



RADBOUD UNIVERSITY  
Nijmegen School of Management  
International Economics & Development  
Master Thesis

## Counting Children to make Children Count: Determinants of Birth Registration and the Importance of Context Characteristics in Sub-Saharan Africa

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*This paper examines the determinants of birth registration in developing countries using multilevel logistic models with data on 567407 children, 753 sub-national regions, and 34 countries in Sub-Saharan Africa for the years 2005 until 2018. Although several papers have made an enquiry into the determinants of birth registration, this paper is the first to look into determinants of birth registration at the household, sub-national regional, and national level simultaneously for multiple countries and to look into the interrelationship of the determinants by means of interactions. The results indicate that most of the variation is found at the household level, but that the sub-national regional and national level can also explain part of the variation. At the household level both socio-economic and demographic and care variables are important for birth registration rates. At higher levels, especially the availability of health facilities, urbanization, birth registration legislation, a decentralized birth registration system, a low fertility rate, and a country that has been colonized are beneficial for the birth registration rate. The interaction analysis shows that the effects of the determinants depend on the context the family lives in, thus is situation specific. Therefore, specific policy-making that takes into account the complex dynamics of birth registration is needed.*

*Keywords: birth registration, children aged 0-4, developing countries, Sub-Saharan Africa, household level, sub-national regional level, national level, interaction analysis*

Date: 14-08-2020

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## Table of contents

1. INTRODUCTION	P. 3
2. LITERATURE REVIEW	P. 6
2.1. BIRTH REGISTRATION	P. 6
2.2. DETERMINANTS OF BIRTH REGISTRATION	P. 7
2.2.1. HOUSEHOLD LEVEL	P. 9
2.2.1.1. SOCIO-ECONOMIC AND DEMOGRAPHIC VARIABLES	P. 9
2.2.1.2. CARE VARIABLES	P. 12
2.2.2. SUB-NATIONAL REGIONAL LEVEL	P. 14
2.2.2.1 SOCIO-ECONOMIC AND DEMOGRAPHIC VARIABLES	P. 14
2.2.2.2. CARE VARIABLES	P. 15
2.2.3. NATIONAL LEVEL	P. 16
2.2.3.1. SOCIO-ECONOMIC AND DEMOGRAPHIC VARIABLES	P. 16
2.2.4. VARIATION AMONG CONTEXTS	P. 18
3. RESEARCH DESIGN	P. 21
3.1 DATA	P. 21
3.2 METHODOLOGY	P. 23
3.3 INDEPENDENT VARIABLES	P. 27
3.3.1. SOCIO-ECONOMIC AND DEMOGRAPHIC HOUSEHOLD-LEVEL VARIABLES	P. 27
3.3.2. CARE HOUSEHOLD-LEVEL VARIABLES	P. 29
3.3.3. HANDLING OF MISSING VALUES HOUSEHOLD-LEVEL VARIABLES	P. 30
3.3.4. SOCIO-ECONOMIC AND DEMOGRAPHIC SUB-NATIONAL REGIONAL-LEVEL VARIABLES	P. 30
3.3.5. CARE SUB-NATIONAL REGIONAL-LEVEL VARIABLES	P. 31
3.3.6. SOCIO-ECONOMIC AND DEMOGRAPHIC NATIONAL-LEVEL VARIABLES	P. 31
4. RESULTS	P. 34
4.1. DESCRIPTIVE STATISTICS	P. 34
4.2. MULTILEVEL LOGISTIC ANALYSES	P. 39
4.2.1. SOCIO-ECONOMIC AND DEMOGRAPHIC HOUSEHOLD-LEVEL DETERMINANTS	P. 40
4.2.2. CARE DETERMINANTS	P. 43
4.2.3. SOCIO-ECONOMIC AND DEMOGRAPHIC SUB-NATIONAL REGIONAL-LEVEL VARIABLES	P. 44
4.2.4. SOCIO-ECONOMIC AND DEMOGRAPHIC NATIONAL-LEVEL VARIABLES	P. 44
4.2.5. VARIATION AMONG CONTEXTS	P. 46
4.2.5.1. VARIATION AMONG ETHNICITIES AND RELIGIONS	P. 46
4.2.5.2. VARIATION AMONG SUB-NATIONAL REGIONS AND COUNTRIES	P. 50
4.2.5.3. VARIATION OF CARE VARIABLES	P. 53
5. CONCLUSION & DISCUSSION	P. 55
5.1. POLICY RECOMMENDATIONS	P. 59
6. BIBLIOGRAPHY	P. 61
7. APPENDIX	P. 65

## 1. Introduction

“Birth registration is a human right, yet less than three quarters of children under 5 years of age worldwide are registered” (The United Nations, 2019, p.55). Birth registration is part of sustainable development goal 16; “promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels” (The United Nations, 2019, p.19). In particular goal 16.9, concerning legal identity, is important for birth registration (The United Nations, 2020). Notwithstanding that the problem is recognized, progress has been slow and limited (Bequele, 2005; Bhatia, Ferreira, Barros, & Victora, 2017; Bhatia, Krieger, Beckfield, Barros, & Victora, 2019; Fagernäs & Odame, 2013). For example, according to Fagernäs & Odame (2013, p.459) “the average registration rate was 53% in 1999-2003 and 49% in 2004-2010, with only a few countries making notable progress” for children younger than 5 years old living in countries in Sub-Saharan Africa. The latest data from 2010-2018 shows that the registration rate was only 46% for children younger than 5 years old in Sub-Saharan Africa (The United Nations, 2019).

The consequences of not having a birth registration are enormous. Research shows that these unregistered children have limited access to services, like health care and education, and cannot be protected from abuse and exploitation by the law as the children do not have a nationality (Apland et al., 2014; Bequele, 2005; Li, Zhang, & Feldman, 2010; Pirlea, 2019; Todres, 2003; UNICEF, n.d.). Not having a birth registration has also consequences for the child’s future since a birth registration is often needed for acquiring property, employment, and social security for example (Amo-Adjei & Annim, 2015; Li et al., 2010; Mackenzie, 2008; Pelowski et al., 2015; Todres, 2003). Accordingly, birth registration remains a huge issue mainly persistent in developing countries (The United Nations, 2019). With the non-registration of births being an important international topic, it is of the utmost importance to get a comprehensive understanding of the factors that drive this phenomenon.

Most research on birth registration was focused on developed countries until around 1995 (Årbyholm, 1978; Coward, 1982; Mccaw-Binns, Fox, Foster-Williams, Ashley, & Irons, 1996; Shapiro, 1954; UNICEF, 1998). Since the problem of under-registration in developing countries became apparent, several studies have made an enquiry into the causes and effects of non-birth registration of children in these countries (Amo-Adjei & Annim, 2015; Apland et al., 2014; Bhatia et al., 2019; Corbacho et al., 2012; Corbacho & Osorio Rivas, 2012; Duff et al., 2016; Duryea et al., 2006; UNICEF, 2005). Some studies have been starting to investigate the consequences of not having a birth registration for children. For example, Corbacho et al. (2012) and Phillips et al. (2015) have shown that not having a birth registration has a negative effect on the years of schooling and graduating and on health outcomes. However, most research has focused on the reasons for not registering children in developing countries (Bequele, 2005; Bhatia et al., 2019; Corbacho & Osorio Rivas, 2012; Duryea et al., 2006; UNICEF, 1998, 2005). The most important factors scrutinized so far are the distance to birth registration offices, the ethnicity or religion of a household, unawareness or ignorance of the parents, household wealth, and not being born in a hospital (Amo-Adjei & Annim, 2015; Bequele, 2005; Bhatia et al., 2017;

Cappa, Gregson, Wardlaw, & Bissell, 2014; Corbacho & Osorio Rivas, 2012; Isara & Atimati, 2015; Nomura et al., 2018; UNICEF, 1998, 2005; United Nations Children's Fund, 2013).

Although these studies are the first to look into the subject of birth registration in developing countries, the studies have only focused on household-level factors affecting the birth registration of children (Bhatia et al., 2019; Corbacho & Osorio Rivas, 2012; Duryea et al., 2006; UNICEF, 2005). The reason for using the household level is twofold. First, it is argued that the birth registration of children is mainly dependent on child and household characteristics (UNICEF, 2005). Second, studies have been using household surveys in order to be able to perform a statistical analysis, because of the fact that only a few developing countries have a precise and objective assessment of birth registration coverage (Duryea et al., 2006; UNICEF, 1998). As a result, factors at other levels, like the economic (under)development of a country or region, the previous colonial regime, and the legislative framework of a country, are often disregarded although these are argued to have an effect on birth registration (Bequele, 2005; Isara & Atimati, 2015; Li et al., 2010; Mohanty & Gebremedhin, 2018; Nomura et al., 2018; UNICEF, 1998). Only recently, the study of Mohanty & Gebremedhin (2018) has emphasized how researching the interrelation between household factors and factors at higher levels can significantly improve the understanding of the birth registration problem. A follow up study is needed, however, because the study of Mohanty & Gebremedhin (2018) focusses on one country only and no additional empirical studies in this subject have been performed.

Hence, the aim of this study is to contribute to the existing literature on the determinants of the birth registration of children in developing countries by taking into account determinants at different levels of analysis simultaneously, in particular the household, sub-national regional, and national level, and several developing countries. Additionally, this study will be the first to take into account the influence of the context on the household-level determinants of birth registration by using interactions. Therefore, the following research questions will be answered: *(1) Which household, sub-national regional, and national factors influence the decision whether or not to register a child? (2) Which context characteristics affect the household-level determinants of birth registration?*

Accordingly, the problem under investigation will more realistically reflect the complex situation by improving the estimates of marginal effects of the determinants (Huisman & Smits, 2015). Moreover, this study will improve on the external validity since determinants at three different levels for several developing countries are taken into account. Both accuracy and generalizability are crucial for making more specific policy interventions in order to tackle the problem. Tackling the problem is not only important for the protection of the children, but also for the efficacy of the government, which needs population data for the creation of other services and development strategies concerning aid or sanitation for example (Mackenzie, 2008; Pais, 2002; United Nations Children's Fund, 2013). Moreover, improving the situation is increasingly urgent due to the growing population in developing countries, which makes the problem bigger in absolute terms, and the increasing number of people that

migrate for better opportunities or due to conflict (Bequele, 2005; Cappa et al., 2014; Dunning et al., 2014; Unicef, 2013).

In order to address the research questions, an extensive theoretical framework structuring the various factors will be made based on previous literature (Bequele, 2005; Bhatia et al., 2019; Corbacho & Osorio Rivas, 2012; Duryea et al., 2006; Isara & Atimati, 2015; Li et al., 2010; Mohanty & Gebremedhin, 2018; UNICEF, 1998, 2005). The theoretical framework will structure the factors according to their level of analysis within which the factors are discussed according to their main theme, either socio-economic and demographics or care. The hypotheses formed by the theoretical framework will be tested by means of a multilevel logistic regression with data on 567407 children, 753 sub-national regions, and 34 countries from the Database Developing World (Global\_Data\_Lab, n.d.). Data will be obtained for countries in Sub-Saharan Africa for the first two decades of the 21<sup>st</sup> century, since this is the most accurate representation of the problem for the part of the world in which the problem is most pressing (The DHS Program, n.d.-a; The United Nations, 2019).

The structure of the paper will be as follows. In section 2, the literature review will show an extensive theoretical framework, in which the concept of birth registration and the already known determinants of birth under-registration will be discussed according to the different levels of analysis and within that according to their main theme. The theoretical framework will lead to the development of hypotheses. In section 3, the data and the methodology used for testing the determinants of birth under-registration will be discussed. This will be followed by a section in which the hypotheses are tested, and the results will be discussed. Finally, a conclusion about this research will be made and limitations will be discussed, after which policy recommendations are given.

## 2. Literature Review

To make an enquiry into the determinants of birth (under)registration, a comprehensive analysis of all relevant factors at the different levels should be made simultaneously, following the papers of Huisman & Smits (2015) and Mohanty & Gebremedhin (2018). In order to perform such an analysis, an extensive theoretical framework will be made. This theoretical framework will first address the concept of birth registration, after which the factors influencing the birth registration decision will be discussed. These factors will be addressed according to their level of analysis and within that with respect to their main themes, either socio-economic and demographics or care. By creating this theoretical framework, the paper builds on previous literature while making a new comprehensive model that looks at three levels of analyses.

### 2.1. Birth registration

Birth registration for all children is generally accepted as a human right as stated in article 7 of The United Nations Convention on the Rights of the Child, which is one of the several international legal instruments for children's rights (Apland et al., 2014; Todres, 2003; UNHCR & Plan International, 2012). Birth registration is defined as: "the continuous, permanent, and universal recording, within the civil registry, of the occurrence and characteristics of births in accordance with the legal requirements of a country" (Unicef, 2013, p.4). Birth registration entails the following procedure: firstly, an official statement of the birth of a child by a spokesman; secondly, the registration of child and birth by some administrative level of the government that coordinates civil registry; and finally the publication and circulation of a birth certificate (Pais, 2002; United Nations Children's Fund, 2013). This procedure is improved by the notification role of hospitals, midwives and local government officials, who can report new births to the administrative level of the government coordinating civil registry in order for an extra check to take place (United Nations Children's Fund, 2013). Although a healthcare worker can help with registering a child and notify the government as a control, the decision regarding the legal registration of a child's birth can only be carried out at the household level by parents or caregivers for instance (Todres, 2003; United Nations Children's Fund, 2013). After registration, a birth certificate is issued that includes information of the recording such as the date and place of the birth, the names of the child, the parents, and the witness of the birth, and some additional relevant information like the nationality of the child (Apland et al., 2014; Todres, 2003). This last step of the procedure often follows automatically and only in exceptional cases another request must be made (United Nations Children's Fund, 2013).

When the registration procedure is complete the child is legally existent and has documentation as proof, enabling the protection of other child's rights as well, such as the opportunity to use services like healthcare and education, legal protection from crimes like child labor, and the right to have a nationality (Apland et al., 2014; Bequele, 2005; Todres, 2003). While compliance with these rights cannot be assured, a child faces a higher chance of compliance when having a birth registration (Todres,

2003). A birth registration cannot only secure rights in childhood, but is also important for securing rights in adulthood like social security (Li et al., 2010; Mackenzie, 2008; Todres, 2003). As identity documents are important for obtaining employment, property, and a functioning infrastructure, birth registration can result in economic advancement as well (Amo-Adjei & Annim, 2015; Li et al., 2010; Pelowski et al., 2015). Therefore, having a birth registration has far-reaching consequences for active participation in the community and can be seen as an investment in the future (Mackenzie, 2008; Smits & Huisman, 2013).

Although the benefits of having a birth registration seem considerably large, countries in Sub-Saharan Africa have relatively low registration rates, namely 46% compared to around 90% in other parts of the world (Bequele, 2005; The United Nations, 2019). Nevertheless, developing countries with high birth registration rates exist despite economic challenges, for example in Benin, Comoros and Mali (Cappa et al., 2014; United Nations Children's Fund, 2013). Correspondingly, it is shown in several articles that a deliberate birth registration decision can be made, in which the perceived value and costs of having a birth registration are considered (Chereni, 2016; Corbacho et al., 2012; Pelowski et al., 2015). In many developing countries, the immediate costs of birth registration are apparently higher than the future benefits as seen by low birth registration rates in developing countries (Corbacho & Osorio Rivas, 2012; Pelowski et al., 2015; Smits & Huisman, 2013). However, the differences in birth registration rates across Sub-Saharan Africa show that the conscious birth registration decision is influenced by the context of the decisionmaker, which can affect the costs and benefits of having a birth registration (Pelowski et al., 2015; Smits & Huisman, 2013). Accordingly, not only differences in registration rates across countries are found, but also within the country context at the sub-national regional and household level (Apland et al., 2014; Mohanty & Gebremedhin, 2018).

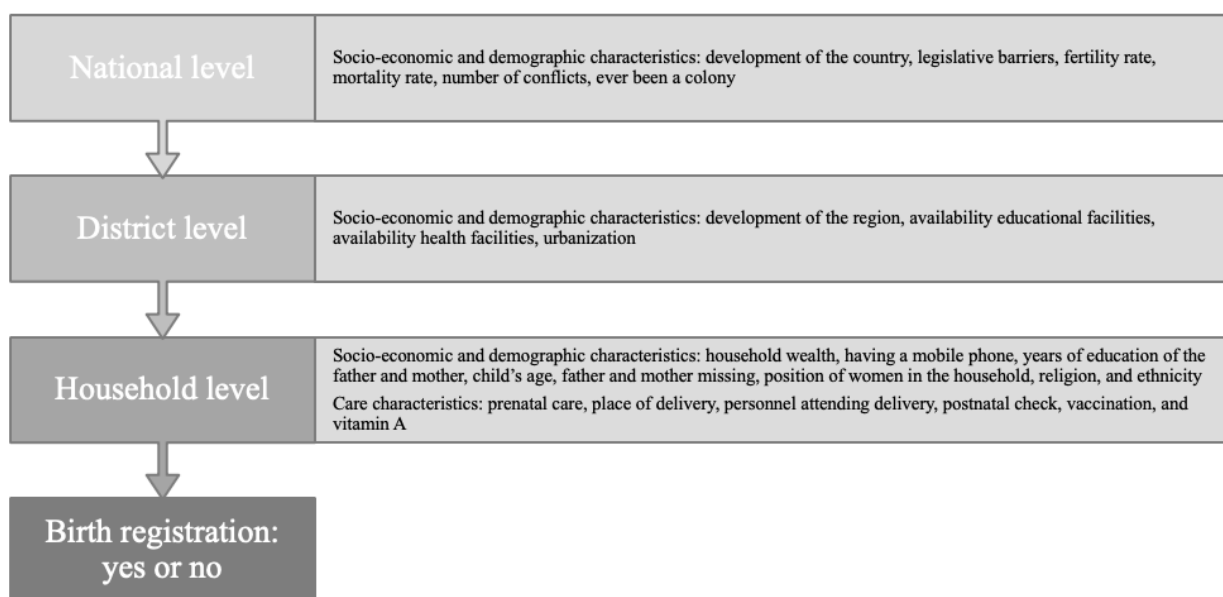
## ***2.2. Determinants of birth registration***

Following Huisman & Smits (2015), the context in which the spokesman, who declares the birth, lives can be divided in three groups, namely: the household context, the sub-national regional context, and the national context. They also state that multiple factors within these differentiating contexts can influence the decision to be made at the same time. With regards to birth registration, the following two examples show how factors at different contexts can influence the decision to be made. First, as stated by Unicef (2013, p.7): "Sound national policies and the commitment of government agencies are often not enough. Whether parents register the birth of their child(ren) depends on their awareness of the process and its importance, their ability to access civil registrar services, and their willingness to interface with State authorities". Second, Mohanty & Gebremedhin (2018, p.1) found the following in their paper: "The results show that between-districts and between individuals differences share a considerably high and an almost equal proportion of the variations in probability of birth registration in India". Accordingly, the problem of birth under-registration is a consequence of the interaction of several factors by stakeholders at different levels among which the household, sub-

national regional, and the national level (Li et al., 2010). Therefore, the theoretical framework will discuss the factors determining whether or not to register a child with respect to these three levels.

Within these three levels, the determinants are divided into two groups, namely socio-economic and demographic variables and care variables. Following UNICEF (2005), differences in birth registration rates depend on inequalities in resources, knowledge, status, demographics and in the amount of care that a child receives in the first 4 years of his or her life. For example, for households with a lack of economic resources the relative costs of birth registration are higher than for richer households. Even if a household has enough resources, it must be aware of the importance of birth registration, which can depend on the availability of education or existing legislation. Moreover, the amount of care a child receives in the first 4 years of life can be important as situations in which care is needed can prove the importance of a birth registration or make parents more aware. Thus, the parents must have enough knowledge about birth registration and must be able to adhere to the procedure, depending on birth registration legislation, in order to make birth registration happen, which can be influenced by the socioeconomic and demographic and care variables at the household, sub-national regional, and national level.

A representation of the theoretical framework can be seen in figure 1. The decision whether or not to register a birth can be found at the bottom. There are three levels that can influence this decision, the household, sub-national and national level (Mohanty & Gebremedhin, 2018; United Nations Children's Fund, 2013). Next to their context, the factors are shown according to the category they belong to, either socio-economic and demographic characteristics or care characteristics. The higher-level factors influence the lower-level factors as lower-level factors are embedded in the context of the higher level (Huisman & Smits, 2015). The factors, according to their levels and subgroups, are discussed in the next three subsections.



**Figure 1:** Theoretical model explaining birth registration in countries in Sub-Saharan Africa



### ***2.2.1. Household level***

The birth registration decision is made at the household level, by for example parents or caregivers of the child involved (UNICEF, 2005; United Nations Children's Fund, 2013). Therefore, factors at the household level that determine the particular situation surrounding the decisionmaker can affect the decision whether or not to register a child. Within the household context, there are two groups of factors that can influence the decision made, namely socio-economic and demographic variables and care variables.

#### ***2.2.1.1. Socio-economic and demographic variables***

A household must have enough socio-economic resources in order to complete birth registration of a child (Mackenzie, 2008; UNICEF, 2005). One of the most important determinants in this category is household wealth (Bhatia et al., 2017; Mohanty & Gebremedhin, 2018; Pais, 2002; UNICEF, 2005). In most Sub-Saharan African countries, a fee is involved in the birth registration procedure (United Nations Children's Fund, 2017). Even if countries do not have to pay for birth registration initially, there might be a fee that needs to be paid when the birth is not registered within a certain amount of time (Mohanty & Gebremedhin, 2018). Accordingly, households need to have enough money in order to pay for a birth registration. In developing countries, (extreme) poverty may cause households to have other priorities than birth registration, such as buying food in order to survive (Bequele, 2005; Fagernäs & Odame, 2013; Pais, 2002; UNICEF, 2005; United Nations Children's Fund, 2013). Besides the direct costs of birth registration, indirect costs like travelling costs or opportunity costs including time that cannot be spend on working instead are playing a role (Fagernäs & Odame, 2013; Pais, 2002; UNICEF, 2005; United Nations Children's Fund, 2013). These indirect costs are often higher for poorer families as they most likely live in a more disadvantaged neighborhood that has a bad infrastructure and is located further away from registration offices (Bequele, 2005; Fagernäs & Odame, 2013). Thus, direct and indirect costs are more noticeable and more significant for poor households (Huisman & Smits, 2015).

Connected to wealth, having a mobile phone in the household is argued to be beneficial for birth registration rates (Candia, 2019; Dunning et al., 2014). The effect of having at least one mobile phone in a household is two-fold. Firstly, according to Candia (2019), a mobile phone grants access to internet, which can improve the access to information about birth registration. The author argues that a mobile phone is especially important and useful in rural areas because these areas are often not accessed by other forms of mass media, for example due to the insufficient (technological) infrastructure, and because mobile phones are relatively cheap compared to other technological devices. Therefore, a mobile phone is an easy and cheap way to obtain information about birth registration. Secondly, technological advancement allows for the development of systems in which a birth can be registered by using a mobile phone (Dunning et al., 2014). In some countries, these systems are already starting to work and reduce the direct (in case of a late fee) and indirect costs of birth registration (Dunning et al., 2014).

Besides the proper resources, knowledge about the importance and procedure of birth registration is needed in order for high birth registration rates to exist (UNICEF, 2005; United Nations Children's Fund, 2013). Accordingly, knowledge can create consciousness and in turn motivate to register births (Bequele, 2005). The most straightforward way of creating knowledge about birth registration is by ensuring that parents or caregivers are properly educated (Bhatia et al., 2017; Makinde, Olapeju, Ogbuaji, & Babalola, 2016; Mohanty & Gebremedhin, 2018; Pais, 2002; UNICEF, 2005). Important subjects of everyday life are to be discussed in school, including the importance of hygiene for health and human rights (Anne & Ong'ondo, 2013). As a result, schooling can be important for notifying people about birth registration and how to register a birth (United Nations Children's Fund, 2013). The higher the level of education, the higher the chance that parents or caregivers recognize the value of having a birth registration (Isara & Atimati, 2015; United Nations Children's Fund, 2013). Besides the direct effects of parental education, indirect effects can also be seen. Parental education can result in better educated social networks of the household, which can result in better advice in general (Mohanty & Gebremedhin, 2018). Better educated social networks are crucial as Parmar, Jakasania, & Rathod (2016) have shown that knowledge about birth registration is mostly gained by talking to relatives or neighbors, part of the social network of the household. As a result, better educated parents have more knowledge about birth registration while they also have better informed social contacts.

Looking at demographics, the child's age has proven to be important while no significant differences have been found in sexes (Amo-Adjei & Ananim, 2015; Candia, 2019; Duff et al., 2016; Isara & Atimati, 2015; Makinde et al., 2016; Mohanty & Gebremedhin, 2018; UNICEF, 2005; United Nations Children's Fund, 2013). Previous literature has shown that older children have a higher chance of having a birth registration (Duff et al., 2016; Makinde et al., 2016). "Concerning a child's age, children aged 36-37 months (36.4%) and 48-59 months (35%) had the highest proportion registered while those aged <12 months (26.1%) having the least" (Candia, 2019, p.14). This is the case, according to Unicef (2013), because having a birth registration and sometimes a birth certificate are becoming more important at larger ages. For instance, some schools have a policy that requires identity documents in order to enter school or to graduate (Corbacho et al., 2012). In other cases, having a birth registration and certificate might be a prerequisite for access to health services (United Nations Children's Fund, 2013). Thus, the older the child, the more situations are encountered in which a birth certificate is needed, leading to a higher perceived value of having a birth registration.

In addition to age, the household structure can be an important variable influencing the rate of birth registration (Pais, 2002; UNICEF, 2005). Especially a missing parent can have a negative influence on birth registration rates, as stated by UNICEF (2005, p.12): "Children who live with both parents may have a higher level of birth registration than those living with neither parent, or those living with the mother or father only". Of course, the situation is the worst if the child is not living with either of the parents (UNICEF, 2005). In such a situation, it is unlikely that the child or caregiver has the (child specific) information needed to apply for a birth registration if there is someone who has taken the

responsibility to register the child in the first place. However, having one missing parent can also create problems. For example, in some countries, the father must be present in order to register a child, which can make registration impossible if the father is not in the picture (Pais, 2002; UNICEF, 1998). In other cases, a missing mother may lead to disregarding the task of birth registration by others caregivers as mothers are primary caregivers regularly (UNICEF, 1998).

Not only the family structure, but also the relational structure within the household is important (Mohanty & Gebremedhin, 2018). Since mothers, generally, take care of the children, their autonomy or position within the household is important since this can directly influence child outcomes accordingly (Lépine & Strobl, 2013; Mohanty & Gebremedhin, 2018). Bloom, Wypij, & Das Gupta (2001) have shown that women with more autonomy seek more antenatal or prenatal care, which also leads to better child health outcomes. Mohanty & Gebremedhin (2018, p.13) follow the same reasoning for the period after birth: “As primary caregivers for children, mothers’ ability to move around is crucial for a number of activities that enhance the welfare of children such as immunization, health check-ups, and possibly birth registration”. They also argue that this leads to a bigger social network that can provide new and relevant information on birth registration. Not only the ability to move around as the mother perceives needed, but also bargaining power is important in this respect, since women with more bargaining power are more likely to spend resources on their children (Mohanty & Gebremedhin, 2018). The results of Mohanty & Gebremedhin (2018) indeed confirm their claims. As a result, the position of women is not only important for child health outcomes but also for other child’s rights such as birth registration.

Finally, the effects of these household factors and birth registration rates in itself can be influenced by two other socio-economic household-level variables, namely religion and ethnicity (Nomura et al., 2018; Pais, 2002; Todres, 2003; UNICEF, 1998, 2005). Besides having an effect on birth registration, the political and social nature of religion and ethnicity can affect the importance of other factors influencing birth registration as well, by having certain ideas about birth registration for example (Pais, 2002). Ethnic and religious groups can have multiple reasons for not registering births. First, the particular culture of these groups can have certain traditions and practices that instruct parents to either give a name to the child by means of traditional practices, making birth registration less valuable, or to only give the child a name after some period of time (Chereni, 2016; UNICEF, 1998; United Nations Children’s Fund, 2013). For example, Mohanty & Gebremedhin (2018) state that traditional religions are less likely to register births, which corresponds with other results that have found that birth attendants belonging to a traditional religion are not beneficial to birth registration rates (Candia, 2019; Chereni, 2016; Nomura et al., 2018; UNICEF, 1998; United Nations Children’s Fund, 2013).

Second, ethnic and religious minorities, like traditional religious or ethnic groups, might not register births due to having misgivings about the way the birth registrations are handled (Cappa et al., 2014; Mohanty & Gebremedhin, 2018). These minorities might fear that birth registration will be

misused, for example by using the information in order to weaken the particular culture or to discriminate them (Bequele, 2005; UNICEF, 1998). An example of misusing birth registrations including information about the religion and ethnicity is found in Rwanda in 1994, where this type of information was used to exterminate a particular group of people (Pais, 2002).

Third, since ethnic minorities and traditional religions are relatively small groups within the population, these groups may have the additional disadvantage of speaking a different language (Pais, 2002). In most developing countries, various languages exist within different ethnic and religious groups, which can cause language barriers (Pais, 2002). As a result, groups might be illiterate in the language in which the registration form needs to be filled in (Nomura et al., 2018; Pais, 2002). In addition, there might be no information about birth registration might not be available in the language of the ethnic or religious group, which can cause ignorance about the importance of birth registration and the birth registration procedure (Mackenzie, 2008). As a result, belonging to an ethnic minority or traditional religion can cause differentiating birth registration rates and other household-level determinants to have a different effect.

Concludingly, the literature shows that households in which more economic resources are available, no parents are missing, parents are educated, women have autonomy, in which children are older, and which households do not belong to an ethnic minority or traditional religion, are more likely to have a spokesman that decides to register the birth of a child. Therefore, *the first hypothesis is that children from a more favorable socio-economic and demographic background in the household-context are more likely to be registered.*

#### **2.2.1.2. Care variables**

Not only socio-economic and demographic household-level variables influence the situation in which a birth registration decision is made, but also care variables can have an effect on the situation surrounding the decisionmaker. Care variables concern events in which health care is provided to a pregnant mother or a child aged 0-4 during the time period from the pregnancy of the mother until the first 4 years of the child's life, which can increase the awareness surrounding birth registration (UNICEF, 2005). Contact with health facilities can be valuable for increasing awareness among households because skilled health personnel are a credible and reliable source of information and can explain the benefits of birth registration easily (Candia, 2019; Corbacho et al., 2012; Makinde et al., 2016; Mohanty & Gebremedhin, 2018; UNICEF, 1998, 2005). Moreover, as stated by Fagnäs & Odame (2013, p.460), "The fact that registration offices are often located within health facilities or close to them implies a direct connection between health care and registration". Contact with skilled health personnel and visiting health facilities during pregnancy and the first 4 years of the life of the child can make a difference for birth registration rates, correspondingly.

There are 3 main events concerning health care surrounding the pregnancy and in the first 4 years of the child that are important for higher birth registration rates. First, receiving prenatal care by

skilled health personnel is of great importance (Adi et al., 2015; Corbacho et al., 2012; Duryea et al., 2006; Nomura et al., 2018). If mothers have received prenatal care, they have had contact with educated health personnel who can distribute information about birth registration to them, recommend to register the birth, and propose a registration office to them (Makinde et al., 2016; Mohanty & Gebremedhin, 2018). Furthermore, if mothers receive prenatal care in facilities where a birth can be registered as well, they have more knowledge about where to register a birth and the birth registration procedure as well (Adi et al., 2015). As a result, mothers will be better informed of the benefits and the procedure of birth registration.

Second, a child's first contact with the world can already be of an important event determining whether a child is going to be registered or not (Adi et al., 2015; Mohanty & Gebremedhin, 2018; UNICEF, 2005). If a child is born in an institutional facility, the child will have a higher probability of having a birth registration because the birth is attended by skilled health personnel who cannot only provide information about birth registration but also help with the paperwork needed while also having the notification role (Adi et al., 2015; Corbacho et al., 2012; Isara & Atimati, 2015; Makinde et al., 2016; Nomura et al., 2018; Pelowski et al., 2015; UNICEF, 1998; United Nations Children's Fund, 2013). For instance, according to Candia (2019, p.14) "registration of births and issuance of short birth certificates is mandatory for all births in government hospitals". As information is already being gathered for these short birth certificates, the next step towards official birth registration is easier. As a consequence, being born at home will pose more restrictions on birth registration, for example, by travelling costs and hours and by not being notified by health personnel. However, not only the place of delivery but also the person attending the delivery can be important for the birth registration decision (Candia, 2019). In previous research, traditional birth attendants were proven to not motivate parents to register the births of their newborns, probably due to traditional beliefs and practices, while skilled birth attendants did motivate parents (Candia, 2019; Chereni, 2016; Nomura et al., 2018; UNICEF, 1998; United Nations Children's Fund, 2013).

Third, primary care provided by modern health institutions in the first 4 years of a child's life is important (Bhatia et al., 2017; Candia, 2019). When children are in contact with health facilities, for example for receiving a vaccination or vitamin supplements, health care personnel will have the opportunity to notice that a child has no birth certificate and discuss this fact with the family (Fagerlös & Odame, 2013; UNICEF, 2005). As stated by Pelowski et al. (2015, p. 900), "using vaccine delivery (particularly Diphtheria-tetanus-pertussis, DTP) as an occasion to register births may also provide a means of reaching children born outside health facilities". Although it is true that a child without a birth registration cannot always get access to primary care in some countries, there are countries in which providing vaccinations is part of public service or of special health programs (Bequele, 2005; Heap & Cody, 2009; Mackenzie, 2008; Pelowski et al., 2015). Since there is evidence that parents still vaccinate their children even if they were not born at an health institution, getting a vaccination before the age of 5 can be important for the birth registration decision of the household (Pelowski et al., 2015). The same

reasoning is made for receiving vitamin A before the age of 5 (Fagernäs & Odame, 2013; UNICEF, 2005). As a result, *the second hypothesis is that households that are more often in contact with health facilities and skilled health personnel, are more likely to register a child.*

### ***2.2.2. Sub-national regional level***

Although the birth registration decision is made at the household level, the situation at the sub-national regional level can still influence the choices made at the household level (Amo-Adjei & Annim, 2015; Corbacho et al., 2012; Mohanty & Gebremedhin, 2018). At the sub-national regional level, there can be huge differences in the availability and efficacy of services like education and health care across sub-national regions (Mohanty & Gebremedhin, 2018). As households live in the same sub-national region, they face the same policies and infrastructure, which can in turn have an effect on decisions that have to be made at the household level such as whether to register a child but also where to deliver the baby and whether or not to go to school for example (Mohanty & Gebremedhin, 2018). Accordingly, both the categories socio-economic and demographic variables and care variables are important at the sub-national regional level.

#### ***2.2.2.1. Socio-economic and demographic variables***

Considering the socio-economic and demographic characteristics at the sub-national regional level, the development of the particular sub-national region is important because this factor can reflect the quality of facilities and the infrastructure within the region, which can influence the awareness and the aggregate costs of birth registration at the household level (Amo-Adjei & Annim, 2015; Huisman & Smits, 2015; Mohanty & Gebremedhin, 2018; Nomura et al., 2018). Following Mohanty & Gebremedhin (2018), higher incomes at the sub-national region can indicate better health infrastructure and quality, which leads to better health services. The same reasoning can be made for other facilities and services, like education and birth registration offices.

Related to the quality of facilities and the infrastructure, is the rate of urbanization. Rural areas tend to have worse infrastructures than urban areas, causing birth registration systems often to not stretch out to remote areas, making travelling to a registration office more difficult and more expensive (Bequele, 2005; Corbacho & Osorio Rivas, 2012; Todres, 2003). Both travelling and opportunity costs are most likely higher in rural areas since households have to travel further and longer than households in urban areas, lowering the chances of having a birth registration for children aged 0-4 (Bhatia et al., 2017; Candia, 2019; Corbacho & Osorio Rivas, 2012; UNICEF, 2005). A study using GPS data has shown that the further the travel distance to the nearest registry office, the higher the probability of not registering a child (Corbacho & Osorio Rivas, 2012). Of course, the further the distance to the registry office, the higher the indirect costs are of a birth registration because more time and money is needed to travel. According to Corbacho & Osorio Rivas (2012), not only the costs are higher but also the information flow about birth registration is lower. They argue that a higher distance from the registry

office leads to worse information access about the birth registration procedure and prerequisites. As stated by UNICEF (2005), these restrictions are most problematic to households living in a rural area. Therefore, households living in rural areas are less likely to register a birth.

In addition to the development of the region and the rate of urbanization, the availability of education at the sub-national region is important for birth registration rates since more educational availability can increase the knowledge about birth registration in the sub-national region. The availability of schools is important for the parental education at the household level. “If there are fewer schools available, average distance to school will be longer, which might negatively affect the likelihood to stay in school” (Huisman & Smits, 2015, p.4). Assuming that most parents will stay in the sub-national region that they have grown up in, less school availability in the sub-national region will have had a negative effect on the parental education, which in turn has resulted in less mean years of education and worse educated social networks (Huisman & Smits, 2015; Mohanty & Gebremedhin, 2018; UNICEF, 2005). As a consequence, less information and advice can be obtained on the procedure of birth registration. On the contrary, higher availability of education can lead to higher average years of education in the region, which might lead to spillover effects to the household level.

#### ***2.2.2.2. Care variables***

Not only the availability of educational facilities, but also the availability of health facilities and thus of registration offices, as explained in section 2.2.1.2., within the sub-national region can be of great importance for birth registration rates. Following the reasoning of Huisman & Smits (2015) and Mohanty & Gebremedhin (2018), if there are few health facilities and thus registration offices available, the average distance to such places will be longer, which will in turn increase the travelling and opportunity costs and thus the total costs of birth registration. Besides that, in some countries it is only allowed to register a child in the region in which he or she was born (Amo-Adjei & Annim, 2015). If only a few hospitals or registration offices are available in the sub-national region, a family member will have to travel far in order to register the birth at a later point. However, not only the indirect costs of birth registration are affected by the amount of health facilities and registration offices available, but also the amount of care a child receives (Jackson, Duff, Kusumanigrum, & Stark, 2014). When few health facilities are available, the chances of the mother receiving prenatal care, a child being born in a hospital, and the household receiving regular primary care are low (Jackson et al., 2014). Accordingly, a low availability of registration offices and health facilities or resources will decrease the chance of registering a birth at the household level by increasing the costs of birth registration and decreasing the amount of healthcare received.

On the whole, socio-economic, demographic and care factors belonging to a certain sub-national region such as the development, the availability of educational and health facilities, and the urbanization rate of the region can influence the situation surrounding the birth registration decision at the household

level. As a consequence, *the third hypothesis is that more favorable socio-economic, demographic and care conditions at the sub-national regional level increase the odds that a child is registered.*

### **2.2.3. National level**

Not only the influence of the sub-national regional level on the household level should be considered, but also the influence of the national level on the lower levels (Dunning et al., 2014). The huge differences in birth registration rates across developing countries can be mainly attributed to the variation of national factors (Bequele, 2005; Cappa et al., 2014; The United Nations, 2019). At the national level, only determinants in the category socio-economic and demographic variables are useful because these national factors do not have the detail needed for the category care.

#### **2.2.3.1. Socio-economic and demographic variables**

Socio-economic and demographic variables at the national level can have a significant influence on the birth registration decision at the household level as the overall level of development of a country may already affect the quality and availability of birth registration systems in developing countries (Bequele, 2005; UNICEF, 1998). For example, many civil registration systems are underdeveloped in developing countries due to the lack of economic resources (Mackenzie, 2008; Pais, 2002; UNICEF, 1998; United Nations Children's Fund, 2013). In developing countries, governments might be unwilling to spend their already scarce resources on the creation or the maintenance of registration systems, including skilled personnel, basic materials, and registration offices with the right provisions (Mackenzie, 2008; Pais, 2002). Consequently, the (non-)existing registration systems are highly dependent on the national income of a country (United Nations Children's Fund, 2013).

Moreover, the government might not perceive birth registration as important enough to spend resources on it, which can result in the following legislative barriers concerning birth registration: no legislation at all, outdated legislation, and weak enforcement of the laws (Bequele, 2005; Heap & Cody, 2009; Li et al., 2010; Mackenzie, 2008; Pais, 2002; United Nations Children's Fund, 2013). As mentioned by Bequele (2005, p.17), "Laws relating to births and deaths may not be well known or harmonized with other legislation". Consequently, abiding the law and enforcement of the law is difficult. Besides that, the content of the law, like whether a fee must be paid and the time within a birth must be registered, might be damaging (Mackenzie, 2008; Makinde et al., 2016; Mohanty & Gebremedhin, 2018; United Nations Children's Fund, 2017). A fee for registering a child can be detrimental for birth registration rates in developing countries where poverty is an issue (Bequele, 2005; Fagnäs & Odame, 2013; Pais, 2002; UNICEF, 2005; United Nations Children's Fund, 2013). Also, specified legal time periods in which one can register a child can be harmful for birth registration rates since long allowed time periods for a long process can lead to procrastination and too short time periods can make timely birth registration unfeasible for people living in disadvantageous living conditions (Duff et al., 2016; Li et al., 2010; Pelowski et al., 2015). As a result, legal barriers can make it difficult



to achieve high birth registration rates while the enforcement of the birth registration laws is also unachievable in most cases (Mackenzie, 2008).

Apart from weak enforcement, another consequence of imperfect legislation is that the formation of the appropriate institutions for birth registration is problematic (Bequele, 2005). Due to the complex nature of decentralized birth registration systems, centralized systems can be preferred despite the fact that these systems are located in urban or other central areas only and thus cannot oversee the local problems and reach other areas (Chereni, 2016; Mackenzie, 2008; Makinde et al., 2016; Pelowski et al., 2015; Todres, 2003). Although decentralized birth registration systems can be complex, expensive, and time-consuming as different institutions with different departments and agents must then interact, they are flexible and make birth registration more accessible for rural areas (Chereni, 2016; Mackenzie, 2008; Makinde et al., 2016; Pelowski et al., 2015; Todres, 2003). As a consequence, several countries have seen their birth registration rates go up after moving from a centralized to a decentralized system, for example in Bangladesh and Kenya (Pelowski et al., 2015; Todres, 2003).

Besides these socio-economic determinants, demographic variables can also influence the birth registration decision on the household level (Dunning et al., 2014; Heap & Cody, 2009). The demographic effect is twofold. Firstly, fertility rates have an effect as they make registering every child harder than when fertility rates are low due to the costs of birth registration (Bequele, 2005; Dunning et al., 2014; Fagnäs & Odame, 2013; Pais, 2002; UNICEF, 2005; United Nations Children's Fund, 2013). Higher fertility rates mean that a household has more children on average. If a household has economic difficulties, birth registration for one child might be feasible but not for all children. Secondly, mortality rates among children under the age of 5 are also affecting the decision whether to register a child or not (Dunning et al., 2014; Heap & Cody, 2009). As stated by Heap & Cody (2009, p.21), "high child mortality rates give parents little incentive to bear the expense of registering children". As having a birth registration has mainly future benefits, current costs may be too high when mortality rates are high (Corbacho & Osorio Rivas, 2012; Smits & Huisman, 2013). Therefore, national demographics can influence the incentive to register a child at the household level.

Finally, the history of the country can have an influence on the current birth registration rate. Especially, the consequences of the colonial era and of periods of war and conflict can still be seen (Pais, 2002; Szreter & Breckenridge, 2012; UNICEF, 1998). With regards to colonialism, path dependency causes the structures from the colonial era hamper the development of birth registration processes because of the fact that the colonizers have introduced birth registration in the colonies, but only non-Africans were allowed to be registered (Bequele, 2005; UNICEF, 1998). Birth registration can still be associated with the colonial period, which causes aversion to the concept of birth registration for some people (Bequele, 2005; Szreter & Breckenridge, 2012). Another reason is that colonial rulers did not invest in the administrative infrastructure needed for birth registration systems since they mainly cared about certain parts of the African countries like the cities or harbors (Szreter & Breckenridge,

2012). Although the civil registration systems in Sub-Saharan Africa grow slowly but surely, it is argued that colonized countries are still making up for lost time (Szreter & Breckenridge, 2012).

With respect to war and conflict, the progress of civil registration systems made in Sub-Saharan African countries can easily be destroyed by conflicts (Dunning et al., 2014). This unstable and dangerous environment makes it impossible to have a functioning registration system if there was one in the first place (Heap & Cody, 2009; Pais, 2002). Furthermore, misuse of the birth registration system during (civil) war, such as the Rwandan genocide, has caused birth registration systems to break down and fail due to mistrust (Amo-Adjei & Annim, 2015; Cappa et al., 2014; Todres, 2003). Several cases have pointed out that war and conflict can have long lasting consequences on the rate of birth registration, such as in Rwanda and the Democratic Republic of the Congo (Cappa et al., 2014; Pais, 2002; Todres, 2003). Accordingly, a history with some kind of conflicts, whether caused by the colonial period or by war or strife, has affected the functionality of birth registration systems.

Concluding, countries that have enough economic resources, proper birth registration legislation (content), decentralized birth registration institutions, low fertility and child mortality rates, and no history of colonialism and conflict have the best chances of high birth registration rates. Accordingly, *the fourth hypothesis is that countries with favorable socio-economic and demographic factors at the national level will increase the probability of birth registration.*

#### **2.2.4. Variation among contexts**

In order to provide even more detail, which is needed for useful and specific policy making with regards to birth registration, this paper is the first to examine how differentiating contexts can influence the birth registration determinants at the household-level. According to Huisman & Smits (2015, p.5), “By studying how the effects of the risk factors discussed differ according to characteristics of the context in which the household lives, we can make our model and predictions more situation-specific”. Accordingly, the variables ethnicity and religion, all sub-national regional-level determinants, and all national-level determinants will be introduced as context factors.

Firstly, for the socio-economic and demographic household-level determinants there are two determinants that are expected to have an indirect effect on birth registration. As explained before, ethnicity and religion can have an influence on the direct household-level determinants of birth registration since beliefs and traditions of ethnic and religious groups can affect the significance of these direct determinants (Pais, 2002). It is expected that especially ethnic minorities and traditional religious groups will affect the direct determinants of birth registration as these groups can have particular reasons for not registering a child, whether it is due to fear for the misuse of birth registration data or beliefs (Bequele, 2005; Cappa et al., 2014; Chereni, 2016; Mackenzie, 2008; Mohanty & Gebremedhin, 2018; Nomura et al., 2018; UNICEF, 1998; United Nations Children’s Fund, 2013). Therefore, having sufficient resources and having a better education, might not be as important factors for increasing birth registration rates as they would have been for households that are not an ethnic minority or belong to a

traditional religion for instance. As a result, *the fifth hypothesis expects that the effects of the main socio-economic and demographic determinants are mitigated if the household belongs to an ethnic minority or traditional religion.*

Secondly, following the reasoning of Huisman & Smits (2015), household-level determinants are perceived to interact with determinants at the higher levels. In their research about school dropout in developing countries, the authors state: “we expect that favorable household conditions, that is, more resources (in terms of wealth and education or work status of the parents) or a more favorable household structure, will compensate children for disadvantageous living conditions” (Huisman & Smits, 2015, p.5). This situation seems to apply to the case of birth registration as well, as found in the qualitative research of Chereni (2016, p.759): “What stands in the way of birth registration success, I argue, is a dynamic interplay of multiple economic and non-economic factors”. Accordingly, the economic and demographic situation within the household can either compensate for the unfavorable context the household lives in or aggravate the detrimental situation (Chereni, 2016; Huisman & Smits, 2015).

For example, if the region the particular household is living in is a rural area or relatively more underdeveloped, leading to a low availability and quality of services and further travel distance, having enough economic resources as a family can reduce the pressure of the direct and indirect costs of birth registration (Amo-Adjei & Annim, 2015; Bhatia et al., 2017; Candia, 2019; Corbacho & Osorio Rivas, 2012; Huisman & Smits, 2015; Mohanty & Gebremedhin, 2018; Nomura et al., 2018; UNICEF, 2005). Moreover, better educated parents have more awareness on the benefits and the procedure of birth registration (Bhatia et al., 2017; Makinde et al., 2016; Mohanty & Gebremedhin, 2018; Pais, 2002; UNICEF, 2005). Although there might be legal or historical barriers, such as an unclear law for birth registration or a failing civil registration system, these parents might still register the births because they know that having a birth registration will be advantageous to their child (Bequele, 2005; Heap & Cody, 2009; Li et al., 2010; Mackenzie, 2008; Pais, 2002; UNICEF, 1998; United Nations Children’s Fund, 2013). Even demographics of the household, such as living with both parents, can be important since in some countries both parents must be present in order to register a birth (Chereni, 2016; UNICEF Data, n.d.-b). Therefore, *the sixth hypothesis is that favorable economic and demographic household-level circumstances can make up for unfavorable context conditions.*

Thirdly, the extent to which a household receives health care surrounding the pregnancy of the mother, the delivery of the child, and the first 4 years of the child’s life can depend on the amount of healthcare that is available (Jackson et al., 2014). Following the reasoning of Corbacho & Osorio Rivas (2012) with regards to health facilities instead of birth registration offices, the further the travel distance to health facilities and the higher the costs, the less likely are the odds of seeking health care by skilled health personnel and thus of having a birth registration. However, it works also the other way around. If there are more health facilities available in the region, the costs will be lower, and people will be more likely to obtain professional health care and a birth registration. Hence, the difference in birth registrations between households that are getting professional health care and not getting professional

health care becomes bigger in regions with more availability of health care. When more health facilities are available and still no professional health care is sought, it can be concluded that this is a deliberate decision a household makes. Thus, there is not only a direct effect between the availability of healthcare facilities and birth registration, but also an indirect effect since the effects of the care variables depend on the availability of healthcare facilities in the sub-national region (Jackson et al., 2014). As a result, *the seventh hypothesis is that the effect of the care variables at the household level are amplified by the availability of health facilities in the sub-national region.*

Although the amount of healthcare a household receives surrounding the pregnancy of the mother, the delivery of the child, and the first 4 years of the child's life cannot compensate for the environment a household lives in like socio-economic and demographic determinants, it might be able to compensate for the availability of education. Since it is argued that education increases knowledge of the parent and the chances of a better educated social network, and in turn increases awareness about birth registration, a low availability of educational services can be balanced out by undertakings that can create awareness as well (Bhatia et al., 2017; Makinde et al., 2016; Mohanty & Gebremedhin, 2018; Pais, 2002; Parmar et al., 2016; UNICEF, 2005; United Nations Children's Fund, 2013). Hence, undertakings in which professional health care is received are expected to weaken the negative effect of low educational availability and the other way around as both can create awareness (Candia, 2019; Corbacho et al., 2012; Makinde et al., 2016; Mohanty & Gebremedhin, 2018; UNICEF, 1998, 2005). Accordingly, *the final and eighth hypothesis is that care variables at the household level and availability of education at the sub-national regional level can compensate each other.*

### 3. Research Design

In order to answer the research questions (1) *Which household, sub-national regional, and national factors influence the decision whether or not to register a child?* (2) *Which context characteristics affect the household-level determinants of birth registration?* an empirical analysis should be made. This section will explain how the empirical analysis will be operationalized. First, the data will be discussed, the source and composition of the data in particular. Second, the methodology and the composition of the variables will be explored.

#### 3.1. Data

Following several previous studies on the topic of birth registration in developing countries, the data used for the three levels will be from the Demographic Health Surveys (DHS), which is a program that collects nationally representative data by doing household surveys and using a probability sample (Apland et al., 2014; Candia, 2019; Corbacho et al., 2012; Croft, Marshall, & Allen, 2018; Duryea et al., 2006; The DHS Program, n.d.-a; UNICEF, 2005; United Nations Children's Fund, 2013). Besides that the DHS are one of the few surveys that contain information on birth registration, the surveys also contain information on socio-economic and care attributes (Corbacho et al., 2012). The Standard DHS Surveys will be used as these contain information about birth registration of children under 5 years old, are conducted regularly by doing them every 5 years, and have large sample sizes (The DHS Program, n.d.-a; United Nations Children's Fund, 2013).

Nevertheless, the DHS data has some limitations, for instance, "prevalence rates are highly sensitive to the way in which questions are formulated" and "observed differences may be the result of differences in data collection methods, bias or standard errors rather than actual changes in birth registration" (UNICEF, 2013, p.11). Although there are some limitations, these surveys are the exclusive and most accurate available data source on birth registration predominantly due to various failing CVRS systems in developing countries, which cannot provide accurate data accordingly (Bhatia et al., 2017; United Nations Children's Fund, 2013). Consequently, the Standard DHS Survey will be used for this research.

The Standard DHS Survey data will be derived from the Database Developing World, where household surveys like the Standard DHS with additional data on the subnational and national level can be accessed (Global\_Data\_Lab, n.d.). Considering that this paper will look into determinants of birth registration in developing countries at three different levels, the Database Developing World is able to provide data on all three levels (Global\_Data\_Lab, n.d.). Data on the household level are readily available while data for the sub-national regional and national level can be acquired by aggregating the household surveys as these surveys contain information about the sub-national region and the country the families live in (Huisman & Smits, 2015).

Although the Global\_Data\_Lab (n.d.) can provide most of the data needed for this research, it does not provide all data required for the independent variables in the empirical analysis. Particularly

data on national-level determinants of birth registration are not present, such as the specifics of birth registration legislation, national demographics, and the history of the country. Accordingly, additional data is retrieved from UNICEF Data, The World Bank, the Uppsala Conflict Data Program, and Encyclopædia Britannica when no data was available for the colonial origin of countries in the Uppsala Conflict Data Program (Encyclopædia Britannica, 2020; The World Bank, 2020a; UNICEF Data, n.d.-b; Uppsala Conflict Data Program, 2018).

Firstly, data concerning birth registration legislation is retrieved from UNICEF Data, in particular: whether there is birth registration legislation, whether there has been an update in legislation, the organizational structure, the time allowed for, and the fee involved in registering a birth (UNICEF Data, n.d.-b). UNICEF Data, part of UNICEF, is globally recognized as an organization that is concerned with children and developmental issues and informs people about these by means of data and reports (UNICEF Data, n.d.-a). UNICEF has published several reports about birth (under)registration, by means of their data, which are also used for various other research about birth registration in developing countries (Apland et al., 2014; Bhatia et al., 2017; Candia, 2019; Duryea et al., 2006; Pais, 2002; President's Emergency Plan for AIDS relief, Plan International, UNICEF, & Vision, 2008; Todres, 2003; UNICEF, 1998, 2005, 2013).

Secondly, The World Bank is used to retrieve national data on economics, demographics and governance, in particular data for the variables national income, the rule of law, government effectiveness, the fertility rate, and the mortality of children under 5 years old (The World Bank, 2020a). The rule of law and government effectiveness are retrieved from the Worldwide Governance Indicators database while the other variables are retrieved from the World Development Indicators database (The World Bank, 2020a). The World Bank is known as an organization that provides accurate data on various topics from officially-recognized sources and is used by other international institutions as well as by researchers interested in birth registration (Corbacho & Osorio Rivas, 2012; Dunning et al., 2014; Makinde et al., 2016; The World Bank, 2020; UNICEF, 2013).

Finally, information about the history of the country, in particular the number of conflicts and whether a country has been colonized, is retrieved from the Uppsala Conflict Data Program Version 19.1 (UCDP) (Gleditsch, Wallensteen, Eriksson, Sollenberg, & Strand, 2002; Therese Pettersson, 2019a, 2019b; Therése Pettersson, Högladh, & Öberg, 2019; Sundberg, Eck, & Kreutz, 2012; Uppsala Conflict Data Program, 2018). "Data on armed conflicts have been collected by UCDP since the 1980s and are continuously updated on a yearly basis. The data have been published yearly in the Journal of Peace Research (since 1993) and in SIPRI Yearbook (since 1988)" (Eck, 2005, p.58). As the UCDP data is used by several research institutes and is one of the few databases that updates their data annually, the UCDP is suitable for providing conflict data for the research in this paper in which recent data on conflicts is required (Eck, 2005; Uppsala Conflict Data Program, 2018). An additional benefit of the UCDP is that it provides conflict summaries that are annually updated as well, which includes information on the colonial period of countries (Eck, 2005; Uppsala Conflict Data Program, 2018).

Therefore, the UCDP has also been used to compute the variable concerning colonialism. In the 7 cases that no information on the colonial period was available at the UCDP, the Encyclopædia Britannica was used instead (Encyclopædia Britannica, 2020; Uppsala Conflict Data Program, 2018). The Encyclopædia Britannica is an encyclopedia that is “universally acknowledged as an outstanding reference work” (Auchter, 1999, p.291). Therefore, the encyclopedia has been useful for filling in the gaps of data of the Uppsala Conflict Data Program.

All in all, the integrated dataset includes 567407 children aged 0 to 4 years old who are living in 753 sub-national regions and 34 countries in Sub-Saharan Africa. Instead of focusing on one specific country like done in previous research, this research focusses on all the countries in the most problematic region with regards to birth registration in order to increase the external validity (Mohanty & Gebremedhin, 2018; The United Nations, 2019). The countries included in the analysis, the distribution of years and sub-national regions among these countries are the following: Angola, 2016, 36; Burundi, 2010, 2017, 10; Benin, 2006, 2011, 2018, 12; Burkina Faso, 2010, 26; Cote d’Ivoire, 2005, 2011, 20; Cameroon, 2011, 20; Congo Democratic Republic, 2007, 2013, 21; Congo, 2005, 2011, 15; Comoros, 2012, 6; Ethiopia, 2016, 21; Gabon, 2012, 19; Ghana, 2008, 2014, 20; Guinea, 2012, 2018, 15; Gambia, 2013, 14; Kenya, 2008, 2014, 15; Liberia, 2007, 2013, 41; Lesotho, 2010, 2014, 20; Madagascar, 2009, 55; Mali, 2006, 2013, 2018, 15; Mozambique, 2011, 21; Malawi, 2016, 26; Namibia, 2006, 2013, 26; Niger, 2012, 14; Nigeria, 2013, 73; Rwanda, 2010, 2015, 10; Senegal, 2011, 2012, 2014, 2015, 2016, 2017, 20; Sierra Leone, 2008, 2013, 27; Sao Tome en Principe, 2009, 8; Swaziland, 2006, 8; Chad, 2015, 15; Tanzania, 2010, 2015, 50; Uganda, 2006, 2011, 2016, 17; Zambia, 2007, 2014, 2018, 18; Zimbabwe, 2006, 2011, 2015, 19.

These countries have at least one Standard DHS Survey year available for the beginning years of the 21<sup>st</sup> century that contains data on birth registration for children aged 0 until 4. Data for the beginning years of the 21<sup>st</sup> century are chosen since these reflect the current problem most accurately (The United Nations, 2019). Accordingly, this paper makes use of independently pooled cross-sectional data. Although Bhatia et al. (2019) argue that it is important to look into the birth registration rates over time in order to see which factors indeed cause improvement, independently pooled cross-sectional data is the only viable option due to the data availability and structure of the Standard DHS Surveys. Despite that every country in the dataset has different observation points in the period 2005-2018, every available year per country will be used instead of only the most recent year like UNICEF (2013) in order to create a more robust analysis by including all data available.

### ***3.2. Methodology***

To test which factors determine the decision to register the child or not, a multilevel logistic regression is required. Several other studies investigating the subject of birth registration have been using a logistic regression since this is the appropriate model to use when the dependent variable is a binary variable, in our case whether the child aged 0-4 has a birth registration or not at the time of the

survey (Amo-Adjei & Annim, 2015; Fagernäs & Odame, 2013; Mohanty & Gebremedhin, 2018; UNICEF, 2005). Compared to most research on birth registration, the model of this paper needs to be expanded because this paper does not only enquire into the household level determinants of birth registration, but also into the context factors that can influence both the household determinants and the dependent variable. Therefore, a multilevel logistic analysis is needed (Mohanty & Gebremedhin, 2018). The multilevel part of the model takes into account the determinants at different levels of analysis while also correcting for the clustering of households within countries and sub-national regions (Huisman & Smits, 2015; Mohanty & Gebremedhin, 2018). According to Mohanty & Gebremedhin (2018), clustering can be a problem because households belonging to a certain sub-national region within the country face the same barriers compared to different sub-national regions, like birth registration offices coverage or effectiveness. The same line of reasoning can be made for the national level. Thus, as multiple countries and sub-national regions are taken into account to address the influence of the context factors, random intercepts are needed in order to attend to these national and sub-national regional differences in birth registration (Huisman & Smits, 2015).

All in all, three-level models are used due to the three levels that are perceived to have an effect, namely the household level, which is part of the sub-national regional level, which is again part of the national level (Smits & Huisman, 2013). Following Mohanty & Gebremedhin (2018), first an empty model with random effects at the highest level will be performed, after which lower levels are added. “The aim here is to study any variations in the null models that were due to each of the confounding factors” (Mohanty & Gebremedhin, 2018, p. 3). The first empty multilevel logistic model corresponds to a random intercept only model for the highest level, which is the national level (Khan & Shaw, 2011; Mohanty & Gebremedhin, 2018; Sommet & Morselli, 2017). This model can be mathematically represented as:

$$\text{logit}(y_{ik} = 1) = \log\left(\frac{y_{ik}}{1 - y_{ik}}\right) = \beta_0 + v_{0k}$$

In which  $\text{logit}(y_{ik} = 1)$  reflects the binary response variable having a birth registration or not for a child in household  $i$  in country  $k$ ,  $\beta_0$  is the fixed intercept or the average log odds of having a birth registration or not, and  $v_{0k}$  is the random intercept or variation from the fixed intercept at the national level for which the mean is expected to be 0 (Huisman & Smits, 2015; Khan & Shaw, 2011; Mohanty & Gebremedhin, 2018; Sommet & Morselli, 2017).

Following the same procedure, the second empty multilevel logistic model representing a random intercept only model for the highest level and the level below that, in particular the national and sub-national regional level, is reflected by the following equation:

$$\text{logit}(y_{ijk} = 1) = \log\left(\frac{y_{ijk}}{1 - y_{ijk}}\right) = \beta_0 + u_{0jk} + v_{0k}$$

In this equation,  $\text{logit}(y_{ijk} = 1)$  reflects the binary response variable having a birth registration or not for a child in household  $i$  in district  $j$  of country  $k$ ,  $\beta_0$  is the fixed intercept or the average log odds of



having a birth registration or not for a typical child living in a typical district of a typical country,  $u_{0jk}$  is the random intercept or variation from the fixed intercept at the district level within a country for which the mean is expected to be 0, and  $v_{0k}$  is the random intercept or variation from the fixed intercept at the national level for which the mean is expected to be 0 (Huisman & Smits, 2015; Khan & Shaw, 2011; Mohanty & Gebremedhin, 2018; Sommet & Morselli, 2017). For these models the intraclass correlation will be estimated in order to determine the variation within and across the different levels (Mohanty & Gebremedhin, 2018; Smits & Huisman, 2013).

Following these two models, two comprehensive models that take into account the household variables and the context variables with random intercepts for the national and sub-national regional level will be tested. The first comprehensive model will include all the variables at the three different context levels in order to investigate how variables at different context levels influence the birth registration decision. Since it is not expected in the theory that the effects of the independent variables change from one sub-national region to another and from one country to another, no random slopes are tested in the empirical analyses (Sommet & Morselli, 2017).

Nevertheless, it is expected that context factors can affect the determinants of birth registration, thus affect the variable birth registration indirectly. Following the reasoning of Huisman & Smits (2015) and Smits & Huisman (2013), in order to see whether the effects of the independent variables are different for varying contexts, interactions between all the household-level variables and ethnicity and traditional religion, between the economic and demographic household-level variables and the sub-national regional-level and the national level variables, and between the care variables at the household level and the availability of education and health at the sub-national regional level have been made. Only if the particular interaction term is significant, the interaction is added to the final model, due to the high number of interactions (Huisman & Smits, 2015; Smits & Huisman, 2013). For the interpretation of the interactions to be the average effect, the implicated continuous variables have been centered (Huisman & Smits, 2015; Smits & Huisman, 2013). In this way, an important step in the birth registration literature can be made since the analysis can show whether the birth registration decision is situation specific and if so, which context factors are important.

The two models will represent a fixed effects model for all independent variables with a random intercept for the national and sub-national regional level. One model will exclude the significant interactions while the other will include them. The models can be mathematically described as:

$$\text{logit}(y_{ijk} = 1) = \log\left(\frac{y_{ijk}}{(1 - y_{ijk})}\right) = \beta_0 + \beta_{1ijk}X_{1ijk} + \beta_{2jk}X_{2jk} + \beta_{3k}X_{3k} + u_{0jk} + v_{0k}$$

In which  $\text{logit}(y_{ijk} = 1)$  reflects the binary response variable having a birth registration or not for a child in household  $i$  in district  $j$  of country  $k$ ,  $\beta_0$  is the fixed intercept or the average log odds of having a birth registration or not for a typical child living in a typical district of a typical country,  $\beta_{1ijk}X_{1ijk}$  reflects the vectors of the household level variables,  $\beta_{2jk}X_{2jk}$  reflects the vectors of the sub-national

regional level variables,  $\beta_{3k}X_{3k}$  reflects the vectors of the national level variables,  $u_{0jk}$  is the random intercept or variation from the fixed intercept at the district level within a country for which the mean is expected to be 0, and  $v_{0k}$  is the random intercept or variation from the fixed intercept at the national level for which the mean is expected to be 0 (Huisman & Smits, 2015; Khan & Shaw, 2011; Mohanty & Gebremedhin, 2018; Sommet & Morselli, 2017).

The dependent variable, birth registration, has a binary outcome with a value of 1 if the child has a birth registration and a value of 0 if the child has no registration. The variable is based on question HV140 in the Standard DHS Survey: “Does (NAME) have a birth certificate? (If no, probe) Has (NAME)'s birth ever been registered with the civil authority?” (National Bureau of Statistics - Nigeria, 2013, Literal question). The variable has 6 possible categories, in particular: neither certificate nor registered, has certificate, registered, has only hospital card, don't know, and missing. In order to get the variable birth registration with value 1 for having a birth registration and value 0 for not having a birth registration, the categories ‘has certificate’ and ‘registered’ were given the value 1 while the category ‘neither certificate nor registered’ was given value 0. The categories ‘don't know’ and ‘missing’ were marked as missing values and thus invalid. Although there can be multiple children from one household in the dataset, the children used for the empirical analysis will be limited to aged 0-4 at the time of the survey since parents only had to answer the question for children aged 0-4 in most of the surveys. Accordingly, 39760 out of 607330 data observations were invalid and were not taken into account in the empirical analysis.

Besides missing cases for the dependent variable, missing cases for the independent variables were handled. To maintain a reliable dataset with as many observations as possible, listwise deletion in combination with dummy variable adjustments are performed for every variable that has missing cases. First of all, listwise deletion was necessary for the variable age. As shown in appendix 1, most missing cases for the variable age were also missing cases for the dependent variable birth registration. Since the birth registration question was asked for children aged 0-4 only, it is very likely that these missing cases do not represent children in that age category. Therefore, missing cases for the variable age are not taken into account in the empirical analyses. Moreover, listwise deletion is conducted for variables with less than 500 missing cases since this only represents 0.1% of the data, in particular for the International Wealth Index and phone.

For the remaining variables with more than 500 missing cases, dummy variable adjustments are used. Although the dummy variable adjustment has been criticized for providing biased estimates over the past few years, it is still appropriate for variables that have missing values that are correlated to another variable in the data (Allison, 2001). Since the variables on which a dummy variable adjustment is performed are correlated to another variable, the technique is still useful and leads to unbiased estimates (Huisman & Smits, 2015). For example, many variables with missing values are related to the variable father missing or mother missing, such as education of the parents, age at first birth, who is the decisionmaker concerning contraception, prenatal and postnatal checks, etc. The variables on which a

dummy variable adjustment is performed, either by giving the value of the mean to missing cases or by adding an extra category that represents the missing values, include: education of the parents, age at first birth, decision on contraception, ethnicity, religion, prenatal care visits, prenatal check personnel, prenatal check location, place of delivery, delivery assistance, postnatal check, vaccination, vitamin A, update legislation, organizational structure, time allowed for registration, fee, and the number of conflicts (Huisman & Smits, 2015). All in all, the empirical analysis can be performed on 567407 valid observations out of the 607330 available observations (see appendix 2).

As the Standard DHS Surveys have a large amount of observations and missing records present less than 10% of the data, in particular 6.6% (see appendix 2), it is not expected that the excluded cases will affect the results (Huisman & Smits, 2015; Makinde et al., 2016). Nevertheless, the selection probability of each child might not have been equal due to the use of survey data, which can lead to biased results (Makinde et al., 2016; Pfeiffermann, 1996). The crosstabulations with probabilities in appendix 3 show that children with certain characteristics, like living in a rural area, father present, and mother present were overrepresented in the data and accordingly have more missing values for the dependent variable. To solve this issue, sampling weights for the household have been used for the empirical analyses, which are calculated by the available variable household sample weight divided by 1000000 (Makinde et al., 2016; The DHS Program, n.d.-b).

### ***3.3. Independent variables***

The composition of the independent variables used in the empirical analysis will be discussed according to their level, either the household, sub-national regional, or the national level. Within these levels, the main themes presented the literature review, socio-economic and demographic determinants and care determinants, are discussed. Besides these two themes, the handling of missing values is also discussed per level.

#### ***3.3.1. Socio-economic and demographic household-level variables***

The socio-economic and demographic independent variables at the household level include income, having a mobile phone, the child's age, the years of education of the mother, the years of education of the father, mother missing, father missing, whether the mother received her first child before the age of 18, whether the mother can decide on the use of contraception, and the ethnicity and religion of the household.

Firstly, factors concerning the socio-economic status of the household are retrieved from the Standard DHS data. Income is measured by the 'International Wealth Index (IWI) of the household'. "IWI measures a household's level of material well-being by looking at the household's possession of durables, access to basic services, and characteristics of the house in which it is living" (Smits & Steendijk, 2015, p.68). As the subjects of this research are households in Sub-Saharan Africa, household wealth can provide more detailed information about the material well-being of a household

than income. Accordingly, the International Wealth Index of the household is used as a proxy for household income. “The IWI scale runs from 0 to 100. If a household has all durables and highest quality housing and services, its IWI value is 100. If it has none of the durables and lowest quality housing and services, its IWI value is 0” (Smits & Steendijk, 2015, p.68).

Part of the IWI is also ‘owning a mobile phone’, which is thus also available in the data. The variable has a value of 1 if the member or one of the household members has a mobile phone and value 0 if no one in the household has a mobile phone. Lastly, to reflect the awareness of parents, two continuous variables for the years of education of both parents have been made, in particular ‘the years of education of the father’ and ‘the years of education of the mother’. This variable was readily available in the data, but an upper limit of 17 years was set, in which higher numbers were given the value 17 since only few cases were available.

Secondly, family demographics have also been obtained directly or computed from the Standard DHS Surveys. The variable ‘age’ was readily available in the survey data and measured in years. Only children with age 0 until 4 years old were selected. Unlike age, the family structure of the child has been computed by hand. Two dummy variables have been made to indicate whether a father (‘famis’) or mother (‘momis’) is missing from the household, with value 1 indicating that the particular parent is missing and value 0 that the parent is present. Moreover, a ‘missing parent’ variable has been computed to indicate whether the child lives in a household in which no parents are present. The dummy variable has a value of 1 if there are no parents present and a value of 0 when at least 1 parent is present.

Thirdly, the social characteristics of the household have been computed. The relational structure within the household, in particular the position of women, is indicated by 2 variables. According to Mohanty & Gebremedhin (2018, p.6), “studies that used multiple and multidimensional measure of empowerment were more likely to find consistent results”. As a result, the variables ‘mother has given birth before the age of 18’ and ‘mother can decide on contraception’ were both computed to indicate the position of women in the household. Following Huisman & Smits (2015, p.6), “to get a rough indication of the strength of a woman’s position within the household, we included a dummy showing whether (1) or not (0) the mother had her first child below age 18”. Based on the reasoning of Mohanty & Gebremedhin (2018) the other variable representing the position of women is a categorical variable that indicates who decides on contraception, either the mother herself (1), the partner (2), or whether it is a joint decision (3).

Finally, the variables ‘ethnicity’ and ‘religion’ were recoded into categorical variables. The variable religion consists of 8 categories, namely: (1) Catholic, (2) Protestant, (3) Christian, not specified, (4) Muslim, (5) no religion, (6) other, and (7) Traditional. Since the variable ethnicity has 274 categories consisting of all different ethnicities, a new variable is computed indicating whether the ethnicity is a (1) majority group, a (2) normal sized group, or a (3) minority group. These values were given based on the percentage distribution of the existing groups within the country. If a group

concerned 0-10% it was seen as a minority, if it concerned 10-30% it was seen as a regular group, and if it concerned 30+% it was seen as a majority.

### ***3.3.2. Care household-level variables***

The care independent variables at the household-level include: who performed the prenatal check, where the prenatal check is performed, the number of prenatal check visits, where delivery of the child took place, by whom the delivery was assisted, whether a postnatal check took place within 2 months, whether the child ever has received a vaccination, and whether the child has received vitamin A in the last 6 months. The care variables were also retrieved from the DHS Surveys although from the woman's surveys instead of the household surveys since these include questions about maternal and child health (National Institute of Statistics of Rwanda (NISR), Ministry of Health Rwanda (MOH), & ICF International, 2015).

With regards to prenatal care, 3 variables are used for the empirical analysis. The first variable, 'prenatal care by whom', indicates by whom the prenatal check was performed. The following values indicate who performed the check: (1) no one, (2) a traditional birth attendant, (3) another person, and (4) skilled health personnel. The second variable, 'prenatal visits', indicates whether the mother has had 4 or more prenatal check visits. According to National Institute of Statistics of Rwanda (NISR), Ministry of Health Rwanda (MOH), & ICF International (2015), at least 4 prenatal check visits are needed to be effective. Accordingly, the value 0 indicates that the mother never went to a prenatal check, the value 1 indicates that the mother went to prenatal checks up to 3 times, and the value 2 indicates that the mother has gone 4 times or more to prenatal checkups. The third variable concerning prenatal care is 'prenatal care location', indicating where the prenatal check was performed, either (1) nowhere since no care was received, (2) at home, (3) at a health institution other than a hospital, (4) or in a hospital.

Concerning delivery, two variables are used to reflect the situation surrounding the delivery. To begin with, 'the place of delivery' is indicated by a dummy variable. The variable place of delivery has a value of 1 when the birth took place at (someone's) home while a value of 0 when the birth took place at an institution. Besides the place of delivery, the assistance received while giving birth is also important. A categorical variable, 'assistance during delivery', was computed to show whether the birth was assisted by: (1) no one, (2) a traditional birth attendant, (3) another person, (4) or skilled health personnel.

The last phase of care concerns primary care during the first 4 years of the child's life. This phase is indicated in the data by means of 3 independent variables. Firstly, the variable 'postnatal check' is included, reflecting whether (0) or not (1) a postnatal check has been performed within 2 months. Although it is important that skilled health personnel perform the checkup since they can educate parents, the indicator was not used for this research. The data was made up from different categories, however, the categories indicated a different group of people in every survey. Therefore,

the data was not suitable for this research to indicate who performed the postnatal checkup. Secondly, two dummy variables are used to indicate the amount of care a child has received after 2 months of birth. The variable ‘never received a vaccination’ shows whether children have ever received a vaccination (0) or not (1) while the variable ‘has not received vitamin A in the past 6 months’ reflects whether a child received vitamin A in the last 6 months (0) or not (1).

### ***3.3.3. Handling of missing values of the household-level variables***

The missing values of most independent household-level variables are handled by listwise deletion or dummy variable adjustments. The listwise deletion has been used for the variables IWI, phone, and age. The missing values of the other variables are corrected by a dummy variable adjustment. Although there has been critique on this method, it is seen as the right technique to handle the missing values in this case since the missing values are dependent on other variables (Allison, 2001). For example, the missing values of ethnicity and religion are related to each other. Although there is no clear theoretical relation between the two, the crosstabulation in appendix 4 shows that within the category religion missing, 75.6% of the observations is also missing for ethnicity and that within the category ethnicity missing, 70.1% of the observations is also missing for religion. The reasoning behind this may be that both religion and ethnicity could be viewed as controversial subjects, leading people to not answer both questions.

Furthermore, many missing values of variables are correlated with the variable indicating that the father or mother is missing from the household. Following Huisman & Smits (2015, p.6), “Children with a missing parent were given the mean score of the other children in the database on the variables indicating characteristics of the parents”. If the variable is not continuous but categorical, another category was added indicating whether data is missing. Characteristics of the parents include education of the father and mother, whether the mother had her first birth before the age of 18, whether the mother decide on contraception, by whom a prenatal check was performed, the number of prenatal check visits, where the prenatal check was performed, where delivery of the baby took place, by whom the birth of the baby was assisted, whether a postnatal check was performed within 2 months, whether the child ever received a vaccination, and whether the child received vitamin A in the last 6 months.

### ***3.3.4. Socio-economic and demographic sub-national regional-level variables***

The socio-economic and demographic independent variables at the sub-national regional variables include the sub-national regional wealth, the availability of education in the sub-national region, and the rate of urbanization. To reflect the quality of services and infrastructure in the sub-national region, such as of education, health care, and birth registration offices, the sub-national regional level of wealth is used as a proxy based on Mohanty & Gebremedhin (2018). The variable ‘the International Wealth Index of the sub-national region’ is computed by aggregating the values of

the International Wealth Index of the households of that region. Accordingly, the variable represents the average well-being and poverty of the sub-national region (Smits & Steendijk, 2015).

In addition to the sub-national regional IWI, the variable ‘the availability of education’ has also been computed by hand. The variable was obtained by following the paper of Smits & Huisman (2013, p. 330): “the availability of educational facilities in the nearby environment was indicated by the average number of years of education of adult males in the cluster”. They also state that only men are taken into account as the education of women is dependent on several factors, such as patriarchy. The method was adjusted to the situation of the sub-national region instead of the cluster. Moreover, the years of education of the father used for the aggregation was corrected by a dummy variable adjustment.

On the contrary, the variable ‘level of urbanization’ is readily available in the data and measured by a dummy variable with a value of 1 indicating that the household lives in an urban area and a value of 0 indicating that the household lives in a rural area. The urbanization variable has no missing values, even as the sub-national regional level International Wealth Index, and the availability of educational facilities. Accordingly, no adjustments were necessary in order to handle missing values.

### ***3.3.5. Care sub-national regional-level variables***

Besides the socio-economic and demographic sub-national regional-level variables, there is also a variable in the category care in at this level, namely ‘the availability of health facilities in the sub-national region’. Following again the reasoning of the paper of Smits & Huisman (2013, p. 330): “the availability of educational facilities in the nearby environment was indicated by the average number of years of education of adult males in the cluster”, the availability of health facilities is computed as well. The availability of health facilities is reflected by the average number of prenatal check-up visits a mother has made in the sub-national region. A dummy variable adjustment was performed on the variable number of antenatal visits first since it is a parental characteristic on the child’s record and missing values were present. After, the variable was aggregated to the sub-national regional level. As a result, this variable had no missing values either.

### ***3.3.6. Socio-economic and demographic national-level variables***

At the highest level, variables at the national level are considered. Especially the economic, legislative, demographic, and historic situation of the country are important. The economic situation of the country is a proxy for the availability and quality of the birth registration systems (Bequele, 2005; UNICEF, 1998). The economic situation of the country is represented in the data by means of the variable ‘Gross Domestic Product per capita’ (in current US dollars) retrieved from The World Bank (2020). For this variable, a different source of data is chosen instead of aggregating the IWI at the household level since IWI is also used for measuring the development of the sub-national region and aggregating it to the national level as well can cause high correlations.

The legislative situation surrounding birth registration is depicted by several variables. The variable ‘birth registration legislation’ is a dummy that indicates whether a country has (1) a legislation for birth registration or not (0). In turn, the variable ‘no update in legislation’ represents whether there has been an update in birth registration legislation over the years. The value 0 depicts an update in the legislation while the value 1 depicts the situation in which no update has taken place. Moreover, the variables ‘time allowed for registration’ and ‘fee’ reflect the content of the legislation. Time allowed for registration is recoded in a categorical variable, in which every category concerns a time span: (1) within 2 weeks, (2) within 1 month, (3) within 2 months, (4), within 2+ months, (5) and no legal period. Fee is a dummy variable, in which a value of 1 indicates that there is a fee involved in birth registration and a value of 0 indicates there is no fee involved in birth registration. Besides the content of the legislation, the ‘organizational structure’ of the birth registration system is also important. This variable is a dummy variable indicating whether the procedure is decentralized (0) or centralized (1). As most missing cases of the variables concerning the content of the legislation and structure of birth registration systems are dependent on whether there is a legislation in the first place, the variables are corrected by a dummy variable adjustment in which an extra category for the missing cases is added.

Although birth registration legislation is important, the level of governance of the country is also determining how well legislation is taken into account by citizens of that country. Accordingly, two of the Worldwide Governance Indicators are used for the empirical analysis, namely the variables ‘rule of law’ and ‘government effectiveness’ (The World Bank, 2020a). The variable rule of law represents the attitude and behavior of citizens towards the law while the variable government effectiveness represents the perceptions of citizens on policies, in which -2.5 is the lowest score and 2.5 the highest (The World Bank, 2020b). The demographic indicators are also retrieved from The World Bank (2020). The ‘fertility rate’ represents the average amount of births per women considering that she has a long life and acts in accordance with the standard (The World Bank, n.d.). The ‘mortality rate of children under 5 years old’ represents the probability that a child will die before the age of 5 per 1000 (The World Bank, n.d.).

Finally, the history of the country is represented by 2 variables retrieved from the Uppsala Conflict Data Program (2018) and Encyclopædia Britannica (2020). Firstly, the ‘number of conflicts’ represents the number of conflicts a country has had in the period 1990 until the particular year of the DHS Survey used. The variable is computed by adding two variables, namely non-state conflict and state conflict (Gleditsch et al., 2002; Therese Pettersson, 2019a, 2019b; Therése Pettersson et al., 2019; Sundberg et al., 2012). Only conflicts with more than 25 battle deaths are taken into account (Therese Pettersson, 2019b). Since the variables non-state and state conflict have missing values for the same countries, a dummy variable adjustment is used in which the mean of the number of conflicts is given to the countries that have missing data. Next to the number of conflicts, the variable ‘colonized’ represents whether a country was colonized and by whom. The variable ‘colonized’ is a dummy



variable with value 1 when the country was colonized and a value 0 when the country was never colonized.

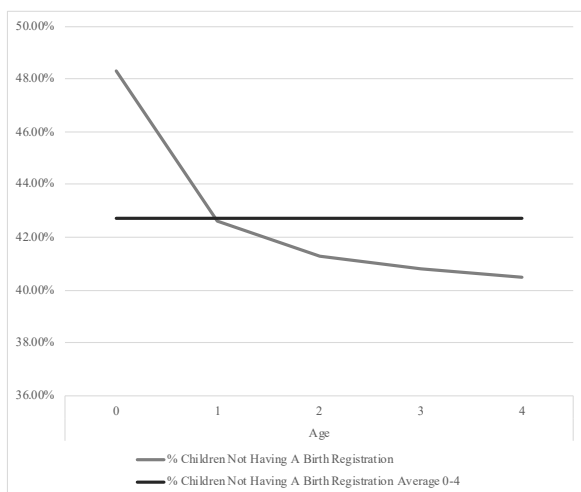
## 4. Results

This section will show and discuss the empirical results of the statistical analyses and reject or accept the hypotheses made in the literature review accordingly. To begin with, the descriptive statistics will be shown and discussed in order to demonstrate the composition and distribution of the data. The descriptive statistics will be followed by two empty models and two multilevel logistic regressions. The resulting outcomes will be used to reject or accept the hypotheses and to answer the research questions.

### 4.1. Descriptive statistics

Figure 2 depicts that 42.7% of the children aged 0-4 in this research do not have a birth registration. During the timespan of this research (2005-2018), the non-registration of children was highest among children aged 0 and 2 and lowest among children aged 4. Accordingly, birth registration rates seem to increase with age. In appendix 5 it can be seen that within all Sub-Saharan African countries the percentage of children that are not registered is the highest in the age group of age 0, except for Malawi with the highest percentage in the group of 3 years old. The percentage of children aged 0 with no birth registration is especially high in Gabon, Sao Tome en Principe, and Congo, with 36% or more children not having a birth registration. Moreover, the appendix also shows that indeed the percentage of children aged 0-4 that do not have a birth registration is decreasing with age.

However, in most countries, there is a slight increase in the percentage non-registration of children around the age of 3 years old. The reason for this phenomenon might be that at the age of 3 the benefits for having a birth registration are low while at the age of 4 having a birth registration is becoming more important and beneficial again due to the prospect of going to school, for example. Consequently, until the age of 2 the reason for registering is just because the baby is a newborn and because of the awareness of parents while after the age of 2 birth registration is something parents do for practical reasons like making sure that the child can go to school. The high percentage of children that are not registered at age 0 and 1 illustrates that many children are not registered within the legal time that is allowed for registering births. Hence, registering late is a huge problem.



**Figure 2:** Percentage of children not having a birth registration by age. Data source: Global\_Data\_Lab (n.d.)

**Table 1:** Descriptive Statistics.

<b>Variables</b>	<b>N (%)</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Std. Deviation</b>
<b><i>Dependent variable</i></b>					
Birth registration	567569	0.00	1.00	0.57	0.49
No	242621 (42.7%)				
Yes	324948 (57.3%)				
<b>Independent variables household level</b>					
<b><i>Socio-economic and demographic</i></b>					
International Wealth Index	607210	0.00	100.00	32.09	22.67
Phone	607183	0.00	1.00	0.61	0.49
No	234445 (38.6%)				
Yes	372738 (61.4%)				
Child's age	606099	0.00	4.00	2.00	1.42
Years of education father	607330	0.00	17.00	4.82	4.06
Dummy years of education father missing	607330	0.00	1.00	0.29	0.45
No	430513 (70.9%)				
Yes	176817 (29.1%)				
Years of education mother	607330	0.00	17.00	3.93	4.09
Dummy years of education mother missing	607330	0.00	1.00	0.08	0.27
No	557567 (91.8%)				
Yes	49763 (8.2%)				
Father not present	607330	0.00	1.00	0.28	0.45
Father present	436586 (71.9%)				
Father not present	170744 (28.1%)				
Mother not present	607330	0.00	1.00	0.08	0.27
Mother present	560540 (92.3%)				
Mother not present	46790 (7.7%)				
No parent present	607330	0.00	1.00	0.07	0.25
At least one parent present	567012 (93.4%)				
No parent present	540317 (6.6%)				
Age at first birth	607330	0.00	2.00	0.58	0.72
At age 18 or older	340128 (56.0%)				
Before age 18	184809 (30.4%)				
Missing	82393 (13.6%)				
Mother usually decides on contraception	607330	0.00	3.00	0.50	1.05
Mother does not decide herself	13824 (2.3%)				
Mother decides alone	27744 (4.6%)				
Joint decision mother and another person	82722 (13.6%)				
Missing	483040 (79.5%)				
Ethnicity majority/minority	607330	0.00	3.00	1.55	1.07
Majority 30+%	166429 (27.4%)				
Regular 10-30%	169391 (27.9%)				
Minority 0-10%	144505 (23.8%)				
Missing	127004 (20.9%)				
Religion	607330	0.00	7.00	2.41	1.75
No religion, atheist	17384 (2.9%)				
Catholic	91028 (15.0%)				
Protestant	109096 (18.0%)				
Christian, not specified	73900 (12.2%)				
Muslim	177163 (29.2%)				
Traditional	13974 (2.3%)				
Other	6990 (1.2%)				
Religion missing	117795 (19.4%)				
<b><i>Care</i></b>					
Prenatal checkups more than 4 visits	607330	0.00	3.00	2.08	0.92
No checkups	35992 (5.9%)				
Up to 3 checkups	127866 (21.1%)				
Yes, 4 or more	194123 (32.0%)				
Missing	249349 (41.1%)				

<b>Table 1 continued</b>	<b>N (%)</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Std. Deviation</b>
Prenatal care by whom	607330	0.00	4.00	2.19	1.92
No care	35298 (5.8%)				
Traditional birth attendant	8406 (1.4%)				
Skilled health personnel	313659 (51.6%)				
Other	6908 (1.1%)				
Missing	243059 (40.0%)				
Prenatal care location	607330	0.00	4.00	1.90	1.88
No care	35298 (5.8%)				
Home	2857 (0.5%)				
Hospital	236280 (38.9%)				
Other health	54945 (9.0%)				
Missing	277950 (45.8%)				
Place of delivery	607330	0.00	2.00	0.85	0.67
Home	186203 (30.7%)				
Institution	324494 (53.4%)				
Missing	96632 (15.9%)				
Delivery assistance	607330	0.00	4.00	2.81	1.48
No assistance	24275 (4.0%)				
Traditional birth attendant	77717 (12.8%)				
Skilled health personnel	301051 (49.6%)				
Other	107225 (17.7%)				
Missing	97061 (16.0%)				
Baby postnatal check within 2 months	607330	0.00	2.00	1.29	0.84
No	150811 (24.8%)				
Yes	130269 (21.4%)				
Missing	326250 (53.7%)				
Ever had vaccination	607330	0.00	2.00	1.62	0.60
No	38169 (6.3%)				
Yes	154932 (25.5%)				
Missing	414228 (68.2%)				
Received vitamin A in last 6 months	607330	0.00	2.00	0.94	0.73
No	180999 (29.8%)				
Yes	282307 (46.5%)				
Missing	144023 (23.7%)				
<b>Independent variables sub-national regional level</b>					
<i>Socio-economic and demographic</i>					
International Wealth Index region	607330	5.59	81.07	32.09	16.89
Average years education fathers in region	607330	0.51	12.80	4.79	2.16
Average number of visits antenatal care region	607330	2.57	12.13	4.62	0.94
Urban or rural area	607330	0.00	1.00	0.30	0.46
Rural	427861 (70.4%)				
Urban	179469 (29.6%)				
<b>Independent variables national level</b>					
<i>Socio-economic and demographic</i>					
GDP per capita	607330	234.24	9813.48	1276.67	1263.11
Birth registration legislation	607330	0.00	1.00	0.92	0.27
No legislation	48246 (7.9%)				
Legislation	559084 (92.1%)				
Birth registration legislation updated	607330	0.00	2.00	0.54	0.64
No	327209 (53.9%)				
Yes	231875 (38.2%)				
Missing	48246 (7.9%)				
Birth registration organizational structure	607330	0.00	2.00	0.62	0.63
Centralized	276267 (45.5%)				
Decentralized	282817 (46.6%)				
Missing	48246 (7.9%)				
Time allowed for registration	607330	0.00	5.00	2.38	1.19
Within 2 weeks	51390 (8.5%)				
Within 1 month	276618 (45.5%)				

<b>Table 1 continued</b>	<b>N (%)</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Std. Deviation</b>
Within 2 months	97567 (16.1%)				
Within 2+ months	117405 (19.3%)				
No legal period	16105 (2.7%)				
Missing	48246 (7.9%)				
Fee for birth registration	607330	0.00	2.00	0.82	0.55
No fee	154756 (25.5%)				
Fee	404328 (66.6%)				
Missing	48246 (7.9%)				
Rule of law	607330	-1.78	0.27	-0.70	0.47
Government effectiveness	607330	-1.75	0.19	-0.78	0.40
Fertility rate, total (births per woman)	607330	3.24	7.38	5.18	0.85
Mortality rate, under-5 (per 1,000 live births)	607330	41.30	180.30	88.34	30.86
Number of conflicts	607330	0.00	27.00	7.03	8.48
Ever been colonized	607330	0.00	1.00	0.97	0.17
No	18734 (3.1%)				
Yes	588595 (96.9%)				
<b>Valid N (listwise)</b>	<b>567407</b>				

The summary statistics portrayed in table 1 demonstrate that the households in which the children live have an average IWI of 32.09 and a phone in 61.4% of the cases, which reflects the situation in developing countries. Furthermore, 71.9% of the fathers and 92.3% of the mothers are still present in the household. The fathers present have enjoyed more years of education (4.82) than mothers present (3.93) on average. Two other factors can also represent the culture with respect to women, namely the age of the mother at first birth and whether the mother can decide on the contraception decision (Mohanty & Gebremedhin, 2018; Smits & Huisman, 2013). 30.4% of the women have given birth before the age of 18 and only 4.6% of the mothers can decide on whether or not to use contraception herself. Related to culture are the ethnicity and religion of the households. Almost the same number of people belong to an ethnicity that is a majority (27.4%) as to an ethnicity that is a middle-sized (27.9%) or minority group (23.8%). With regards to religion, the distribution is not that equal. Most people are Muslim (29.2%) or Christian (Catholic 15.0%, Protestant 18.0%, not specified 12.2%) while other groups are notably smaller.

With regards to care, the results are mixed. Although most people have received prenatal care by skilled health personnel (51.6%) in a hospital (38.9%) and most deliveries take place in a hospital (53.4%) with help of skilled health personnel (49.6%), only about 30% of the women also visit prenatal checkups at least 4 times. Moreover, the statistics for care after birth are not promising as well. More children did not have a postnatal check within 2 months (150811) after birth than children who did have a postnatal check (130269). Nevertheless, most children did receive a vaccination (25.5%) and vitamin A (46.5%) after birth.

The average International Wealth Index of the region (32.09), the average years of education of fathers in the region (4.79), and the average number of prenatal care visits of the region (4.62) are all lower than half of the maximum value possible. Accordingly, most households live in regions that are less well developed. Since most of the families live in rural areas (70.4%) and the data includes 34 developing countries in Sub-Saharan Africa, these results were to be expected. Consequently, the

average mean of GDP per capita for the countries is 1276.67 as well. The mean fertility rate (5.18) and the mean mortality rate of children under 5 years old (88.34) are also indicating that the sample consists of developing countries.

Nevertheless, most countries do have a birth registration legislation (92.1%) and birth registration system that is either centralized (45.5%) or decentralized (46.6%). Of these countries, most legislation was not updated once (53.9%). Birth registration must be performed within a month (45.5%) and involves a fee (66.6%) in most cases. However, the enforcement of the legislation seems not to be good as indicated by the means of the variables rule of law (-0.7) and government effectiveness (-0.78). Besides that, the history of most countries has not been the easiest. The average number of conflicts in the period 1990 until the survey year is 7.03 and almost all Sub-Saharan countries (96.9%) have been colonized.

Besides the summary statistics, a correlation matrix is examined. Although multicollinearity is unlikely to be an issue given that the enormous size of the dataset will decrease the variance and produce more trustworthy estimates and smaller confidence intervals, a correlation matrix is still used to examine the independent variables in more detail (O'Brien, 2007). The correlation matrix in appendix 6 shows that some variables are showing the same phenomenon, such as father not present and the dummy indicating if the father is missing for the years of education of the father. It is logical that these variables are showing the same effect since missing values of the father's years of education are often due to a father that is not present in the household. Nevertheless, some of the variables are still needed for the dummy variable adjustments, like the dummy indicating if the father is missing for the years of education of the father in the previous example. For the variables that are not necessarily needed for the empirical analysis a choice between variables that show the same phenomenon will be made.

First, the variable parents missing will not be included in the empirical analysis if mother and father missing are included. The variables mother and father missing are preferred since these variables can provide more detail by providing information on whether sex of parents can have an influence on the birth registration decision. Second, the variable postnatal check will be used instead of prenatal check. These variables seem to explain the same thing, but in theory the postnatal check will be more important since the baby is being born then and can actually be registered. Thirdly, prenatal care location will be preferred over prenatal care personnel. The location of the prenatal care can implicitly say something about whether the mother was seen by skilled health personnel or not. Also, the prenatal care location can be important in itself as registration offices are often located in or near health facilities thus providing information on where to register the birth (Adi et al., 2015). Fourthly, the IWI of the region will be removed from the analysis since this variable correlates with the IWI of the household and with the urbanization of the region. The IWI of the region was added to the analysis to reflect the availability, quality and infrastructure of services in the region. Since this is partly reflected by the two variables average years of education of fathers in the region and average number of visits of prenatal care of women in the region, the theory can still be tested. Finally, rule of law is used in the empirical analyses

instead of government effectiveness since the rule of law more directly captures the effect of law enforcement and how well people abide by the law (The World Bank, 2020b).

#### ***4.2. Multilevel logistic analyses***

Following Khan & Shaw (2011), bivariate analyses are run for all independent variables, except the ones left out due to high correlations, before running the multilevel logistic analyses. appendix 7 shows that all variables are significant except for some subcategories of a variable or a dummy indicating missing values used for a dummy variable adjustment. In particular, a dummy indicating that the variable years of education of the father has a missing value, the category joint decision on contraception, the category traditional religion, and the category no update of birth registration legislation. Since these variables indicate that there is no significance difference between these missing values and the existing values or other categories of the particular variable are still significant, the variables are still taken into account in the empirical analyses. Thus, all the independent variables used for these bivariate analyses will be selected for the multilevel logistic analyses as well.

As stated in the methods section, the multilevel logistic analyses are performed in a series of stages. This paper will follow the steps taken by other papers that use multilevel logistic models, in particular Khan & Shaw (2011), Mohanty & Gebremedhin (2018), and Sommet & Morselli (2017). Accordingly, two empty models with only a random intercept for the national level and the national and sub-national regional will be performed first. After, two comprehensive models with and without interactions will be performed. The latter and final model will only include the interactions that are significant for the readability of the results (Huisman & Smits, 2015).

The results of these empty models can be found in table 2 below. Model 1 represents the random intercept only model for the national level. Model 2 reflects the random intercept only model for both the national and sub-national regional level. Both the log odds and the odds ratio are presented since the log odds show the untransformed data while the odds ratio will be used to interpret the results as these are more suitable for a theoretical understanding of the results (Huisman & Smits, 2015; Mohanty & Gebremedhin, 2018; Smits & Huisman, 2013; Sommet & Morselli, 2017).

Model 1 and 2 show that there is indeed variation, although small, among countries and sub-national regions with regards to birth registration. The Intraclass Correlation (ICC) of the intercept only model including the national level shows that 25% of the total variation in birth registration in Sub-Saharan Africa is due to differences between countries while 75% of the variation is due to within country differences. Following the reasoning of Mohanty & Gebremedhin (2018), the ICC is also calculated for the intercept only model including the national and sub-national regional level since most of the variance seems to be due to within country differences. The ICC of model 2 presents that 25% of the variation is still due to between country differences. Moreover, 10% of the variation is a consequence of between sub-national regional differences. As a result, 65% of the variation is caused by within sub-

**Table 2:** Intercept only models with the national level effects (Model 1) and the national and sub-national regional level effects (Model 2).

	Model 1**		Model 2**	
	Log Odds	Odds Ratio <sup>a</sup>	Log Odds	Odds Ratio <sup>a</sup>
<b>Intercepts</b>				
National level	0.06	1.07	0.06	1.06
Sub-national regional level	-	-	0.02	1.02
Fixed intercept	0.60	1.82	0.63	1.87
Number of observations	567569		567569	
Residual	0.19		0.17	
-2 Restricted log likelihood	665245.483		616607.645	
Intraclass correlation <sup>b</sup>				
Nation	0.25		0.25	
Sub-national region	-		0.10	

\* significant at the 5 per cent level, \*\* significant at the 1 per cent level.

<sup>a</sup> Odds ratio are calculated by raising the coefficient to the exponential (Sommet & Morselli, 2017).

<sup>b</sup> Following the OECD (2009), the Intraclass Correlation is calculated by the following formula:

$$\rho = \left( \frac{\text{between level variance}}{\text{between level variance} + \text{variance household level}} \right).$$

national regional differences. Thus, most of the variance with regards to birth registration of children aged 0-4 is found at the household level, where the birth registration decision is made.

Since most of the variation in birth registration is found at the household level, the two comprehensive models including the household-level determinants of birth registration and the context factors at the sub-national regional and national level will be presented. The results of the two comprehensive models can be found in table 3. Model 1 reflects the comprehensive model with the main effects and without interactions while model 2 does show the effect of the context on the main determinants of birth registration by presenting interactions. Following the structure of the paper of Huisman & Smits (2015), the significant interactions can be found in a separate table, namely table 4, for the readability of the results.

#### ***4.2.1. Socio-economic and demographic household-level determinants***

Table 3 shows that most of the socio-economic and demographic determinants at the household level have an effect that is expected. The variables IWI, phone, age, years of education of the father and mother are all significantly positive, indicating that having more wealth, a phone, a higher age, and more years of education all significantly increase the odds of having a birth registration. Although a father and mother missing in the household indeed both show the negative expected effect, only the variable father missing is significant. As can be seen in appendix 7, the bivariate effect of a missing mother on the odds of having a birth registration was even significantly positive. Nevertheless, the effect of the missing mother becomes significantly negative in model 2. Hence, the effect of a missing mother depends on other independent factors added to the model.



With regards to the cultural or social factors within the household, the results of the position of women in the household are mixed. On the one hand, the children of a mother that has had her first birth before the age of 18 has 0.987 times or 1.3% lower odds of having a birth registration compared to children with a mother that has had her first birth after the age of 18. On the other hand, if the partner is the main decisionmaker or at least has some influence on the contraception decision, a positive effect can be seen on the odds of having a birth registration. The effect of the partner being the main decisionmaker is not significant, however. The effects of both the partner being the decisionmaker and mother and partner being the decisionmakers have flipped compared to the bivariate analysis of both variables in appendix 7, indicating that the effects of these variables depend on the context. Although the effect of the contraception decision being a joint decision seems counterintuitive, the mother having a say, together with her partner, in the contraception decision indicates already a form of bargaining power as stated in the paper of Sidney Ruth, Syed Mesbahuddin & Ann (1997).

Concerning ethnicity and religion, the significant results can seem counterintuitive as well. Belonging to an ethnic minority or a middle-sized group increases the odds of having a birth registration compared to belonging to an ethnic majority group. However, appendix 7 shows that both variables show a negative effect bivariately. Accordingly, other independent variables affect the effect of ethnicity, indicating that particular ethnicities are not the main cause of not registering a child. Table 4 indeed shows that several variables interact with ethnicity. The same conclusion can be made for religion, except for belonging to a traditional religion. The results show that belonging to a religion compared to no religion is not negatively affecting the odds of having a birth registration, except for traditional religions as expected. Belonging to a traditional religion decreases the odds of having a birth registration 0.979 times compared to belonging to no religion. Hence, the particular religion a household belongs to does not really matter for the odds of having a birth registration unless it concerns a traditional religion.

Therefore, the first hypothesis can be accepted in general. Children from a more favorable socio-economic and demographic background in the household-level context have higher odds to have a birth registration. In particular, households in which more economic resources are available, no father is missing, parents have more years of education, women have some form of autonomy, in which children are older, and that do not belong to a traditional religion have higher odds of having a birth registration. Only the variables mother missing and belonging to an ethnic minority do not have the expected effect of lowering the odds of having a birth registration. Nevertheless, mother missing is significantly negative in the interaction model (model 2) and, as shown in table 4, the variable ethnic minority does have a negative association in situations in which a household does have more wealth, children have a higher age, and mothers have higher years of education. Therefore, it can be argued that these variables do have a negative effect that works indirectly.

**Table 3:** Logistic fixed effects models with random intercepts (Model 1) and with interaction effects (Model 2).

	Model 1		Model 2	
	Log Odds	Odds ratio <sup>a</sup>	Log Odds	Odds ratio <sup>a</sup>
<b>Intercepts</b>				
National level <sup>b</sup>	0.190	1.209	0.175	1.191
Sub-national regional level <sup>b</sup>	0.010	1.010	0.009	1.009
Fixed intercept	0.692*	1.998	0.917**	2.502
<b>Household level</b>				
<i>Socio-economic and demographic</i>				
IWI	0.003**	1.003	0.003**	1.003
Phone	0.015**	1.015	-0.027**	0.973
Age	0.021**	1.021	0.050*	1.051
Years education father	0.004**	1.004	0.005**	1.005
Years education mother	0.004**	1.004	0.002	1.002
Father missing	-0.016**	0.984	-0.062**	0.940
Mother missing	-0.011	0.989	-0.059**	0.943
Age at first birth 18-	-0.013**	0.987	-0.022**	0.978
Decisionmaker contraception				
Mother	Ref	Ref	Ref	Ref
Partner	0.003	1.003	-0.008	0.992
Joint Decision	0.013**	1.013	0.020**	1.020
Ethnicity				
30+%	Ref	Ref	Ref	Ref
10-30%	0.021**	1.021	0.029**	1.029
0-10%	0.009**	1.009	0.036**	1.037
Religion				
No religion	Ref	Ref	Ref	Ref
Catholic	0.063**	1.065	0.059**	1.061
Protestant	0.054**	1.055	0.050**	1.051
Christian, not specified	0.049**	1.050	0.046**	1.047
Muslim	0.048**	1.049	0.047**	1.048
Traditional	-0.021**	0.979	-0.003	0.997
Other	0.047**	1.048	0.045**	1.046
<b>Care</b>				
Prenatal care location				
Hospital	Ref	Ref	Ref	Ref
No care	-0.067**	0.935	-0.066**	0.936
Home	-0.005	0.995	-0.007	0.993
Other health	-0.025**	0.975	-0.020**	0.980
Place delivery				
Institution	Ref	Ref	Ref	Ref
Home	-0.090**	0.914	-0.085**	0.919
Delivery assistance				
Skilled health personnel	Ref	Ref	Ref	Ref
No assistance	-0.025**	0.975	-0.028**	0.972
Traditional birth attendant	-0.008**	0.992	-0.013**	0.987
Other	-0.017**	0.983	-0.017**	0.983
No postnatal check within 2 months	-0.024**	0.976	-0.024**	0.976
Never had vaccination	-0.060**	0.942	-0.062**	0.940
No vitamin A in last 6 months	-0.025**	0.975	-0.024**	0.976

Table continued

	Model 1		Model 2	
	Log odds	Odds ratio <sup>a</sup>	Log odds	Odds ratio <sup>a</sup>
<b>Sub-national regional level</b>				
<b><i>Socio-economic and demographic</i></b>				
Average years of education father	-0.012**	0.988	-0.021**	0.979
Urban	0.028**	1.028	0.018	1.018
<b><i>Care</i></b>				
Average number of visits prenatal care	0.043**	1.044	0.026**	1.026
<b>National level</b>				
<b><i>Socio-economic and demographic</i></b>				
GDP per capita	0.0001**	1.0001	0.00009**	1.00009
Legislation	0.131**	1.140	0.173**	1.189
No update legislation	-0.026**	0.974	-0.039**	0.962
Organizational structure				
Decentralized	Ref	Ref	Ref	Ref
Centralized	-0.357*	0.670	-0.336*	0.715
Time allowed for registration				
Within 2 weeks	Ref	Ref	Ref	Ref
Within 1 month	0.046**	1.047	0.076**	1.079
Within 2 months	-0.278	0.757	-0.251	0.778
Within 2+ months	-0.085	0.919	-0.117	0.890
No legal period	0.219	1.245	0.179	1.196
Fee	0.094	1.099	0.106	1.112
Rule of law	-0.291**	0.748	-0.189**	0.828
Fertility	-0.341**	0.711	-0.342**	0.710
Mortality under 5	0.008**	1.008	0.008**	1.008
Number of conflicts	-0.003**	0.997	-0.002**	0.998
Colonized	0.340	1.405	0.285	1.330
Number of observations		567407		567407
Residual		0.159		0.157
-2 Restricted Log likelihood		571750.79		566100.75

\* significant at the 5 per cent level, \*\* significant at the 1 per cent level.

<sup>a</sup> Odds ratio are calculated by raising the coefficient to the exponential (Sommet & Morselli, 2017).

<sup>b</sup> No significance level is given for the random intercepts.

Note: Dummy variable adjustment variables that indicate the effect of missing values are not shown in this table for readability. These can be found in appendix 8.

#### 4.2.2. Care household-level determinants

Secondly, the effects of the care variables at the household level are all in the expected direction. Although the variable prenatal care at home is not significant, the other variables indicating the location of prenatal care do reflect that not receiving prenatal care in a hospital does lower the odds of having a birth registration. In the bivariate analysis (see appendix 7), the variable prenatal care at home was also significantly negative. The addition of other variables makes the variable insignificant. Nevertheless, the results still point out that receiving prenatal care in a hospital is beneficial for the birth registration decision. The same result is found for the variable place of delivery. Children being born at home have 0.914 times or 8.6% lower odds of having a birth registration than children being born in a hospital.

In line with these results, children born with no assistance during the delivery, with the assistance of a traditional birth attendant, and with other assistance like a friend of the family, have 2.5%, 0.8%, and 1.7% lower odds of having a birth registration than children born with the help of skilled health personnel. Besides receiving care during the delivery, the primary care in the first 4 years of the child's life has also proven to be important. The coefficients of received no postnatal check within 2 months, never received a vaccination, and has not received vitamin A in the last 6 months are all significantly negative. Hence, receiving care during the first 4 years of the child's life does increase the odds of having a birth registration. Consequently, support for the second hypothesis has been found. Children of households that are more often in contact with health facilities or health personnel, either during the pregnancy, during the delivery, or after the delivery of the child, have higher odds of having a birth registration.

#### ***4.2.3. Socio-economic, demographic and care sub-national regional-level variables***

Regarding the sub-national regional effects, the results of the variables urban and the availability of health facilities, represented by the average number of visits for prenatal care within the region, show significant positive coefficients. If the average number of visits of prenatal care increases with 1, a child has 1.044 times higher odds of having a birth registration. Furthermore, living in an urban area instead of a rural area increases the odds of having a birth registration with 2.8%. The effect of the average years of education of the father within the region is unexpectedly significantly negative, however. This result has also been found in the bivariate analysis. The reason for this unexpected result might be the way in which the availability of educational facilities is measured and computed in the data. The concerning variable is computed by aggregating the father's years of education by region with the assumption that most parents grew up and were educated in the region they live in now. Since migration is common in developing countries, due to either seeking better opportunities or due to conflict, the assumption might not have been upheld, causing the unexpected flip in the sign of the effect (Bequele, 2005). As a result, the third hypothesis can only be partly supported. A better socio-economic and demographic situation at the sub-national regional level does increase the odds that a child has a birth registration with regards to the availability of health facilities and urbanization.

#### ***4.2.4. Socio-economic and demographic national-level variables***

With respect to the national level, the results are mixed. Firstly, GDP per capita has a significantly positive effect on the odds of having a birth registration, namely if GDP per capita increases with 1 dollar, the odds of having a birth registration increase with 0.01%. Moreover, the presence and content of birth registration legislation both have notable effects as well. A country that has birth registration legislation compared to no legislation significantly increases the odds of having a birth registration with 14%. If the legislation is not updated recently, the odds of having a birth registration are 0.974 times lower. With regards to the content of the law, when birth registration must be performed

within 1 month, the odds of having a birth registration for a child aged 0-4 years is 1.047 times higher than for children living in countries in which the time allowed for registration is only 2 weeks. The time periods of 2 months, more than 2 months, and no legal period are not significant. Nevertheless, these variables were significantly negative in the bivariate analysis and still seems to work through other variables as shown by the interaction effects in table 4. For example, interactions between time periods allowed for birth registration of 2(+) months and phone show significant negative effects, indicating that in countries in which registration must be performed within 2(+) months, the positive effect of phone is weakened.

Although this negative effect was also expected for fee, the sign was in the opposite direction and not significant either. Fee seems to be influenced by other variables as it was significantly negative in the bivariate analysis and negatively influences the effects of IWI, age, and the years of education of the mother. Nevertheless, other content of birth registration legislation is important, namely having a decentralized birth registration system can significantly influence birth registration rates. If the organizational structure of the birth registration system is centralized instead of decentralized, the odds of having a birth registration is significantly lower with 33%. Accordingly, decentralizing birth registration systems is needed for notably improving birth registration rates.

Next to the content of birth registration legislation, the rule of law, the fertility rate, the mortality rate of children under 5, the number of conflicts of a country, and whether a country has been colonized have proven to be important for the odds of having a birth registration. However, the effects of the variables rule of law, the probability that a child will die before the age of 5, and whether a country was colonized are not as expected. The rule of law was expected to represent the enforcement of law, which induces people to comply with the law instead of ignore it (Chereni, 2016). The effect is significantly negative, nevertheless. The reason for this result might be that the developmental status of all of the countries in the analyses makes it difficult for patterns to exist. Another reason might be that people abide by the law but that the law has its flaws, which makes the effect on the odds of having a birth registration negative.

Regarding demographics, the effect of the mortality rate for children under the age of 5 is unexpected as well. Higher mortality rates significantly increase the odds of having a birth registration. The effect is not as expected, but might be explained by the reasoning that child mortality rates might depend on the amount of health care received and thus on having a birth registration, since children that do not have a birth registration have limited access to health care (Pirlea, 2019; UNICEF, n.d.). Instead of high mortality rates giving no incentive, it might provide an incentive since a child could have been alive if the child had proper access to healthcare. Nevertheless, higher fertility rates indeed significantly lower the odds of having a birth registration. If the mean births per women increases with 1, the odds of having a birth registration are 28.9% lower.

Finally, the history of the country is important for the birth registration decision due to path dependency. An extra conflict that is existent in a country during the time period of this research indeed

significantly decreases the odds of a child aged 0-4 having a birth registration with 0.3%. Besides the number of conflicts, the variable colonized is unexpectedly positive. A negative sign was expected since colonizers had set up the administration for birth registration, but they were only interested in certain parts of the country while original inhabitants were not allowed to register, creating aversion for birth registration (Bequele, 2005; UNICEF, 1998). Nevertheless, in countries that have not been colonized, the systems might have not been created at all, explaining the positive sign of the variable. In spite of the fact that the variable has an unexpected sign, the variable is not significant. Hence, it cannot be stated with certainty that the colonial era has had an influence on current birth registration rates.

All in all, the hypothesis, stating that more favorable socio-economic and demographic factors at the national level will increase the probability of a birth registration, cannot be fully supported. Although the development of a country, measured by GDP per capita, and the presence and content of birth registration legislation are of great importance, several favorable national factors do have a negative influence on the odds of having a birth registration or are not significant. In particular, a better rule of law and a lower mortality rate decrease the odds of having a birth registration while the variable colonized is not significant. Accordingly, national-level determinants of birth registration are important although a favorable context does not automatically improve birth registration rates.

#### ***4.2.5. Variation among contexts***

Table 3 presents the coefficients of the direct effects for the interaction model (model 2). Compared to the model without interactions (model 1), the variables the years of education of the mother, a traditional religion, and the rate of urbanization are not significant anymore. In the interaction model, the main effects show the average effect of the variable while the interactions show the variation from the average. The variables that have become insignificant due to including the interactions thus show that their overall effects in model 1 work in combination with other variables. Moreover, the multilevel logistic regression including the interactions has a lower -2 Restricted Log likelihood than the model without the interactions, meaning that the model including interactions is indeed a better fit of the model. Table 4 presents the actual interactions of the multilevel logistic regression with interactions.

##### ***4.2.5.1. Variation among ethnicities and religions***

The positive effects of a household having a higher IWI, having an older child, or living with a mother who has had an additional year of education on the odds of having a birth registration are lower for households belonging to an ethnicity group that contains 10-30% of the population compared to a group that contains 30+% of the population. The same is the case for households belonging to ethnic minority groups, which contain only 0-10% of the population. Besides that, the negative effects of a missing mother, having a mother that has given birth to her first child before the age of 18 in the household, and the partner being the main decisionmaker regarding contraception (only for the ethnic

**Table 4:** Interaction coefficients of the multilevel logistic regression with significant interactions (Model 2).

	Model 2	
	Log odds	Odds ratio <sup>a</sup>
<b>Ethnicity 10-30%</b>		
IWI	-0.0004**	0.9996
Age	-0.0106**	0.9895
Years of education mother	-0.0026**	0.9974
Mother missing	0.0631*	1.0651
Age at first birth 18-	0.0096*	1.0096
Decisionmaker contraception partner	0.0347**	1.0353
<b>Ethnicity 0-10%</b>		
IWI	-0.0004**	0.9996
Age	-0.0118**	0.9883
Years of education mother	-0.0017**	0.9983
Mother missing	0.1162**	1.1232
Age at first birth 18-	0.0135**	1.0136
<b>Traditional</b>		
Phone	0.0270**	1.0274
Years of education mother	0.0103**	1.0104
Mother missing	0.1561**	1.1689
Age at first birth 18-	0.0290**	1.0294
<b>Average years education father region</b>		
IWI	-0.0003**	0.9997
Age	0.0015**	1.0015
Years of education father	-0.0008**	0.9992
Years of education mother	0.0007**	1.0007
No prenatal care	0.0134**	1.0135
Prenatal care home	0.0088*	1.0088
Prenatal care other location	0.0057**	1.0057
Delivery at home	0.0048**	1.0048
No delivery assistance	0.0180**	1.0182
Other delivery assistance	0.0034**	1.0034
No postnatal checkup	0.0052**	1.0052
No vaccination	0.0066**	1.0066
No vitamin A	0.0027**	1.0027
<b>Average number of visits prenatal care</b>		
Age	0.0056**	1.0056
Years of education father	-0.0005**	0.9995
No prenatal care	-0.0332**	0.9673
Prenatal care home	-0.0298**	0.9706
Prenatal care other location	-0.0260**	0.9743
Delivery at home	0.0099**	1.0099
No delivery assistance	-0.0339**	0.9667
Other delivery assistance	0.0060*	1.0060
No postnatal checkup	-0.0046*	0.9954
No vaccination	-0.0255**	0.9748
No vitamin A	-0.0070**	0.9930
<b>Urban</b>		
Phone	0.0241**	1.0244
Age	-0.0033**	0.9967

Table continued	Log odds	Odds ratio <sup>a</sup>
<b>GDP per capita</b>		
IWI	0.0000009**	1.0000009
Phone	0.00001**	1.00001
Age	0.000002**	1.000002
Years of education father	0.0000006**	1.0000006
Years of education mother	0.0000008*	1.0000008
<b>Rule of law</b>		
Phone	-0.0120**	0.9881
Age	-0.0187**	0.9815
Years of education mother	-0.0018**	0.9982
<b>Fertility</b>		
IWI	0.0007**	1.0007
Age	0.0026**	1.0026
Years of education father	0.0015**	1.0015
Mother missing	-0.0350**	0.9656
<b>Mortality</b>		
IWI	-0.0002**	0.9998
Age	-0.0001**	0.9999
Years of education mother	0.00002*	1.00002
<b>Birth registration legislation</b>		
Phone	0.0343**	1.0349
Age	-0.0409**	0.9599
Father missing	0.0369**	1.0376
<b>No update legislation</b>		
IWI	-0.0006**	0.9994
Phone	0.0231**	1.0234
Age	0.0082**	1.0082
Years of education mother	-0.0013**	0.9987
<b>Centralized</b>		
IWI	0.0011**	1.0011
Phone	-0.0607**	0.9411
Years of education father	0.0015**	1.0015
Years of education mother	0.0028**	1.0028
Father missing	0.0363**	1.0370
Mother missing	-0.0175**	0.9827
<b>Registration within 1 month</b>		
IWI	-0.0012**	0.9988
Phone	-0.0654**	0.9367
Years of education father	-0.0025**	0.9975
Years of education mother	-0.0032**	0.9968
<b>Registration within 2 months</b>		
Phone	-0.0778**	0.9251
Age	0.0059**	1.0059
Mother missing	-0.0143*	0.9858
<b>Registration within 2+ months</b>		
IWI	0.0003*	1.0003
Phone	-0.0429**	0.9580
Age	0.0203**	1.0205
Mother missing	-0.0299**	0.9705



Table continued	Log odds	Odds ratio <sup>a</sup>
<b>Registration no legal period</b>		
IWI	-0.0025**	0.9975
Age	0.0248**	1.0251
Years of education mother	-0.0077**	0.9923
<b>Fee</b>		
IWI	-0.0010**	0.9990
Phone	0.0280**	1.0284
Age	-0.0043**	0.9957
Years of education mother	-0.0019**	0.9981
<b>Number of conflicts</b>		
Age	-0.0011**	0.9989
Years of education father	-0.00008**	0.99992
Years of education mother	0.0001**	1.0001
Mother missing	0.0027*	1.0027
<b>Colonized</b>		
IWI	0.0017**	1.0017
Phone	0.0524**	1.0538
Age	0.0094**	1.0094
Years of education mother	0.0062**	1.0062

\* significant at the 5 per cent level, \*\* significant at the 1 per cent level.

<sup>a</sup> Odds ratio are calculated by raising the coefficient to the exponential (Sommet & Morselli, 2017).

Note: Dummy variable adjustment variables that indicate the effect of missing values are not shown in this table for readability. These can be found in appendix 8.

group containing 10-30% of the people) are compensated if belonging to these groups instead of to an ethnic majority. Thus, the position of the mother in the household is less important for the birth registration decision if the household belongs to a certain ethnicity as these ethnicities might have particular beliefs about birth registration anyways. Hence, socio-economic and demographic determinants at the household level seem to be less important for these groups as expected.

Considering a household that follows a traditional religion, the effect of having a phone or a living with a mother that has had an additional year of education on the odds of having a birth registration has become even stronger compared to all other religions. This indicates that having a phone compared to no phone and a mother having one extra year of education compared to no extra year can compensate for the negative effect of belonging to a traditional religion. In addition, the negative effects of a missing mother and having a mother that has had her first child before the age of 18 on the odds of having a birth registration are less negative if the household of the child belongs to a traditional religion as well.

All in all, since the effects of socio-economic and demographic determinants of birth registration at the household level can be mitigated by whether the household belongs to an ethnic minority, middle-sized ethnic group or a traditional religion, the fifth hypothesis can be supported. However, it should be noted that socio-economic and demographic variables that can increase awareness about

birth registration are increasing the odds of having a birth registration for traditional religions, indicating that that is the main problem for those groups.

#### ***4.2.5.2. Variation among sub-national regions and countries***

With regards to the eighth hypothesis, the results show that the effects of some socio-economic and demographic household-level determinants are influenced by the sub-national regional level. The effect of IWI and years of education of the father are less strong in sub-national regions in which the average years of education of fathers in the region, a proxy for the availability of education, is higher. This means that having sufficient wealth and education are less important for the birth registration decision since the availability of education is higher and is creating awareness surrounding birth registration already. Accordingly, as in the paper of Mohanty & Gebremedhin (2018), there seem to be spillover effects for the amount of education in the region. The effect and the reasoning for the years of education of the father is the same for the availability of health facilities in the region, proxied by the average number of visits of prenatal care in the sub-national region, as health facilities can create awareness surrounding birth registration as well.

Not only the effect of the years of education of the father is the same for the availability of educational and health facilities, but also the effect of the variable age. When a child is living in a sub-national region that has more educational or health facilities and is a year older, the positive effect of age on the odds of having a birth registration is even stronger. This indicates that some children indeed get a birth registration in order to go to school or to acquire health services. For the educational availability, this is also the case for years of education of the mother. Accordingly, there is an accumulation of positive effects. If there are more schools available in the region, older children and children with a mother that has more years of schooling have even higher odds of having a birth registration.

Considering urbanization, the significant negative effects of age indicates that in urban areas the positive effects of this variable is lower while the significant positive effect of phone indicates that its positive effect is even stronger in urban areas. These results demonstrate that practical reasons such as going to school are not the main determinative reasons for the birth registration decision in urban areas, where registration offices are often located, since less obstacles are encountered in these areas. Moreover, it demonstrates that having a phone is more important in urban areas for the odds of having a birth registration. This can be explained by Smits & Huisman (2013), who argue that in urban areas the communication infrastructure and accessibility of education is better than in rural areas. As a result, an accumulation of positive effects takes place.

Not only sub-national regional level variables influence the socio-economic and demographic household-level determinants of birth registration, but also national-level variables. For households living in a country with a higher GDP per capita, the positive effects of IWI, phone, age, and the years of education of both parents are even stronger. As found in the paper of Huisman & Smits (2015) as

well, although on another subject, the higher the level of development of a country, the more important household characteristics seem to become. This effect does not apply to the variable rule of law, however. In countries with a better rule of law, the positive effects of phone, age, and the mother's years of education on the odds of having a birth registration are reduced. These results are logical since a better rule of law induces a better enforcement of law, including the time allowed for birth registration, making factors like awareness and the age of the child less important for registering a birth.

Regarding demographics, in countries with a higher fertility rate, children from households with a higher IWI, with older children, and with a father with more years of education are more likely to have a birth registration, in which IWI, age and the education of the father compensate for the high fertility rate. Nevertheless, the negative effect of having a missing mother is even stronger in these countries. This result indicates that in countries with bigger families on average and in households without a mother present, children are less likely to have a birth registration. The most likely reason for this is that accordingly only the father is able to and has to take care of the children, making it harder to obtain a birth registration for the children as opportunity costs increase relatively as well.

For the mortality rate, the effects are the opposite. The higher the mortality rate, the less important are the effects of IWI and age and the more important the effect of the years of education of the mother. This indicates that households that have more children aged 0-4 that have passed away are more incentivized to register a birth so the child can get health care, making the effects of having wealth and an older child not as important. The years of education of the mother is even more important in an environment with higher mortality rates as it can be assumed that there is low awareness about the benefits of having a birth registration, such as health care.

Also, the legislation on the subject of birth registration is influencing the birth registration decision indirectly. In countries with birth registration legislation, the positive effects of having an older child are reduced while the negative effect of a missing father is reduced as well, indicating that people do comply with the law to some extent. The effect of phone is even stronger if there is birth registration legislation, probably since more awareness in combination with birth registration legislation increases the odds of having a birth registration even further.

If the birth registration legislation was not updated recently, the interaction term changes from a negative to a positive effect, meaning that the positive effect of age becomes even stronger. Nevertheless, the effect of phone is still enhanced as well. On the contrary, the positive effects of IWI and years of education of the mother are reduced. If no update has taken place in the past few years, there is still some kind of legislation explaining the reduced effect of IWI and the years of education of the mother. However, the birth registration system might be just set up or outdated, indicating that the system is not working well yet and explaining the accumulated effects of phone and age.

The content of the legislation is also important. If registration is allowed within 1 month compared to within 2 weeks, the positive effects of IWI, phone, and years of education of the father

and mother are mitigated. This indicates again that 1-month time allowed for birth registration seems like the optimal time period for registering a birth since the socio-economic determinants become less important in that case. When longer time periods are allowed, the positive effect of phone on the odds of having a birth registration is reduced, indicating that people are aware or that phone-based systems are not useful since enough time is given to obtain information about birth registration and to fulfil the birth registration procedure. However, the positive effect of age and the negative effect of mother missing are even stronger. The reason for the increased importance of the household structure, such as the mother not being present, can be that the identification of both parents is needed to perform a birth registration for example (UNICEF Data, n.d.-b). The stronger positive effect of age can be explained by the fact that more time is given to register a birth, leading to encountering more situations in which a birth registration is beneficial. Finally, the positive effect of IWI indicates that having sufficient economic resources can compensate for the long time period that is allowed for birth registration.

For countries that have no legal period for registering a birth, the effect of having a higher IWI at the household level on the odds of having a birth registration is reduced. This indicates that money is not necessarily the problem in situations in which birth registration can be postponed until a family has enough money. Also, the positive effect of the years of education of the mother is reduced, indicating that awareness is not the problem if no legal time period is set for registering a birth. The age effect is even more important in such a country nonetheless, since there is no time trigger for registering a birth, increasing the importance of practical reasons for registering a birth such as going to school.

If a fee must be paid for birth registration, socio-economic and demographic determinants of birth registration are also affected. In a country in which a fee must be paid, the positive effects of IWI, age and the years of education of the mother are alleviated. Accordingly, these factors cannot make up for the disadvantageous legal environment. The only variable that can compensate for the disadvantageous environment is the variable phone, probably as phone-based systems make in time registration easier since late registration is often the reason for having to pay a fee (UNICEF Data, n.d.-b).

The situation is the opposite when a centralized birth registration system is encountered. Having a phone cannot compensate for the unfavorable environment while having a higher IWI and a father and mother with more years of education can. With respect to a centralized system, people must travel further for registering a birth and less awareness is created locally, making money and education more important (Chereni, 2016; Mackenzie, 2008; Makinde et al., 2016; Pelowski et al., 2015; Todres, 2003). Since phone-based systems cannot really work in centralized systems, the positive effect of phone is reduced. Furthermore, centralized systems make it easier to register a birth when having a missing father but harder when having a missing mother.

Regarding the history of the country, both the number of conflicts and colonization are affecting birth registration indirectly. On the one hand, an increase in the number of conflicts mainly decreases the positive effects of socio-economic and demographic household-level determinants, in particular age and the years of education of the father. This indicates that the environment is so dangerous or destroyed that the positive effects of such factors are reduced. For example, a conflict can destroy educational infrastructure of a country, which makes getting a birth registration in order to go to school less often a reason for registering a birth. Although the positive effect of the years of education of the father is reduced, that of the mother is increased. The reason for this phenomenon is probably that fathers are more physically involved during times of conflicts and combat. Hence, their presence at home is limited and their level of education is less important. Also, the negative effect of a missing mother is reduced, indicating that a missing parent is common during times of conflict, making registration with only one parent easier since it is not uncommon.

On the other hand, living in a country that was once colonized only positively influences the effects of socio-economic household-level determinants and in particular the variables IWI, phone, age, and the years of education of the mother. Since colonizers only set up the birth registration with regards to certain areas that they were interested in, it is logical that the effects are in the same direction as the main effect but a bit stronger as some areas still lag behind and this research mainly consists of rural areas (Bequele, 2005; Szreter & Breckenridge, 2012; UNICEF, 1998).

All in all, there is support for the sixth hypothesis. Although favorable socio-economic and demographic household-level determinants do not compensate for all disadvantageous situations, it can in some cases. For example, on the one hand the IWI has a reduced effect in countries with high mortality rates, with no update in legislation, with no legal time period for registering a birth and in which a fee has to be paid for birth registration. On the other hand, IWI does compensate in regions with lower educational availability, in countries with high fertility rates and in countries with a centralized birth registration system. Therefore, it can be concluded that socio-economic and demographic household-level variables can compensate for the disadvantageous environment children can live in.

#### ***4.2.5.3. Variation of care variables***

With regards to the seventh hypothesis, the availability of health care in the sub-national region, proxied by the average number of visits for prenatal care, does influence the effect of the care variables at the household level on the odds of having a birth registration. If the average number of visits of prenatal care in the sub-national region is increased, the negative effects of no prenatal care, prenatal care at home, prenatal care at another location, no delivery assistance, no postnatal checkup, no vaccination, and no vitamin A are even stronger. It can be argued that these results indicate that if there is more health availability in the sub-national region and households still do not use professional health care, they do so deliberately as travel distance and thus costs go down. Nevertheless, the

negative effects of delivery at home and other delivery assistance on the odds of having a birth registration are decreased if the household lives in a region with more health facilities. The reason is probably that if there are more health facilities in the sub-national region, there are higher chances that professional guidance is received during delivery at home either by professional health personnel that is able to come to the home or by other assistance like a friend or relative that has at least some knowledge about health and birth registrations. Consequently, support for the seventh hypothesis is found except for the variables delivery at home and other assistance during delivery, which results indicate there is a compensation effect taking place.

Besides the fact that care variables depend on the availability of health facilities, they can also depend on the availability of educational facilities in the sub-national region. The negative effects of the care variables, including no prenatal care, prenatal care at home, prenatal care at another location, delivery at home, no delivery assistance, other delivery assistance, no postnatal checkup, no vaccination, and no vitamin A, on the odds of having a birth registration are weaker if the household lives in a sub-national region with higher average years of education of fathers in the region. For example, if no awareness for birth registration had been created since no prenatal care was received, a higher educational availability in the sub-national region can have spillover effects and still create awareness at the household level (Mohanty & Gebremedhin, 2018). Hence, more educational availability in the sub-national region can create more awareness in itself and compensate for the loss of awareness when not getting or receiving professional health care. For that reason, support is found for the eighth hypothesis that states that care variables at the household level and availability of education at the sub-national regional level can compensate each other.

## 5. Conclusion & Discussion

Birth under-registration in developing countries, with Sub-Saharan Africa being the most problematic region with a non-registration rate of 54%, is an acknowledged international problem (The United Nations, 2019). Since the consequences of non-registration can be disastrous, such as not being able to receive health care or protection from the law, several papers have made an enquiry into the causes of birth registration (Bequele, 2005; Bhatia et al., 2019; Corbacho & Osorio Rivas, 2012; Duryea et al., 2006; Pirlea, 2019; UNICEF, n.d., 1998, 2005). While these papers are the first to look into the reasons for non-registration in developing countries, the focus of the papers is only on household-level determinants although factors at higher levels are also argued to have an effect (Bequele, 2005; Bhatia et al., 2019; Corbacho & Osorio Rivas, 2012; Duryea et al., 2006; Isara & Atimati, 2015; Li et al., 2010; Mohanty & Gebremedhin, 2018; Nomura et al., 2018; UNICEF, 1998, 2005). Consequently, this paper fills in a gap in the literature by investigating determinants of birth under-registration at different levels of analysis simultaneously, in particular for 567407 children, 753 sub-national regions, and 34 countries retrieved from the Database Developing World (Global\_Data\_Lab, n.d.). Furthermore, this paper is the first to make an enquiry into the interrelation of determinants at different levels by means of interactions.

The following two research questions are answered accordingly: (1) *Which household, sub-national regional, and national factors influence the decision whether or not to register a child?* (2) *Which context characteristics affect the household-level determinants of birth registration?* By answering these questions, this paper has produced improved estimates of the marginal effects for the determinants of birth registration and reflect the situation more realistically (Huisman & Smits, 2015). In that way, more specific policy making for increasing birth registration rates can be made while the government can be more effective by having accurate population data (Mackenzie, 2008; Pais, 2002; United Nations Children's Fund, 2013).

The extensive theoretical framework of chapter 2 looked at the determinants of birth registration in more detail by dividing the determinants of birth registration according to their context level and theme, either socio-economic and demographic variables or care variables. Eight hypotheses were formulated based on the theory. The first four concern the direct effects of household, sub-national regional, and national level determinants of birth registration: (1) the *first hypothesis* reflects the expectation that children from a more favorable socio-economic and demographic background in the household-context are more likely to be registered; (2) the *second hypothesis* predicts that families at the household level that are more in contact with health facilities and skilled health personnel are more likely to register a child; (3) the *third hypothesis* states that more favorable socio-economic, demographic, and care conditions at the sub-national regional level increase the odds that a child is registered; (4) the *fourth hypothesis* reflects the expectation that countries with favorable socio-economic and demographic factors at the national level will increase the probability of having a birth registration.

The last 4 hypotheses concern expectations with regards to variation among contexts: (5) the *fifth hypothesis* reflects the effect that ethnicities and religions can have on socio-economic and

demographic household-level determinants, predicting that the effects of the latter determinants can be mitigated if the household belongs to an ethnic minority or traditional religion; (6) the *sixth hypothesis* predicts that favorable economic and demographic household-level circumstances can make up for unfavorable context conditions; (7) the *seventh hypothesis* looks at the influence of the availability of health facilities in the sub-national region, stating that the effect of the care variables at the household level can be amplified by this; (8) and finally the *eighth hypothesis* expects that care variables at the household level and availability of education at the sub-national regional level can compensate each other.

These eight hypotheses will be tested by means of the empirical analysis. The descriptive statistics, two intercept-only models (intercept for the national level, and the national and sub-national regional level) and two comprehensive multilevel logistic models (including and excluding interaction effects) test the effects of these household, sub-national regional, and national level factors simultaneously for various data observations at different points in time during the period 2005-2018. The descriptive statistics show that, at the time of the surveys, the registration rate is lowest among children aged 0-2 and highest among children aged 4. At an older age, a birth registration is more beneficial since the child encounters more situations in which a certificate is needed, for example for receiving education or health care (Corbacho et al., 2012; United Nations Children's Fund, 2013). Accordingly, the problem seems to be to register children for which the benefits of having a birth registration cannot yet compensate for the costs within the legal time period allowed for birth registration (Chereni, 2016; Corbacho et al., 2012; Pelowski et al., 2015).

With respect to the determinants of birth registration, the empty models with random intercepts for the sub-national regional and national level show that most variation in birth registration rates is found at the household level. The results indicate that both favorable socio-economic and demographic living conditions and seeking care at the household level are important, supporting the first and second hypotheses. Children from households with more socio-economic resources, indicated by a higher IWI, having a phone, and having parents with higher years of education have higher odds of having a birth registration. Not only the socio-economic resources, but also the demographics of the household are important. Although a missing father has a significant negative effect, especially the positive effect of age seems to be important. For every time the age of the child increases with 1 year, the odds of having a birth registration are 2.1% higher. Within the household structure, the relational structure is also essential as seen by the significance of the variables age at first birth, the decisionmaker on contraception, ethnicity, and religion. These variables indicate that bargaining power of women and non-traditional beliefs are essential for the chances of a birth registration. Therefore, the first hypothesis is accepted.

Besides most socio-economic and demographic variables, the care variables all have a significant effect except for prenatal care at home, which can be due to the fact that some people receive prenatal care from skilled health personnel at home. The significant positive interaction effects between



the availability of health facilities in the region and delivery at home and having other delivery assistance show that this reasoning is plausible. The results of the other care variables are in the expected direction and indicate that children from households that are less in contact with health facilities and health personnel, have lower odds of having a birth registration. With regards to the care variables at the household level, a mother that has not received prenatal care, has given birth at home, and a child that has not received vaccination are especially detrimental factors for the birth registration rate.

Nevertheless, there is variation among sub-national regions and countries as well, indicating that determinants at the sub-national regional and national level are indeed important for the birth registration decision. The results indicate that, similar to the household level, the socio-economic, demographic and care sub-national regional-level determinants the availability of health facilities and urbanization do increase the odds that a child has a birth registration. The variable availability of educational facilities does not, which might be due to the computation of the variable. It is recommended that future research investigates this angle from a different perspective.

Although the variation at the national level is not as expected for every variable, and the fourth hypothesis cannot be fully supported, some important insights have been found. The GDP per capita of the country is important for birth registration rates, indicating the amount of money spend on the birth registration system. Related to that, birth registration legislation presence and content can significantly increase the odds of having a birth registration as well. In particular, birth registration legislation, an update in birth registration legislation, 1-month time allowed for the registration of a child, and a decentralized system are all important for increasing the odds of having a birth registration. Moreover, demographics can influence the birth registration decision. A high fertility rate is a detrimental factor as it is harder to register all children when having more while a high child mortality rate is not since it can motivate parents to register their children. Besides that, the history of the country is also important. In particular, the number of conflicts is negatively influencing birth registration rates although the variable colonized is not having a significant influence.

Finally, the context in which the birth registration decision is made has proven to be important. For ethnic minorities, middle-sized ethnic groups and traditional religions socio-economic and demographic household-level characteristics are less important for the birth registration decision, supporting the fifth hypothesis. Only for traditional religions, variables that can increase awareness surrounding birth registration do improve the odds of having a birth registration. This result indicates that for households belonging to a traditional religion, a lack of knowledge about birth registration is the main cause for not registering a birth compared to all other religions. Nevertheless, all of the socio-economic and demographic variables at the household level with a positive effect on the odds of having a birth registration can compensate for some disadvantageous living environment at the sub-national regional and national context. Furthermore, all disadvantageous environments can be compensated by at least one favorable economic or demographic household-level variable. Accordingly, the sixth hypothesis can be confirmed.

Not only the effect of socio-economic and demographic variables at the household level depend on the context, but also the care variables. The results have shown that both hypothesis 7 and 8 can be supported since the effect of the care variables are enlarged by the availability of health facilities in the region, except for delivery at home and other delivery assistance, and the care variables and the average years of father's education in the region can compensate for each other. These results indicate that creating awareness surrounding birth registration is key for increasing birth registration rates in Sub-Saharan Africa.

All in all, the empirical analyses testing the hypotheses have answered the research questions. Concerning the first research question, all household, sub-national regional, and national factors included in this analysis influence the birth registration decision, except the variables mother missing, the decisionmaker concerning contraception being the partner, home being the location where prenatal care has been given, the time periods longer than 1 month allowed for birth registration, fee, and a country being colonized. Nevertheless, these variables do have an indirect effect as shown in the multilevel logistic model including interactions. Regarding the second research question, all context variables included in the analysis affect the determinants of birth registration at the household level. Therefore, it can be concluded that the birth registration problem is a very complex problem, having many determinants that also depend on the context a particular household is living in. The complexity of the problem might have been underestimated, explaining the limited and slow progress in obtaining universal birth registration (Bequele, 2005; Bhatia et al., 2017, 2019; Fagernäs & Odame, 2013).

However, it should be noted that this research has some limitations. Since this paper is the first to look into the effects of multiple levels on birth registration simultaneously for multiple countries, further research on this subject must be performed in order to increase the robustness of the findings. Results of effects like the availability of health facilities in the sub-national region, the education of the father and mother, the IWI, age of the child, and place of delivery are similar to the results found in the research of Mohanty & Gebremedhin (2018) on multilevel determinants of birth registration in India. Nevertheless, there are differences as well, such as the effect of the mortality rate, the availability of education in the sub-national region, and the effect of religion and ethnicity for example.

Moreover, the paper of Mohanty & Gebremedhin (2018) does not examine effects at the national level due to scope of their research. Therefore, it is recommended that further research is done to verify the results found in this paper. Especially validation of unexpected results is recommended, such as the effect of the mortality rate, the rule of law, and a colonized country. Moreover, validation of the effects of the availability of education and health in the sub-national region and are requested since those are computed by aggregating household-level data. Although Huisman & Smits (2015) argue that aggregated data for the district is more reliable, the sign of education availability is unexpected. This might be due to the fact that the sub-national regions used still consist of multiple districts and communities. Hence, it is recommended that future research checks the robustness of the results for the sub-national regional and national determinants of birth registration in particular.

Also, the data used to measure birth registration has its limitations. Although the DHS survey data is mostly the only form of accurate and suitable data on birth registration, the question in which the interviewer asks whether the children 0-4 have a birth registration or certificate does not ask for evidence of the birth registration or certificate (Bhatia et al., 2017; Makinde et al., 2016; United Nations Children's Fund, 2013). As stated by Makinde et al. (2016, p. 331): "Therefore, we cannot be certain that all those who stated that their child had been registered but did not present a birth certificate had actually registered the child." Since the data from 2010-2018 showed that the registration rate was only 46% for children younger than 5 years old in Sub-Saharan Africa while the descriptive statistics show that 57.3% of the children in the dataset have a birth registration, it is likely that the birth registration rate is overestimated in this paper (The United Nations, 2019). Especially since homeless children cannot be taken into account in the DHS household surveys, in which the birth registration question is asked.

Besides the question asked with respect to birth registration in the DHS Surveys, another limitation of the surveys is that the surveys are performed every 5 years, meaning that pooled cross-sectional data is used (The DHS Program, n.d.-a; United Nations Children's Fund, 2013). Accordingly, the change in birth registration rates over time is not investigated in this research, although important to see which factors cause improvement (Bhatia et al., 2019). Following the reasoning of Schrijner & Smits (2018b, 2018a), it is not possible to deduce whether the independent variables play a role in the causation of birth under-registration accordingly.

Finally, as in other papers with many significant interactions like in the paper of Huisman & Smits (2015, p.13), "it is difficult to give clear interpretations for the outcomes of the interaction analysis, which not always point clearly to one direction". Nevertheless, this paper is the first to look into the effects of household, sub-national regional, and national level simultaneously for multiple countries while also looking into the (cross-level) interrelation of these determinants. Consequently, a huge step in the birth registration literature is made. Variables at sub-national regional and national level have shown to affect the birth registration decision while the interaction analysis shows that the birth registration decision is context-specific and more complex than was known.

### ***5.1 Policy recommendations and suggestions for future research***

With respect to the determinants of birth registration, the empty models with random intercepts for the sub-national regional and national level show that most variation in birth registration rates is found at the household level. Consequently, policies should mainly focus on improving the situation at the household level. Previous research investigating the determinants of birth registration in developing countries has recommended to focus on household wealth, education, and access to governmental services such as health care (Candia, 2019; Mohanty & Gebremedhin, 2018; Todres, 2003; UNICEF, 2005). The results of this study indeed show that these focus areas are needed for higher birth registration rates. However, this study has also shown that groups that are put in an unfavorable position like

households belonging to a traditional religion or mothers that do not have autonomy within the household are at a disadvantage like in the paper of Mohanty & Gebremedhin (2018). Hence, extra focus on spreading knowledge about birth registration is needed in areas with these types of characteristics. This could be done by working together with local agents and organizations, like a church or NGO (UNICEF, 2005).

Nevertheless, there is variation among sub-national regions and countries as well, indicating that determinants at the sub-national regional and national level are important for the birth registration decision. Hence, policy should focus on the sub-national region and especially the nation as well since these explain part of the variation and are easier to influence than the household context. For example, the government could invest in the establishment of more educational and health services or make sure that birth registration legislation is updated and improved, and systems are decentralized in order to localize services (Candia, 2019; Todres, 2003). Furthermore, improving birth registration rates does not have to be a goal in itself. As shown by the fertility rate and the GDP per capita, reducing birth under-registration can be combined with other sustainable development goals like goal 1 and 3, that aim to reduce poverty and improve health and well-being.

Most importantly, this study was the first to look at the (cross-level) interrelation between determinants of birth registration. The interaction analysis has shown that effects of the determinants of birth registration differentiate among contexts. Therefore, recommendations made by previous research, like in the report of UNICEF (2005, p.24): “for countries where the initial cost or late fees are listed as major barriers to registration, the national government may decide to adjust or abolish fees in order to increase registration rates. In countries where the population perceives distance to be the main barrier, mobile units may be employed to reach rural populations”, should be adjusted. Policies should not focus on differentiating national contexts alone anymore, but also take into account the influence of differentiating lower level contexts and thus decentralize policies as well. For example, campaigns about the practical benefits of birth registration like going to school do not work as well in urban areas as in rural areas according to the results. Moreover, the beneficial effect of having a phone can be enhanced by ensuring a better technological infrastructure in rural areas. Another example is that the results indicate that the beneficial effect of IWI is reduced for ethnic minorities, leading to a reduced effect of proposed conditional cash transfer programs by previous research (Mohanty & Gebremedhin, 2018). Hence, these examples illustrate the importance of taking into account the specific context the decisionmaker of the birth registration decision lives in. Future research is needed to fully understand the complex dynamics underlying the birth registration decision in order to make context-specific policies.

## 6. Bibliography

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## 7. APPENDIX

### APPENDIX 1

Crosstabulation birth registration by age

		Age					
		Missing	0	1	2	3	4
<b>Birth registration</b>	Missing	1095	6416	5860	7344	8891	9941
	No registration	0	57802	47507	46340	48192	45758
	registration	6	61421	63672	65722	69667	67333
<b>Total</b>		1101	125639	117039	119406	126750	123032

### APPENDIX 2

Frequency of missing cases

	Frequency	Percent	Valid percent	Cumulative percent
0	567407	93,4	93,4	93,4
1	38614	6,4	6,4	99,8
2	1289	0,2	0,2	100
3	13	0	0	100
4	7	0	0	100
<b>Total</b>	607330	100	100	

## APPENDIX 3

## Crosstabulation birth registration by urban

		<b>Urban or rural area</b>	
		Rural	Urban
<b>Birth registration</b>	Missing	29903a – (75.2%)	9858b – (24.8%)
	No registration	190654a – (78.6%)	51967b – (21.4%)
	Registration	207304a – (63.8%)	117644b – (36.2%)
<b>Total</b>		427861 – (70.4%)	179469 – (29.6%)

## Crosstabulation Birth registration by father missing

		<b>Father missing</b>	
		Present	Missing
<b>Birth registration</b>	Missing	25169a – (63.3%)	14591b – (36.7%)
	No registration	175418a – (72.3%)	67202b – (27.7%)
	Registration	235998a – (72.6%)	88950b – (27.4%)
<b>Total</b>		436585 – (71.9%)	170743 – (28.1%)

## Crosstabulation birth registration by mother missing

		<b>Mother missing</b>	
		Present	Missing
<b>Birth registration</b>	Missing	32080a – (80.7%)	7681b – (19.3%)
	No registration	226107a - (93.2%)	16514b - (6.8%)
	Registration	302353a - (93.0%)	22595b - (7.0%)
<b>Total</b>		560540 - (92.3%)	46790- (7.7%)

## APPENDIX 4

Crosstabulation religion by ethnicity majority/minority

Religion		Ethnicity majority/minority			Total	
		Missing	0-10%	10-30%		30+%
Missing	Count	89041	1503	3890	23361	117795
	% within religion	75.60%	1.30%	3.30%	19.80%	100.00%
	% within ethnicity	70.10%	1.00%	2.30%	14.00%	19.40%
Catholic	Count	11365	24170	29420	26074	91029
	% within religion	12.50%	26.60%	32.30%	28.60%	100.00%
	% within ethnicity	8.90%	16.70%	17.40%	15.70%	15.00%
Protestant	Count	8286	34561	30328	35921	109096
	% within religion	7.60%	31.70%	27.80%	32.90%	100.00%
	% within ethnicity	6.50%	23.90%	17.90%	21.60%	18.00%
Christian, not specified	Count	5394	22503	37731	8272	73900
	% within religion	7.30%	30.50%	51.10%	11.20%	100.00%
	% within ethnicity	4.20%	15.60%	22.30%	5.00%	12.20%
Muslim	Count	6931	51688	56906	61637	177162
	% within religion	3.90%	29.20%	32.10%	34.80%	100.00%
	% within ethnicity	5.50%	35.80%	33.60%	37.00%	29.20%
No religion	Count	4218	4186	3937	5043	17384
	% within religion	24.30%	24.10%	22.60%	29.00%	100.00%
	% within ethnicity	3.30%	2.90%	2.30%	3.00%	2.90%
Other	Count	1141	1975	1436	2438	6990
	% within religion	16.30%	28.30%	20.50%	34.90%	100.00%
	% within ethnicity	0.90%	1.40%	0.80%	1.50%	1.20%
Traditional	Count	628	3919	5743	3684	13974
	% within religion	4.50%	28.00%	41.10%	26.40%	100.00%
	% within ethnicity	0.50%	2.70%	3.40%	2.20%	2.30%
<b>Total</b>	Count	127004	144505	169391	166430	607330
	% within religion	20.90%	23.80%	27.90%	27.40%	100.00%
	% within ethnicity	100.00%	100.00%	100.00%	100.00%	100.00%

## APPENDIX 5

Percentage of children aged 0-4 that do not have a birth registration by country

Country	Age				
	0	1	2	3	4
Angola	24.5%	21.0%	18.4%	18.9%	17.0%
Burundi	31.7%	21.6%	16.6%	15.0%	15.1%
Benin	23.2%	18.5%	17.2%	21.8%	19.2%
Burkina Faso	25.0%	17.5%	17.9%	19.2%	20.3%
Ivory Coast	25.8%	19.2%	19.0%	18.7%	17.3%
Cameroon	26.1%	21.0%	17.9%	18.8%	16.2%
Congo Democratic Republic	23.2%	19.2%	19.9%	19.5%	18.2%
Congo	36.0%	18.5%	16.8%	15.9%	12.9%
Comoros	31.3%	21.8%	19.0%	17.0%	10.9%
Ethiopia	21.2%	18.1%	19.0%	20.0%	21.7%
Gabon	50.0%	16.3%	12.2%	11.2%	10.2%
Ghana	28.7%	16.9%	17.3%	19.0%	18.2%
Guinea	23.4%	18.3%	17.2%	21.2%	19.8%
Gambia	33.3%	21.7%	15.8%	15.4%	13.8%
Kenia	21.2%	19.1%	20.4%	20.3%	19.0%
Liberia	22.4%	18.4%	18.2%	20.7%	20.4%
Lesotho	25.0%	20.6%	19.6%	17.1%	17.8%
Madagascar	27.7%	18.2%	17.5%	19.6%	17.0%
Mali	22.7%	17.5%	18.6%	20.1%	21.1%
Mozambique	30.3%	22.2%	16.6%	15.7%	15.1%
Malawi	15.2%	19.3%	19.8%	23.2%	22.5%
Namibia	33.4%	20.6%	17.0%	15.3%	13.6%
Niger	20.5%	17.1%	19.6%	24.7%	18.2%
Nigeria	21.8%	19.3%	19.2%	20.1%	19.6%
Rwanda	29.3%	22.1%	19.5%	17.0%	12.1%
Senegal	23.5%	18.1%	19.7%	20.2%	18.5%
Sierra Leone	24.4%	17.0%	16.5%	22.1%	20.0%
Sao Tome en Principe	47.9%	18.1%	14.1%	9.7%	10.2%
Swaziland	26.0%	20.0%	17.9%	19.0%	17.1%
Tanzania	21.5%	20.5%	18.9%	19.9%	19.2%
Uganda	22.4%	19.4%	19.4%	19.5%	19.4%
Zambia	20.5%	20.2%	19.5%	19.8%	20.0%
Zimbabwe	26.7%	19.9%	19.4%	17.7%	16.3%
<b>Total</b>	23.6%	19.4%	18.8%	19.6%	18.6%

\*Note: Chad has no observations of children aged 0-4 that do not have a birth registration.

APPENDIX 6

Correlations														
Variables	IWI	Phone	Age	Years edu fa	Missing edu fa	Years edu mo	Fa not present	Mo not present	No parent	Age first birth	Contraception	Ethnicity	Religion	
IWI	1													
Phone	0.571	1												
Age	-0.002	-0.002	1											
Years of education father	0.185	-0.021	-0.014	1										
Missing years education father	0.048	-0.01	0.025	-0.044	0.118	1								
Years of education mother	0.373	0.222	-0.044	0.57	0.118	0.057	1							
Missing years education mother	0.017	-0.01	-0.002	-0.002	0.36	-0.01	-0.01	1						
Father not present	0.039	-0.015	0.025	-0.013	0.976	0.121	0.361	0.373	1					
Mother not present	0.013	-0.01	0.172	0.002	0.364	-0.01	0.967	0.426	0.573	1				
No parent present	0.008	-0.012	0.16	-0.006	0.416	-0.009	0.893	0.196	0.529	0.529	1			
Age at first birth	-0.048	-0.039	0.122	-0.063	0.19	-0.107	0.563	0.137	-0.137	-0.047	-0.047	1		
Decisionmaker contraception	0.105	0.079	0.002	0.205	-0.164	0.224	-0.136	-0.168	-0.079	-0.075	-0.075	-0.075	1	
Ethnicity majority/minority	-0.008	-0.022	-0.016	0.041	-0.045	-0.045	-0.086	-0.041	-0.083	-0.043	-0.043	-0.043	-0.043	1
Religion	0.096	0.025	-0.014	-0.131	-0.048	-0.173	-0.078	-0.052	-0.085	0.148	0.148	0.148	0.148	1
Prenatal check visits	0.084	0.039	0.449	0.072	0.078	0.063	0.282	0.078	0.265	0.293	0.293	0.293	0.293	1
Prenatal care by whom	0.091	0.058	-0.494	0.085	-0.04	0.13	-0.323	-0.042	-0.303	-0.381	-0.381	-0.381	-0.381	1
Prenatal care location	0.1	0.119	-0.439	0.075	-0.026	0.125	-0.287	-0.029	-0.269	-0.34	-0.34	-0.34	-0.34	1
Place of delivery	0.221	0.115	0.112	0.142	0.226	0.17	0.488	0.228	0.459	0.486	0.486	0.486	0.486	1
Delivery assistance	0.113	0.071	-0.178	0.126	-0.158	0.16	-0.541	-0.163	-0.507	-0.633	-0.633	-0.633	-0.633	1
Baby postnatal check within 2 months	0.023	-0.089	0.38	0.004	0.066	0.001	0.241	0.068	0.245	0.254	0.254	0.254	0.254	1
Vaccination	0.121	0.093	0.021	0.083	0.088	0.122	0.178	0.089	0.183	0.15	0.15	0.15	0.15	1
Vitamin A	0.041	-0.055	0.156	0.046	0.176	0.041	0.414	0.178	0.388	0.448	0.448	0.448	0.448	1
IWI region	0.745	0.445	-0.01	0.228	0.082	0.29	0.011	0.07	0.009	-0.039	-0.039	-0.039	-0.039	1
Average years education fathers region	0.318	0.148	-0.009	0.538	0.109	0.583	0.031	0.108	0.037	0.187	0.187	0.187	0.187	1
Average number of visits prenatal care region	0.298	0.145	-0.007	0.251	0.098	0.306	0.065	0.097	0.063	0.048	0.048	0.048	0.048	1
Urban or rural area	0.573	0.274	-0.011	0.284	0.052	0.313	0.003	0.043	-0.002	0.069	0.069	0.069	0.069	1
GDP cap	0.276	0.204	-0.009	0.132	0.094	0.182	0.048	0.09	0.046	-0.022	-0.022	-0.022	-0.022	1
Birth registration legislation	0.137	0.15	0	0.044	0.024	0.039	0.007	0.022	0.007	-0.028	-0.028	-0.028	-0.028	1
Legislation updated	-0.006	-0.046	-0.004	0.019	0.02	0.063	-0.015	0.02	-0.009	0.046	0.046	0.046	0.046	1
Organizational structure	-0.058	-0.086	-0.002	-0.246	-0.074	-0.285	-0.042	-0.078	-0.046	-0.042	-0.042	-0.042	-0.042	1
Time allowed registration	0.068	0.145	0.004	0.111	0.035	0.162	0.018	0.04	0.024	0.033	0.033	0.033	0.033	1
Fee	-0.197	-0.231	-0.005	0.034	-0.063	0.011	-0.024	-0.058	-0.024	-0.028	-0.028	-0.028	-0.028	1
Rule of law	0.087	0.122	0.003	-0.093	0.044	-0.02	0.016	0.041	0.019	0.056	0.056	0.056	0.056	1
Government effectiveness	0.118	0.134	0.002	-0.052	0.059	0.038	0.02	0.057	0.026	0.071	0.071	0.071	0.071	1
Fertility rate	-0.18	-0.186	-0.006	-0.149	-0.151	-0.268	-0.073	-0.151	-0.08	-0.003	-0.003	-0.003	-0.003	1
Mortality rate	-0.159	-0.234	-0.002	-0.146	-0.11	-0.226	0	-0.108	-0.014	0.059	0.059	0.059	0.059	1
Number of conflicts	-0.1	-0.012	0.004	0.132	-0.056	0.087	-0.028	-0.027	-0.028	-0.034	-0.034	-0.034	-0.034	1
Colonized	0.091	0.018	-0.004	0.02	0.016	0.056	0.002	-0.001	0.001	-0.007	-0.007	-0.007	-0.007	1

Variables	Correlations																								
	Prenatal visits	Prenatal peris	Prenatal loc	Place delivery	Delivery ass	Postnatal check	Vaccination	Vitamin A	IWI region	Av edu fa	Av pren visits	Urban	GDP cap	Legislation	Update	Organization	Time	Fee	Rule of law	Gov eff	Fertility	Mortality	Conflicts	Colonized	
IWI	-0.603	1																							
Phone	-0.543	0.869	1																						
Age	0.392	-0.25	-0.229	1																					
Years of education father	0.499	0.43	-0.339	0.338	1																				
Missing years education father	-0.295	-0.593	-0.671	0.338	-0.259	1																			
Years of education mother	0.196	0.006	0.008	0.353	-0.125	0.152	1																		
Missing years education mother	0.31	-0.28	-0.277	0.488	-0.492	0.305	0.247	1																	
Father not present	0.071	0.083	0.103	0.208	0.109	0.014	0.114	0.027	1																
Mother not present	0.087	0.077	0.119	0.179	0.119	0	0.085	0.078	0.427	1															
No parent present	0.163	0.055	0.072	0.179	0.057	0.048	0.102	0.106	0.401	0.469	1														
Age at first birth	0.062	0.076	0.058	0.179	0.117	0.036	0.06	0.053	0.371	0.532	0.371	1													
Decisionmaker contraception	0.03	-0.012	0.021	0.049	-0.015	-0.049	0.001	0.053	0.371	0.25	0.267	0.199	1												
Ethnicity majority/minority	0.04	-0.005	0.026	0.027	-0.005	-0.098	-0.007	-0.016	0.184	0.078	0.148	0.079	0.157	1											
Religion	-0.013	0.036	0.01	0.003	0.02	0.081	0.118	0.076	-0.009	0.039	-0.149	-0.016	-0.037	-0.672	1										
Prenatal check visits	-0.064	0.005	-0.028	-0.047	0.028	0.069	-0.025	-0.058	-0.078	-0.452	-0.333	-0.072	-0.185	-0.644	0.412	1									
Prenatal care by whom	-0.003	-0.002	0.021	0.001	-0.043	-0.07	0.077	-0.053	0.092	0.201	0.041	0.003	0.036	0.586	-0.402	-0.564	1								
Prenatal care location	0.019	0.017	-0.042	-0.03	0.033	0.098	0.007	0.044	-0.265	0.064	0.013	-0.039	-0.21	-0.627	0.459	0.261	0.364	1							
Place of delivery	0.018	0.031	0.075	0.066	-0.016	0.051	0.187	0.002	0.117	-0.169	-0.044	-0.026	0.084	-0.275	0.209	0.163	-0.072	0.023	1						
Delivery assistance	0.018	0.035	0.073	0.076	-0.013	0.079	0.195	0.021	0.159	-0.097	-0.042	-0.017	0.114	-0.267	0.254	0.152	-0.006	0.072	0.023	1					
Baby postnatal check within 2 months	-0.05	-0.071	-0.114	-0.142	-0.015	-0.009	-0.218	-0.043	-0.242	-0.276	-0.218	-0.049	-0.28	-0.185	-0.071	0.29	-0.33	0.216	0.24	0.24	1				
Vaccination	-0.019	-0.078	-0.149	-0.122	-0.069	0.072	-0.24	0.014	-0.213	-0.266	0.086	-0.02	-0.151	-0.052	-0.253	0.112	-0.211	0.24	-0.431	-0.502	0.577	1			
Vitamin A	-0.047	-0.043	-0.06	-0.104	-0.014	-0.096	-0.176	-0.079	-0.134	0.23	-0.048	-0.051	-0.071	-0.043	-0.201	-0.186	0.259	0.005	-0.254	-0.237	0.245	0.102	1		
IWI region	0.028	0.014	-0.013	0.06	0.05	0.074	0.028	0.052	0.122	0.033	0.033	0.012	0.079	-0.052	0.151	0.006	-0.063	0.138	-0.021	0.067	0.131	0.105	-0.253	1	
Average years education fathers region																									
Average years education mothers region																									
Urban or rural area																									
Birth registration legislation																									
Legislation updated																									
Organizational structure																									
Time allowed registration																									
Fee																									
Rule of law																									
Government effectiveness																									
Fertility rate																									
Mortality rate																									
Number of conflicts																									
Colonized																									

**APPENDIX 7**

## Bivariate logistic regression models birth registration and all independent variables

	Model 1 Birth registration and IWI	Model 2 Birth registration and phone	Model 3 Birth registration and age	Model 4 Birth registration and years education father
IWI	0.028**	-	-	-
Phone	-	0.697**	-	-
Age	-	-	0.073**	-
Years education father	-	-	-	0.020**
Education father missing	-	-	-	0.006
Constant	-0.562**	-0.129**	0.148**	0.194**
Number of observations	567480	567445	567564	567569

(Table continued)

	Model 5 Birth registration and years education mother	Model 6 Birth registration and father missing	Model 7 Birth registration and mother missing	Model 8 Birth registration and age at first birth
Years education mother	0.042**	-	-	-
Education mother missing	0.031**	-	-	-
Father missing	-	-0.016**	-	-
Mother missing	-	-	0.023*	-
Age at first birth 18+	-	-	-	Reference
Age at first birth 18-	-	-	-	-0.363**
Age first birth missing	-	-	-	-0.066**
Constant	0.165**	0.297**	0.291**	0.412**
Number of observations	567569	567569	567569	567569

\* significant at the 5 per cent level, \*\* significant at the 1 per cent level.

(Table continued)

	Model 9	Model 10	Model 11	Model 12
	Birth registration and decision contraception	Birth registration and ethnicity	Birth registration and religion	Birth registration and prenatal location
Mainly mother	Reference	-	-	-
Mainly partner	-0.045*	-	-	-
Joint decision	-0.009	-	-	-
Decisionmaker missing	-0.252**	-	-	-
Ethnicity 30+%	-	Reference	-	-
Ethnicity 10-30%	-	-0.189**	-	-
Ethnicity 0-10%	-	-0.558**	-	-
Ethnicity missing	-	-0.299**	-	-
No religion	-	-	Reference	-
Catholic	-	-	0.207**	-
Protestant	-	-	-0.209**	-
Christian, not specified	-	-	-0.125**	-
Muslim	-	-	0.356**	-
Traditional	-	-	0.010	-
Other	-	-	0.256**	-
Religion missing	-	-	-0.284**	-
Prenatal care institution	-	-	-	Reference
No prenatal care	-	-	-	-1.260**
Prenatal care home	-	-	-	-0.109**
Prenatal care other	-	-	-	-0.090**
Prenatal care missing	-	-	-	-0.134**
Constant	0.494**	0.539**	0.271***	0.429**
Number of observations	567569	567569	567569	567569

\* significant at the 5 per cent level, \*\* significant at the 1 per cent level.



(Table continued)

	Model 13 Birth registration and place delivery	Model 14 Birth registration and delivery assistance	Model 15 Birth registration and postnatal check within 2 months	Model 16 Birth registration and vaccination
Delivery institution	Reference	-	-	-
Delivery home	-1.049**	-	-	-
Delivery missing	-0.348**	-	-	-
Skilled health personnel	-	Reference	-	-
No assistance	-	-1.252**	-	-
Traditional birth attendant	-	-0.936**	-	-
Other assistance	-	-0.771**	-	-
Assistance missing	-	-0.337**	-	-
Check within 2 months	-	-	Reference	-
No check within 2 months	-	-	-0.693**	-
Check missing	-	-	-0.292**	-
Vaccination	-	-	-	Reference
No vaccination	-	-	-	-0.854**
Vaccination missing	-	-	-	0.276**
Constant	0.666**	0.653**	0.622**	0.153**
Number of observations	567569	567569	567569	567569

\* significant at the 5 per cent level, \*\* significant at the 1 per cent level.

(Table continued)

	Model 17 Birth registration and vitamin A	Model 18 Birth registration and availability education	Model 19 Birth registration and availability health	Model 20 Birth registration and urban
Vitamin A	Reference	-	-	-
No vitamin A	-0.464**	-	-	-
Vitamin A missing	-0.387**	-	-	-
Average years education father region	-	-0.060**	-	-
Average number of visits prenatal care region	-	-	0.276**	-
Urban	-	-	-	0.733**
Constant	0.522**	0.584**	-0.983**	0.084**
Number of observations	567569	567569	567569	567569

(Table continued)

	Model 21 Birth registration and GDP per capita	Model 22 Birth registration and legislation	Model 23 Birth registration and update legislation	Model 24 Birth registration and organizational structure
IWI national	0.000**	-	-	-
Legislation	-	0.423**	-	-
Update legislation	-	-	Reference	-
No update legislation	-	-	-0.002	-
Update missing	-	-	-0.424**	-
Decentralized	-	-	-	Reference
Centralized	-	-	-	-1.174**
Structure missing	-	-	-	-1.046**
Constant	0.278**	-0.096**	0.329**	0.950**
Number of observations	567569	567569	567569	567569

\* significant at the 5 per cent level, \*\* significant at the 1 per cent level.

(Table continued)

	Model 25 Birth registration and time allowed for registration	Model 26 Birth registration and fee registration	Model 27 Birth registration and rule of law	Model 28 Birth registration and fertility rate
Within 2 weeks	Reference	-	-	-
Within 1 month	-0.126**	-	-	-
Within 2 months	-0.456**	-	-	-
Within 2+ months	-0.624**	-	-	-
No legal period	-1.344**	-	-	-
Time missing	-0.744**	-	-	-
No fee	-	Reference	-	-
Fee	-	-0.352**	-	-
Fee missing	-	-0.687**	-	-
Rule of law	-	-	0.068**	-
Fertility rate	-	-	-	-0.203**
Constant	0.649**	0.592**	0.339**	1.344**
Number of observations	567569	567569	567569	567569

(Table continued)

	Model 29 Birth registration and mortality rate children under 5	Model 30 Birth registration and number of conflicts	Model 31 Birth Registration and colonized
Mortality children under 5	-0.001**	-	-
Number of conflicts	-	-0.046**	-
Colonized	-	-	2.374**
Constant	0.350**	0.621**	-2.020**
Number of observations	567569	567569	567569

\* significant at the 5 per cent level, \*\* significant at the 1 per cent level.

## APPENDIX 8

The missing categories or variables, used for the dummy variable adjustments, for fixed effects models with random intercepts (Model 1) and with interaction effects (Model 2).

	Model 1		Model 2	
	Log Odds	Odds Ratio <sup>a</sup>	Log Odds	Odds Ratio <sup>a</sup>
<b>Household level</b>				
<i>Socio-economic and demographic</i>				
Education father missing	0.003	1.003	0.014*	1.014
Education mother missing	-0.0004	0.9996	0.051**	1.052
Age at first birth missing	0.044**	1.045	0.038**	1.039
Decisionmaker contraception missing	-0.007**	0.993	-0.009**	0.991
Ethnicity missing	-0.003	0.997	0.037**	1.038
Religion missing	0.044**	1.045	0.040**	1.041
<i>Care</i>				
Location prenatal care missing	0.013**	1.013	0.012**	1.012
Place delivery missing	-0.083**	0.920	-0.074**	0.929
Assistance delivery missing	0.009	1.009	0.012	1.012
Postnatal check missing	-0.054**	0.947	-0.048**	0.951
Vaccination missing	0.029**	1.029	0.031**	1.031
Vitamin A missing	-0.014**	0.986	-0.028**	0.972
<b>Interactions</b>				
<i>Ethnicity missing</i>				
Phone	-	-	-0.031**	0.969
Age	-	-	0.007**	1.007
Years education father	-	-	-0.002**	0.998
Age at first birth 18-	-	-	0.011**	1.011
Joint decision contraception	-	-	-0.023**	0.977
<i>Religion missing</i>				
Phone	-	-	0.015**	1.015
Age	-	-	-0.014**	0.986
Education mother missing	-	-	-0.044*	0.957
Mother missing	-	-	0.052*	1.053
<i>Education father missing</i>				
GDP per capita	-	-	0.000004**	1.000004
Centralized	-	-	-0.033**	0.968
Time within 1 month	-	-	-0.011**	0.989
<i>Education mother missing</i>				
Ethnicity 10-30%	-	-	-0.057**	0.945
Ethnicity 0-10%	-	-	-0.077**	0.926
Traditional religion	-	-	-0.175**	0.839
Mortality	-	-	-0.0005**	0.9995
Number of conflicts	-	-	-0.003**	0.997
<i>Age at first birth missing</i>				
Ethnicity 0-10%	-	-	-0.025**	0.975
Ethnicity 0-10%	-	-	-0.037**	0.964
Ethnicity missing	-	-	-0.027**	0.973
Religion missing	-	-	0.054**	1.055

Table continued

	Model 1		Model 2	
	Log Odds	Odds Ratio <sup>a</sup>	Log Odds	Odds Ratio <sup>a</sup>
<b><i>Decision contraception missing</i></b>				
Ethnicity 10-30%	-	-	0.020**	1.020
Ethnicity missing	-	-	-0.026**	0.974
<b><i>Prenatal care location missing</i></b>				
Average years education father region	-	-	-0.009**	0.991
<b><i>Postnatal checkup missing</i></b>				
Average years education father region	-	-	0.014**	1.014
Average number of visits prenatal care	-	-	-0.007**	0.993
<b><i>Vaccination missing</i></b>				
Average years education father region	-	-	-0.006**	0.994
Average number of visits prenatal care	-	-	0.006**	1.006
<b><i>Vitamin A missing</i></b>				
Average years education father region	-	-	0.020**	1.020
Average number of visits prenatal care	-	-	0.007*	1.007
Number of observations	567407		567407	
Residual	0.159		0.157	
-2 Restricted Log likelihood	571759.79		566100.75	

\* significant at the 5 per cent level, \*\* significant at the 1 per cent level.

<sup>a</sup> Odds ratio are calculated by raising the coefficient to the exponential (Sommet & Morselli, 2017).