and includes 1 woman with PPH. Sometimes the results are mixed, sometimes clear.	Low confidence

PRR=participant, researcher relationship; P=participant

Appendix H: Truth tables

Stage 1

Element Combination	Truth Table Stage 1		
1.A	*Elements Influencing Recognition*	*Uptake*	*P/A*
	1 Valuation of women (low)	O	P
	2 Birth traditions	O	P
	3 Religion, fate, faith	O	P
	4 Supernatural cause//Biological cause	O	P
	5 Community expectations about uptake	O	P
	6 Social cohesion (cooperate)	O	P
	Result on Recognition	**Not likely**	
1.B	*Elements Influencing Recognition*	*Uptake*	*P/A*
	1 Valuation of women (low)	O	P
	2 Birth traditions	S	P
	3 Religion, fate, faith	S	P
	4 Supernatural cause//Biological cause	S	P
	5 Community expectations about uptake	S	P
	6 Social cohesion (cooperate)	S	P
	Result on Recognition	**Likely**	
1.C	*Elements Influencing Recognition*	*Uptake*	*P/A*
	1 Valuation of women (low)	.	A
	2 Birth traditions	O	P
	3 Religion, fate, faith	O	P
	4 Supernatural cause//Biological cause	O	P
	5 Community expectations about uptake	O	P
	6 Social cohesion (cooperate)	O	P
	Result on Recognition	**Unlikely**	
1.D	*Elements Influencing Recognition*	*Uptake*	*P/A*
	1 Valuation of women (low)	.	A
	2 Birth traditions	O	P
	3 Religion, fate, faith	.	A
	4 Supernatural cause//Biological cause	O	P
	5 Community expectations about uptake	O	P
	6 Social cohesion (cooperate)	O	P
	Result on Recognition	**Unlikely**	
1.E	*Elements Influencing Recognition*	*Uptake*	*P/A*
	1 Valuation of women (low)	O	P
	2 Birth traditions	O	P
	3 Religion, fate, faith	.	A
	4 Supernatural cause//Biological cause	O	P
	5 Community expectations about uptake	O	P
	6 Social cohesion (cooperate)	O	P
	Result on Recognition	**Unlikely**	

Element Combination	Truth Table Stage 1 continued		
1.F	*Elements Influencing Recognition*	*Uptake*	*P/A*
	1 Valuation of women (low)	.	A
	2 Birth traditions	S	P
	3 Religion, fate, faith	S	P
	4 Supernatural cause//Biological cause	S	P
	5 Community expectations about uptake	S	P
	6 Social cohesion (cooperate)	S	P
	Result on Recognition	**Unlikely**	
1.G	*Elements Influencing Recognition*	*Uptake*	*P/A*
	1 Valuation of women (low)	.	A
	2 Birth traditions	S	P
	3 Religion, fate, faith	.	A
	4 Supernatural cause//Biological cause	S	P
	5 Community expectations about uptake	S	P
	6 Social cohesion (cooperate)	S	P
	Result on Recognition	**Unlikely**	

.=no effect, there was no evidence collected on the effect of the element when Present/Absent; O=Oppose, element has an opposing effect on stage; S=Support, element has a supporting effect on stage; P/A=Present or Absent, the presence or absence of the element; P=Present, element is present; A=Absent, element is absent.

Stage 2

Truth Table Stage 2			
Element Combination			
2.A	*Elements Influencing Decision to Act*	*Uptake*	*P/A*
	1 Valuation of women (low)	O	P
	2 Birth traditions	O	P
	3 Religion, fate, faith	O	P
	4 Supernatural cause//Biological cause	O	P
	5 Community expectations about uptake	O	P
	6 Social cohesion (cooperate)	O	P
	7 Control of women (mother in law makes decision)	O	P
	8 Control of women (male to accompany or permission)	O	P
	9 Perception about female strength	O	P
	Result on Decision to Act	**Less likely**	
2.B	*Elements Influencing Decision to Act*	*Uptake*	*P/A*
	1 Valuation of women (low)	.	A
	2 Birth traditions	S	P
	3 Religion, fate, faith	S	P
	4 Supernatural cause//Biological cause	S	P
	5 Community expectations about uptake	S	P
	6 Social cohesion (cooperate)	S	P
	7 Control of women (mother in law makes decision)	S	P
	8 Control of women (male to accompany or permission)	S	P
	9 Perception about female strength	.	A
	Result on Decision to Act	**More likely**	

Truth Table Stage 2 continued																
	Element Combination															
Elements Influencing Decision to Act	**2.C**		**2.D**		**2.E**		**2.F**		**2.G**		**2.H**		**2.I**		**2.J**	
	Uptake	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*
1 Valuation of women (low)	.	A	.	A	.	A	O	P	.	A	.	A	O	P	.	A
2 Birth traditions	O	P	O	P	O	P	O	P	O	P	O	P	O	P	O	P
3 Religion, fate, faith	.	A	O	P	O	P	O	P	O	P	O	P	O	P	O	P
4 Supernatural cause//Biological cause	O	P	O	P	O	P	O	P	O	P	O	P	O	P	O	P
5 Community expectations about uptake	O	P	O	P	O	P	O	P	O	P	O	P	O	P	O	P
6 Social cohesion (cooperate)	O	P	O	P	O	P	O	P	O	P	O	P	O	P	O	P
7 Control of women (mother in law makes decision)	.	A	O	P	O	P	O	P	O	P	O	P	O	P	.	A
8 Control of women (male to accompany or permission)	.	A	O	P	O	P	O	P	.	A	.	A	.	A	.	A
9 Perception about female strength	.	A	O	P	.	A	.	A	.	A	O	P	.	A	.	A
Result on Decision to Act	**Less likely**		**Less likely**		**Less likely**		**Less likely**		**Less likely**		**Less likely**		**Less likely**		**Less likely**	

Truth Table Stage 2 continued																
	Element Combination															
Elements Influencing Decision to Act	**2.K**		**2.L**		**2.M**		**2.N**		**2.O**		**2.P**		**2.Q**		**2.R**	
	Uptake	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*
1 Valuation of women (low)	O	P	O	P	.	A	.	A	.	A	O	P	.	A	.	A
2 Birth traditions	O	P	O	P	O	P	O	P	O	P	O	P	O	P	O	P
3 Religion, fate, faith	O	P	O	P	O	P	.	A	.	A	.	A	.	A	.	A
4 Supernatural cause//Biological cause	O	P	O	P	O	P	O	P	O	P	O	P	O	P	O	P
5 Community expectations about uptake	O	P	O	P	O	P	O	P	O	P	O	P	O	P	O	P
6 Social cohesion (cooperate)	O	P	O	P	O	P	O	P	O	P	O	P	O	P	O	P
7 Control of women (mother in law makes decision)	.	A	.	A	.	A	O	P	O	P	O	P	O	P	O	P
8 Control of women (male to accompany or permission)	.	A	O	P	O	P	O	P	O	P	O	P	.	A	.	A
9 Perception about female strength	.	A	.	A	.	A	O	P	.	A	.	A	.	A	O	P
Result on Decision to Act	**Less likely**		**Less likely**		**Less likely**		**Less likely**		**Less likely**		**Less likely**		**Less likely**		**Less likely**	

.=no effect, there was no evidence collected on the effect of the element when Present/Absent; O=Oppose, element has an opposing effect on stage; S=Support, element has a supporting effect on stage; P/A=Present or Absent, the presence or absence of the element; P=Present, element is present; A=Absent, element is absent.

Stage 3

Truth Table: Combinations of Categories and Result on How to Act														
Category Name	*Category Combinations*													
	A		B		C		D		E		F		G	
	Uptake	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*	*Uptake*	*P/A*
Availability	S	P	O	A	O	A	O	A	O	A	S	P	S	P
Access	S	P	O	A	O	A	S	P	S	P	S	P	O	A
Behavioural Expectations & Ideas	S	P	O	P	S	P	S	P	O	A	O	P	O	A
Result on How to Act	Likely		Not likely		Not likely		Not likely		Not likely		Not likely		Not likely	

O=Oppose, element has an opposing effect on stage; S=Support, element has a supporting effect on stage; P/A=Present or Absent, the presence or absence of the element; P=Present, element is present; A=Absent, element is absent.

Stage 3 Category Availability				
Possible Combinations of Elements and Results on Availability				
Combination	*Elements Influencing Availability*	*P/A*	*Direction*	*Result on Availability*
3.AV.A	36 Distance to biomedical care	A	S	Support BMC
	27 Time of Day (night, no staff)	A	S	
3.AV.B	36 Distance to biomedical care	A	S	Support BMC
	27 Time of Day (night, no staff)	NA	NA	
3.AV.C	36 Distance to biomedical care	A	S	Support OC
	27 Time of Day (night, no staff)	P	O	
3.AV.D	36 Distance to biomedical care	P	O	Support OC
	27 Time of Day (night, no staff)	A	S	
3.AV.E	36 Distance to biomedical care	P	O	Support OC
	27 Time of Day (night, no staff)	NA	NA	
3.AV.F	36 Distance to biomedical care	P	O	Support OC
	27 Time of Day (night, no staff)	P	O	

3.AV.A-F= 3 represents Stage 3, AV represents category Availability, A-F represents the different results of the combinations of elements in this stage and category; P/A=Present or Absent, the presence or absence of the element, or NA not applicable; P=Present, element is present; A=Absent, element is absent; NA=not applicable as time of day does not influence availability; O=Oppose, element has an opposing effect on stage; S=Support, element has a supporting effect on stage; NA=not applicable, as the element itself is not applicable; BMC=biomedical care; OC=Other care.

Stage 3 Category Access				
Possible Combinations of Elements and Results on Access				
Combination	*Elements Influencing Access Comprised of 3 Sub-categories of Elements & 1 Subcomponent*	*P/A*	*Direction*	*Result on Access*
3.AC.A	1) External Elements Beyond an Individual's Immediate Control (2.AC1.A)	All A	.	Support BMC
	2) Affordability Elements (3.AC2.A-D), including [Affordability Subcomponent (3.AC2.B.A)]	P Mix, at least one S	S S	
	3) Bureaucratic Process Elements (3.AC3.A)	Mix	S/.	
Sub-category 1: External Elements Beyond an Individual's Immediate Control				
Combination	*Elements Influencing Access (External Elements Beyond an Individual's Immediate Control)*	*P/A*	*Direction*	*Result on Access*
3.AC1.A	25 Do not know where to seek care//Where to seek care (knowing)	A	.	Support BMC
	34 Transportation unaffordable	A	.	

	35 Lack of confidence to arrange travel	A	.	
	36 Physical barriers, remote, environment, distance	A	.	
	37 Transportation not reliable, not functioning	A	.	
	38 Transportation unavailable	A	.	
	39 Night, do not want to travel at night	A	.	
The above seven elements (25, 34-39) must all be A to move towards BMC, IF this is true then next consider: Access elements about affordability				
Sub-category 2: Considering Affordability Elements				
Combination	*Elements Influencing Access (Affordability Elements)*	*P/A*	*Direction*	*Result on Access*
3.AC2.A	32 Can afford care	P	O	
3.AC2.B	32 Can afford care	P	S	See Subcomponent
3.AC2.C	33 Cannot afford care	P	O	
3.AC2.D	33 Cannot afford care	P	S	
Affordability elements do not always influencing Access. There are examples where people access care when they cannot afford it, and examples where people do not access care when they can afford it. Therefore, Affordability results on Access can be influenced by other elements. See Subcomponent below for elements that can influence the Affordability Elements result.				
Affordability Subcomponent				
Combination	*Elements Influencing Affordability (Affordability Subcomponent)*	*P/A*	*Direction*	*Result on Affordability*
3.AC2.B.A	1 Valuation of women (low)	A	.	Very Likely
	2 Birth traditions	P	S	
	3 Religion, fate, faith	P	S	
	4 Supernatural cause//Biological cause (S//O)	Biomedical Cause	S	
	10 Status, reputation, fashionable, wealthy	P	S	
	11 Status, reputation, reference for BM//Other	P	S	
	16 Quality, effect, BM//Other	P	S	
	17 Comfortable with procedures	A	.	
	18 Fear of procedures (to BM)	A	.	
	19 Fear of BM location	A	.	
	20 Protected (place)	P	S	
	21 Is there a Relationship with HCW?	P	S	
	22 Is there a Relationship with TBA, MW?	P	O	
	23 No one trusts care: BM	A	.	
	24 Quality and effect general (recommendations references) BM//Other	Biomedical Present	S	
3.AC2.D is the only other affordability combination that supports Access to BMC. For 3.AC2.D the Affordability subcomponent follows the same element P/A and direction as the above (3.AC2.B.A), and also includes the presence of increasing severity of the				

bleed/deterioration of the woman's condition. 3.AC2.A is influenced by the above subcomponent and 3.AC2.C may be influenced by the subcomponent (or simply by a lack of funds to use for care). The result of the subcomponent on affordability is uncertain as one element opposing BMC uptake can supersede all other elements in a supportive position. There is no number of elements present or absent that dictate uptake, as one element can be highly influential on its own. One must consider all elements and individual variation of the effect of these on decision making.

Sub-category 3: Bureaucratic Process Elements				
Combination	*Elements Influencing Access (Bureaucratic Process Elements)*	*P/A*	*Direction*	*Result on Access*
3.AC3.A	30 No referral/Have a referral (between levels of care)//Referral not needed	P/A	S/.	Likely
	31 Delay in bureaucratic process	A	.	

3.AC.A=3 represents Stage 3, AC represents category Access, AV1-3 represents the three sub-categories of Access, A-D represents the different results of the combinations of elements in this stage, category and subcategory, the additional A after in the subcomponent example identifies the example results and combinations of elements; P/A=Present or Absent, the presence or absence of the element; P=Present, element is present; A=Absent, element is absent; O=Oppose, element has an opposing effect on stage/category/sub-category/subcomponent; S=Support, element has a supporting effect on stage/category/sub-category/subcomponent; '.'=no evidence but an assumption can be taken that the opposite result occurs (e.g. if P=O then A=S); BMC=biomedical care; OC=Other care; BM=Biomedical; HCW=health care worker; TBA=traditional birth attendant; MW=midwife.

Stage 3 Category Behavioural Expectations & Ideas				
Possible Combinations of Elements and Results on Behavioural Expectations & Ideas				
Combination	*Elements Influencing Behavioural Expectations & Ideas Elements*	*P/A*	*Direction*	*Result on Category*
3.BE.A				Support BMC
See below for elements contributing to 3.BE.A				
Core Elements				
Combination	*Elements Influencing Behavioural Expectations & Ideas Elements Core Elements*	*P/A*	*Direction*	*Result*
3.BE.A	2 Birth traditions	P	S	More likely
	3 Religion, fate, faith	P	S	
	4 Supernatural cause//Biological cause (S//O)	P	S	
	16 Quality, effect, BM//Other	P	S	

These core elements are always in line with one another: if one is O all are O, and if one is S all are S. The term 'More likely' is used in the result of combination 3.BE.A as it is possible that even with these P/A and direction as PS that BMC is not supported, but this combination makes it 'more likely' than not that is it supported. All other combinations of these four core elements will result in support of BMC being less likely.

All other elements in this category, and found below, either strengthen/reinforce the result of the core. It is likely with change in the elements below that the core elements will begin to change, as these elements are interconnected. The P/A and direction of the elements below represent the combination likely to support the core elements being in collective support of this category and Stage 3. Due to non-linearity of element relationships to uptake, it is possible even one opposing element may cause the result of the category to be

'less likely'. Therefore, all other combinations of the elements below can impact the core elements and the category result.				
Elements Influencing Behavioural Expectations & Ideas Core Elements 3.BE.A 1. Part of Core Elements 2. Supporting Core Elements & 3. Relationship with Core Elements				
	Part of Core Element 2	*P/A*	*Direction*	
	Perception about female strength	A	.	
	Blood perceived dangerous	P/A	S/.	
	Supporting Core Elements	*P/A*	*Direction*	
	7 Control of women (mother in law makes decision)	P	S	
	8 Control of women (male to accompany or permission)	P	S	
	5 Community expectations about uptake	P	S	
	6 Social cohesion (cooperate)	P	S	
	10 Status, reputation, fashionable, wealthy	P	S	
	11 Status, reputation, reference for BM//Other	P	S	
	12 Status, reputation, female strength	P	S	
	Relationship with Core Elements	*P/A*	*Direction*	
	17 Comfortable with procedures	A	.	
	18 Fear of procedures (to BM)	A	.	
	19 Fear of BM location	A	.	
	20 Protected (place)	P	S	
	21 Is there a Relationship with HCW?	P	S	
	22 Is there a Relationship with TBA, MW?	P	O	
	23 No one trusts care: BM	A	.	
	24 Quality and effect general (recommendations references) BM//Other	A	.	

3.BE.A=3 represents Stage 3, BE represents category Behavioural Expectations & Ideas, A represents the combinations of elements and results; P/A=Present or Absent, the presence or absence of the element; P=Present, element is present; A=Absent, element is absent; O=Oppose, element has an opposing effect on stage/category; S=Support, element has a supporting effect on stage/category; '.'=no evidence but an assumption can be taken that the opposite result occurs (e.g. if P=O then A=S); BMC=biomedical care; BM=Biomedical; HCW=health care worker; TBA=traditional birth attendant; MW=midwife.

Stage 4

Truth Table Stage 4				
Possible Combinations of Elements and Results on Arrange Travel				
Combination	*Elements Influencing Availability*	*P/A*	*Direction*	*Result on Arrange Travel*
4.A	15 Socially connected	P/A	S	Likely able to arrange travel
	25 Where to seek care (not knowing)	A	.	
	34 Transportation unaffordable	A	.	
	35 Lack of confidence to arrange travel	A	.	
	36 Physical barriers, remote, environment, distance	A	.	
	37 Transportation not reliable, not functioning	A	.	
	38 Transportation unavailable	A	.	
	39 Night, do not want to travel at night	A	.	
	40 Planned/Not planned, communicated to access care	P	S	
4.B-4…*	IF any element is PO or AO then one			Cannot arrange travel

4.A-…=4 represents the stage, A-…represents the combinations of elements and result on the stage; P/A=Present or Absent, the presence or absence of the element; P=Present, element is present; A=Absent, element is absent; O=Oppose, element has an opposing effect on stage; S=Support, element has a supporting effect on stage; '.'= no effect, there was no evidence collected on the effect of the element when Present/Absent. *4.B-4…=this represents all other possible combinations that are not combination '4.A' and therefore do not result in travel being arranged.

Stage 5

Truth Table Stage 5				
Possible Combinations of Elements and Results on Travel				
Combination	*Elements Influencing Availability*	*P/A*	*Direction*	*Result on Travel*
5.A	36 Physical barriers, remote, environment, distance	A	.	Likely to be successful
	37 Transportation not reliable, not functioning	A	.	
	41 Increasing severity	A	.	
5.B	36 Physical barriers, remote, environment, distance	P	O	Not successful
	37 Transportation not reliable, not functioning	A	.	
	41 Increasing severity	A	.	
5.C	36 Physical barriers, remote, environment, distance	A	.	Not successful
	37 Transportation not reliable, not functioning	P	O	
	41 Increasing severity	A	.	
5.D	36 Physical barriers, remote, environment, distance	A	.	Likely to be successful
	37 Transportation not reliable, not functioning	A	.	
	41 Increasing severity	P	O	
5.E	36 Physical barriers, remote, environment, distance	P	O	Not successful
	37 Transportation not reliable, not functioning	A	.	
	41 Increasing severity	P	O	
5.F	36 Physical barriers, remote, environment, distance	P	O	Not successful
	37 Transportation not reliable, not functioning	P	O	
	41 Increasing severity	A	.	
5.G	36 Physical barriers, remote, environment, distance	A	.	Not successful
	37 Transportation not reliable, not functioning	P	O	
	41 Increasing severity	P	O	
5.H	36 Physical barriers, remote, environment, distance	P	O	Not successful
	37 Transportation not reliable, not functioning	P	O	
	41 Increasing severity	P	O	

5.A-H=5 represents the stage, A-H represents the combinations of elements and result on the stage; P/A=Present or Absent, the presence or absence of the element; P=Present, element is present; A=Absent, element is absent; O=Oppose, element has an opposing effect on stage; S=Support, element has a supporting effect on stage; '.'= no effect, there was no evidence collected on the effect of the element when Present/Absent.

Stage 6

Truth Table Stage 6				
Possible Combinations of Elements and Results on Travel				
Combination	*Elements Influencing Availability*	*P/A*	*Direction*	*Result on Travel*
6.A	27 Time of Day (night, no staff)	A	.	Care successful
	28 Care available//Care not available (S//O)	P	S	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P/A	S/.	
	31 Delay in bureaucratic process	A	.	
	42 What quality effect BM provides	P	Good	
6.B	27 Time of Day (night, no staff)	P	O	Care not successful (can change over time)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P/A	S/.	
	31 Delay in bureaucratic process	A	.	
	42 What quality effect BM provides	P	Good	
6.C	27 Time of Day (night, no staff)	A	.	Care not successful (can change over time)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P	O	
	31 Delay in bureaucratic process	A	.	
	42 What quality effect BM provides	P	Good	
6.D	27 Time of Day (night, no staff)	A	.	Care not successful (can change over time)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P/A	S/.	
	31 Delay in bureaucratic process	P	O	
	42 What quality effect BM provides	P	Good	
6.E	27 Time of Day (night, no staff)	P	O	Care not successful (can change over time)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P	O	
	31 Delay in bureaucratic process	A	.	
	42 What quality effect BM provides	P	Good	
6.F	27 Time of Day (night, no staff)	P	O	Care not successful (can change over time)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P/A	S/.	
	31 Delay in bureaucratic process	P	O	
	42 What quality effect BM provides	P	Good	
6.G	27 Time of Day (night, no staff)	A	.	Care not successful (can change over time)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P	O	
	31 Delay in bureaucratic process	P	O	
	42 What quality effect BM provides	P	Good	
6.H	27 Time of Day (night, no staff)	P	O	Care not successful (can change over time)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P	O	
	31 Delay in bureaucratic process	P	O	
	42 What quality effect BM provides	P	Good	

6.I	27 Time of Day (night, no staff)	A	.	Care not successful
	28 Care available//Care not available (S//O)	P	S	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P/A	S/.	
	31 Delay in bureaucratic process	A	.	
	42 What quality effect BM provides	P	Poor	
6.J	27 Time of Day (night, no staff)	P	O	Care not successful (will wait for care but care results will not change)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P/A	S/.	
	31 Delay in bureaucratic process	A	.	
	42 What quality effect BM provides	P	Poor	
6.K	27 Time of Day (night, no staff)	A	.	Care not successful (will wait for care but care results will not change)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P	O	
	31 Delay in bureaucratic process	A	.	
	42 What quality effect BM provides	P	Poor	
6.L	27 Time of Day (night, no staff)	A	.	Care not successful (will wait for care but care results will not change)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P/A	S/.	
	31 Delay in bureaucratic process	P	O	
	42 What quality effect BM provides	P	Poor	
6.M	27 Time of Day (night, no staff)	P	O	Care not successful (will wait for care but care results will not change)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P	O	
	31 Delay in bureaucratic process	A	.	
	42 What quality effect BM provides	P	Poor	
6.N	27 Time of Day (night, no staff)	P	O	Care not successful (will wait for care but care results will not change)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P/A	S/.	
	31 Delay in bureaucratic process	P	O	
	42 What quality effect BM provides	P	Poor	
6.O	27 Time of Day (night, no staff)	A	.	Care not successful (will wait for care but care results will not change)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P	O	
	31 Delay in bureaucratic process	P	O	
	42 What quality effect BM provides	P	Poor	
6.P	27 Time of Day (night, no staff)	P	O	Care not successful (will wait for care but care results will not change)
	28 Care available//Care not available (S//O)	A	O	
	30 No referral/Have a referral (between levels of care)//Referral not needed	P	O	
	31 Delay in bureaucratic process	P	O	
	42 What quality effect BM provides	P	Poor	

6.A-P=6 represents the stage, A-P represents the combinations of elements and result on the stage; P/A=Present or Absent, the presence or absence of the element; P=Present, element is present; A=Absent, element is absent; O=Oppose, element has an opposing effect on stage; S=Support, element has a supporting effect on stage; '.'= no effect, there was no evidence collected on the effect of the element when Present/Absent; BM=biomedical.