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# **Household and context-level determinants of birth registration in sub-Saharan Africa**

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## **Abstract**

This paper examines the determinants of birth registration in developing countries using multilevel logistic models with data on 567407 children within 34 countries in sub-Saharan Africa for the years 2005 to 2018. Determinants of birth registration at the household, community, and national level are analyzed simultaneously and interrelationships between the determinants are studied with interaction analyses. The results indicate that most of the variation is found at the household level, but that the community and national level also explain a substantial part of it. 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 with little conflicts 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, community level, national level, interaction analysis

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## 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 SSA. The latest data from 2010-2018 shows that the registration rate in SSA even has decreased further since then (The United Nations, 2019).

The consequences of not having a birth registration are enormous. Research shows that unregistered children have limited access to services, like health care and education, and cannot be protected from abuse and exploitation by the law as they 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 (Amo-Adjei & Annim, 2015; Li et al., 2010; Mackenzie, 2008; Pelowski et al., 2015; Todres, 2003). Accordingly, birth registration remains a huge issue 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.

Until around 1995, most research on birth registration was focused on developed countries (Årbyholm, 1978; Coward, 1982; Mccaw-Binns, Fox, Foster-Williams, Ashley, & Irons, 1996; Shapiro, 1954; UNICEF, 1998). Since then, the problem of under-registration in developing countries has become apparent, shifting the focus of research to the causes of non-registration 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). Important factors identified 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).

Most of these studies focus on factors at the household level, where decisions regarding registration are generally taken (Bhatia et al., 2019; Corbacho & Osorio Rivas, 2012; Duryea et al., 2006; UNICEF, 2005). An important reason for this is that available data are usually derived from household surveys, as only a few developing countries have a precise and objective assessment of birth

registration coverage (Duryea et al., 2006; UNICEF, 1998, 2005). Potentially relevant factors at other levels, like the economic (under)development of the region, lack of infrastructure, a previous colonial regime, or the national legislative framework are often disregarded (Bequele, 2005; Isara & Atimati, 2015; Li et al., 2010; Mohanty & Gebremedhin, 2018; Nomura et al., 2018; UNICEF, 1998). A recent study for India, however, indicates that researching the interrelation between household factors and factors at higher levels can significantly improve the understanding of the birth registration problem (Mohanty & Gebremedhin (2018). It therefore seems important to study the role of context factors also for other countries and global regions. In the current study, this will be done for sub-Saharan Africa (SSA). The central research question we aim to answer is:

*To what extent and in which ways is the birth registration of SSA children influenced by factors at the household, community and national level?*

To answer this question, we first develop an encompassing framework, including the factors at these three levels of analysis that are known or expected to be important for birth registration of children, as well as the way they are expected to interact with each other. The hypotheses derived from this framework will subsequently be tested by applying multilevel logistic regression analyses to a database with information on 567,407 children living in 753 communities within 34 SSA countries. In this way we aim to improve on earlier research in several important ways. First, by studying the determinants of birth registration at the household and context level simultaneously, better estimates of the relative contribution of risk factors at the different levels can be obtained. Second, by using a very large sample of children from many SSA countries, a better overview of the situation in the sub-continent is obtained than in earlier research using data on only one or a few countries. Third, by including interactions in our model, information is obtained about the importance of the various risk factors under different circumstances, which makes it possible to develop situation-specific policy measures.

Tackling the problem in this way is important for the protection of children, as well as for the efficacy of governments, which need population data for the creation of services and development strategies concerning aid or sanitation for example (Mackenzie, 2008; Pais, 2002; United Nations Children's Fund, 2013). 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).

## **2. Birth registration**

Birth registration is generally accepted as a human right, as stated in article 7 of The United Nations Convention on the Rights of the Child, one of the most important 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: (1) an official statement of the birth of a child by a spokesman; (2) the registration of child and birth by some administrative level of the government that coordinates civil registry; and (3) 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).

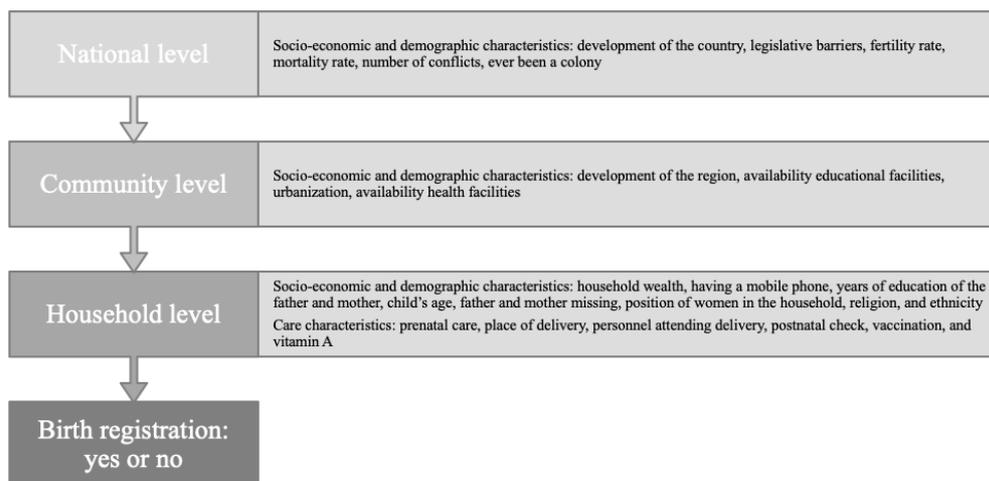
Although the benefits of having a birth registration are substantial, countries in sub-Saharan Africa have relatively low registration rates, namely 46% compared to around 90% in other parts of the world (Bequele, 2005; The United Nations, 2019). In these countries, the immediate costs of birth registration are apparently considered higher than the future benefits (Corbacho & Osorio Rivas, 2012; Pelowski et al., 2015; Smits & Huisman, 2013). Nevertheless, there are also poor African countries with high registration rates, for example Benin, Comoros and Mali (Cappa et al., 2014; United Nations Children's Fund, 2013), and also within countries clear differences between communities and households are found (Apland et al., 2014; Mohanty & Gebremedhin, 2018). These differences point towards the importance of the context in which the decision takes place (Pelowski et al., 2015; Smits & Huisman, 2013).

### 3. Determinants of birth registration

The context in which the spokesman, who declares the birth, lives has basically three relevant levels: household, community and country level. According to Unicef (2013, p.7): “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”. Li et al. (2010) consider the problem of birth under-registration to be the result of interactions between several factors by stakeholders at different levels among which the household, community, and the national level. We therefore will focus our research on these three levels.

Differences in birth registration rates are supposed to depend on inequalities in resources, knowledge, status, demographics and in the amount of (health) care that children receive in the first years of their lives (UNICEF, 2005). For households with a lack of economic resources, the relative costs of birth registration are higher than for richer households. However, even if a household has enough resources, it must also be aware of the importance of birth registration, which can depend on the educational level of the parents or the complexity of existing legislation. The amount of care a child receives in the first years of life can also be important. Situations in which care is needed can make parents more aware of the importance of a birth registration. 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, community, and national level.

An overview of the theoretical framework is presented in figure 1. The decision whether or not to register a birth can be found at the bottom. Factors are included at the household, community and national level. 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

### ***3.1 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). The decision is expected to be influenced by socio-economic and demographic characteristics and care variables at the household level (UNICEF, 2005). One of the most important determinants 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 parents 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). However, (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).

Associated with 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 is expected to be 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). An important factor influencing this knowledge is education (Bhatia et al., 2017; Makinde, Olapeju, Ogbuoji, & 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 is more important than its gender (Amo-Adjei & Annim, 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). 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%) had the least" (Candia, 2019, p.14). The reason might be that sometimes having a birth registration becomes more important with age (United Nations Children's Fund, 2013). 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.

Besides age, the structure of the household can be an important variable influencing the rate of birth registration (Pais, 2002; UNICEF, 2005). Especially a missing parent can have a negative effect UNICEF (2005). Of course, the situation is the worst if both parents are missing (UNICEF, 2005). In that case, the caregiver might lack the information needed to apply for a birth registration (if there is someone who can register the child in the first place). Missing one parent can also be problematic, as in some countries the father must register a child, which is impossible if the father is not present or dead (Pais, 2002; UNICEF, 1998). A missing mother may lead to disregarding the birth registration, 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 as 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) consider the mother's ability to move around as crucial for activities that enhance the welfare of children, such as immunization, health check-ups,

and birth registration. Furthermore, the mother's bargaining power is important, since women with more bargaining power are more likely to spend resources on their children (Mohanty & Gebremedhin, 2018).

Other household characteristics that may play a role in the SSA context are religion and ethnicity (Nomura et al., 2018; Pais, 2002; Todres, 2003; UNICEF, 1998, 2005). Ethnic and religious groups can have multiple reasons for not registering births. First, they may have certain traditions or practices with regards to name giving that may make early birth registration problematic, for example if children only obtain a name after some period of time (Chereni, 2016; UNICEF, 1998; United Nations Children's Fund, 2013). Second, ethnic and religious groups that are minorities in their countries might not register births due to having misgivings about the way birth registrations are handled (Cappa et al., 2014; Mohanty & Gebremedhin, 2018). These groups might fear that birth registration will be misused, for example to weaken the particular culture or to discriminate the members (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, ethnic minorities and traditional religious groups may have the additional disadvantage of speaking a different language (Pais, 2002). In most SSA 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 available in the language of the group, which can cause ignorance about the importance of birth registration and the registration procedure (Mackenzie, 2008).

### ***3.2 Care variables***

Care variables concern events in which health care is provided to a pregnant mother or a young child, which can increase the awareness surrounding birth registration (UNICEF, 2005). Contact with health facilities can be valuable because skilled health personnel is 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 Fagernäs & 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".

There are three ways in which health care surrounding pregnancy and early life can affect birth registration. 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 receive prenatal care, they come into contact with educated health personnel, who can provide them with information about birth registration, recommend to register the birth, and propose a registration office (Makinde et al., 2016; Mohanty & Gebremedhin, 2018). If the prenatal care is received in facilities where a birth can be registered as well, registration is even more facilitated. (Adi et al., 2015).

Second, if a child is born in an institutional facility, it has a higher probability of being registered, because the birth is attended by skilled health personnel who can provide information about registration and 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; Mohanty & Gebremedhin, 2018; Nomura et al., 2018; Pelowski et al., 2015; UNICEF, 1998, 2005; 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”, in Uganda, which makes the next step towards official birth registration easier. Hence, being born at home poses more restrictions on birth registration. For example, travelling costs, time, and not being notified by health personnel. Moreover, the person attending the delivery can be important (Candia, 2019). Traditional birth attendants were found to motivate parents less to register the births of their newborns than skilled birth attendants (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 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 discuss birth registration with the family (Fagernäs & Odame, 2013; UNICEF, 2005). According to 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”. Since there is evidence that parents still have their children vaccinated even if they were born at home, getting a vaccination before the age of 5 can be important for the birth registration decision (Pelowski et al., 2015). The same reasoning holds for receiving vitamin A (Fagernäs & Odame, 2013; UNICEF, 2005).

### ***3.3 Community level***

Although the birth registration decision is made at the household level, the situation at the community level can still influence the choices made at the household level (Amo-Adjei & Annim, 2015; Corbacho et al., 2012; Mohanty & Gebremedhin, 2018). At the community level, there can be huge differences in the availability and efficacy of services like education and health care across communities (Mohanty & Gebremedhin, 2018). Households living in the same region face the same policies and infrastructure, which can in turn have an effect on decisions 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).

The level of development of a 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 costs of birth registration (Amo-Adjei & Annim, 2015; Huisman & Smits, 2015; Mohanty & Gebremedhin, 2018; Nomura et al., 2018). Following Mohanty & Gebremedhin (2018), higher incomes at the community level can indicate a better infrastructure. Related to this quality of facilities and

infrastructure, is the rate of urbanization. Birth registration systems often do not stretch out to remote areas, making registration more difficult and expensive (Bequele, 2005; Corbacho & Osorio Rivas, 2012; Todres, 2003). Both travelling and opportunity costs are 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). According to Corbacho & Osorio Rivas (2012), not only the costs are higher but also the information flow about registration is lower. Households living in rural areas are therefore less likely to register a birth. Availability of education at the community level might play an important role in this respect, since education can help increase the knowledge about birth registration. If no schools are available in the region, as is more often the case in rural areas, people are less educated and knowledge on birth registration might spread more difficult (Huisman & Smits, 2015; Mohanty & Gebremedhin, 2018; UNICEF, 2005).

Besides socio-economic context factors, also characteristics of the local care and registration infrastructure are important. If the distance to health facilities and registration offices are longer, the travelling and opportunity costs increase. 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 region, family members will on average have to travel further to register the birth. Moreover, the amount of care received by mother and child – and hence the chance to receive information about registration – will be lower if there are less facilities (Jackson, Duff, Kusumanigum, & Stark, 2014).

### ***3.4 National level***

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; Dunning et al., 2014; The United Nations, 2019). Socio-economic variables at the national level can have a significant influence on the birth registration decision, as the overall level of development of a country may affect the quality and availability of birth registration systems (Bequele, 2005; UNICEF, 1998). In low income countries, civil registration systems are often underdeveloped due to the lack of economic resources (Mackenzie, 2008; Pais, 2002; UNICEF, 1998; United Nations Children’s Fund, 2013). In these countries, governments might be less willing to spend their 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). This may lead to 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 when poverty is a major 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, since long allowed time periods can lead to procrastination and short time periods can make registration unfeasible for people living in disadvantageous living conditions (Duff et al., 2016; Li et al., 2010; Pelowski et al., 2015).

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 often are preferred despite the fact that these systems are located in urban or other central areas only (Chereni, 2016; Mackenzie, 2008; Makinde et al., 2016; Pelowski et al., 2015; Todres, 2003). Although decentralized birth registration systems can be complex and expensive, as different institutions with different departments and agents must 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). Countries like Bangladesh and Kenya therefore have seen their birth registration rates go up after moving from a centralized to a decentralized system (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.

The current birth registration system might also be influenced by the history of the country. 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; Szreter & Breckenridge, 2012; 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).

War and conflicts may have devastating effects on existing registration systems as well, if there was one in the first place (Dunning et al., 2014; Heap & Cody, 2009; Pais, 2002). Misuse of these systems during (civil) war, such as the Rwandan genocide, may lead to mistrust and breaking down of them (Amo-Adjei & Annim, 2015; Cappa et al., 2014; Todres, 2003). This may have long lasting consequences for the rate of 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.

### ***3.5 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), studying how effects of the risk factors differ according to characteristics of the context is a way to “make our model and predictions more situation-specific”. Accordingly, the variables ethnicity and religion, all community-level determinants, and all national-level determinants will be introduced as context factors.

Firstly, for the socio-economic and demographic household-level determinants, ethnicity and religion are expected to have an indirect effect on birth registration. Beliefs and traditions of ethnic and religious groups can affect the significance of the risk factors (Pais, 2002). It is expected that especially ethnic minorities and traditional religious groups will affect the risk factors 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.

Secondly, following the reasoning of Huisman & Smits (2015), household-level determinants are perceived to interact with determinants at the higher levels. The authors state that: “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, meaning that there is a low availability 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).

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, 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. 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 on the community level (Jackson et al., 2014).

Moreover, the amount of healthcare a household receives might be able to compensate for the availability of education. Since it is argued that education can increase 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).

## **4. Data and methods**

### ***4.1 Data***

The data used for our analyses are derived from the Demographic Health Surveys (DHS) ([www.dhsprogram.com](http://www.dhsprogram.com)). The data are derived from the Database Developing World of the Global Data Lab ([www.globaldatalab.org](http://www.globaldatalab.org)). DHS are nationally representative household surveys, based on a two-stage sampling approach. First a sample of non-overlapping areas (called clusters) are randomly drawn, usually communities, villages, or city quarters. Within these clusters a list with all households is made from which a random sample of 25–30 households is selected for the interviews. A DHS survey consists of two or three separate oral interviews. First, a household questionnaire is administered in which basic

information on the household and its members is obtained. Subsequently, all women aged 16–49 in the household obtain an extensive oral interview in which detailed demographic, economic and (reproductive) health information is collected. In another part of the surveys also male household members in a specific age group obtain an oral interview. For the current study, data from the household and women’s surveys is used.

Context factors at the community level were derived from the Area Database of the Global Data Lab ([www.globaldatalab.org/areadata](http://www.globaldatalab.org/areadata)), which contains a broad set of indicators for subnational regions (generally administrative level 1) within the countries constructed by aggregating data from the household surveys to the community level (Huisman & Smits, 2015). Context data at the national level was retrieved from several sources. Data concerning birth registration legislation was downloaded from UNICEF Data: 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.). This data has also been used for other reports about birth (under)registration (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). Data for the national variables national income, rule of law, government effectiveness, fertility rate, and under-five mortality was derived from the World Bank (Corbacho & Osorio Rivas, 2012; Dunning et al., 2014; Makinde et al., 2016; The World Bank, n.d., 2020a; United Nations Children’s Fund, 2013). Information about the history of the country, in particular the number of conflicts and whether a country has been colonized, was 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). An advantage of the UCDP is that it includes information on the colonial period of countries (Eck, 2005; Uppsala Conflict Data Program, 2018). 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 integrated dataset includes 607330 children aged 0 to 4 years old who are living in 753 communities and 34 countries in sub-Saharan Africa. As a consequence of missing cases in the dependent variable, 39760 out of 607330 data observations were invalid and were not taken into account in the empirical analysis. Missing cases in the independent variables were handled by listwise deletion for the variables with less than 500 missing cases since this only represents 0.1% of the data (IWI and phone) and 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. After removing all missing cases, 567407 cases (93.5%) remained for our analyses (see appendix 2). In all analyses the household sampling weights included in the DHS surveys were applied (Makinde et al., 2016; The DHS Program, n.d.-b).

## 4.2 Methods

Since this paper makes an enquiry into household, community, and national level determinants of birth registration, each level nested in the level above, a three-level multilevel logistic analysis is used (Mohanty & Gebremedhin, 2018; Smits & Huisman, 2013). 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 communities (Huisman & Smits, 2015; Mohanty & Gebremedhin, 2018). According to Mohanty & Gebremedhin (2018).

Following Mohanty & Gebremedhin (2018), first two empty models with random effects at the national and community level will be performed. “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). 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 comprehensive models, one that takes into account the household variables and the context variables with random intercepts for the community and national level excluding interaction effects and one including these, will be tested in order to investigate how variables at different context levels affect the birth registration decision as well as the risk factors (Huisman & Smits, 2015; Smits & Huisman, 2013). 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).

The two models will represent a fixed effects model for all independent variables with a random intercept for the national and community 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 community  $j$  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 community 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 community 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 community 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). To compute the variable 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.

### ***4.3 Independent variables***

Household wealth was measured by the ‘International Wealth Index (IWI), which indicates the standard of living of households based on their possession of durable goods, the quality of their housing and access to basic services (Smits & Steendijk, 2015). Mobile phone ownership is measured by a dummy variable with value 1 one of the household members owned a mobile phone and value 0 if no one in the household has a mobile phone. Education of the parents was measured by the years of education they completed.

Of the demographic characteristics of the households, ‘age’ of the children was measured in years. Missing of one or both parents was measured by three dummy variables, indicating whether (1) or not (0) a father (‘famis’), a mother (‘momis’), or both parents (‘pamis’) were missing from the household. The position of women in their households was indicated by two variables, a dummy indicating whether (1) or not (0) the mother has given birth before the age of 18 (Huisman & Smits, 2015) and whether the mother can decide on contraception (Mohanty & Gebremedhin, 2018) with three categories indicating whether the decision on contraception is taken by the mother herself (1), the partner (2), or whether it is a joint decision (3).

The variables ‘ethnicity’ and ‘religion’ were based on pre-coded questions with the option to add additional categories. 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. For ethnicity a three-category variable was constructed indicating whether the ethnic group to which the household belonged was 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.

The care variables were retrieved from the woman’s surveys, as these include questions about maternal and child health. With regards to prenatal care of the mother, three variables have been computed. The first variable, ‘prenatal care by whom’, indicates by whom the prenatal check was performed: (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 (1) no prenatal

checkup visits, (1) up to 3 visits, or (2) 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. 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 with 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.

Primary care 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. 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).

To reflect the quality of services and infrastructure at the community level, the average wealth of the community is used as a proxy based on Mohanty & Gebremedhin (2018). This variable, reflecting the average well-being of the community, was computed by aggregating (taking the mean of) the values of the International Wealth Index of the households within the community (Smits & Steendijk, 2015). The variables ‘the availability of education’ and ‘availability of health services’ were constructed following Smits & Huisman (2013, p.330), by taking “the average number of years of education of adult males” and of the number of prenatal checkup visits of women in the cluster. Only the education of men was taken into account as the education of women is also dependent on other factors, such as patriarchy (Smits & Huisman, 2013). The variable ‘level of urbanization’ was readily available in the data and measured by a dummy variable indicating whether (1) or not (0) the household lived in an urban area.

At the national level, the economic, legislative, demographic, and historic situation of the country are supposed to be important. The economic situation of the country is a proxy for the availability and quality of the birth registration systems (Bequele, 2005; UNICEF, 1998). It was measured by the ‘Gross Domestic Product per capita (in current US dollars)’ retrieved from the World Bank (2020). The legislative situation surrounding birth registration is depicted by several variables. The variable ‘birth registration legislation’ was 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.

Time allowed for registration is recoded in a categorical variable with the following categories: (1) within 2 weeks, (2) within 1 month, (3) within 2 months, (4), within 2+ months, (5) and no legal period. Registration fee is a dummy variable indicating whether (1) or not (0) a fee was involved in birth registration. Besides the content of the legislation, the ‘organizational structure’ of the birth registration system is 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 dummy variable adjustment. Besides legislation, the level of governance of the country, indicated by the ‘rule of law’ and ‘government effectiveness’, is important (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 at the national level were 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 ‘mortality rate of children under 5 years old’ represents the probability that a child will die before the age of 5 per 1000.

The history of the country is represented by two variables retrieved from the Uppsala Conflict Data Program (2018) and Encyclopædia Britannica (2020). Number of conflicts is measured by 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). Whether a country was colonized is measured by a dummy with value 1 when the country has been colonized and a value 0 when the country was never colonized.

For variables with more than 500 missing cases, dummy variable adjustments was used (Allison, 2001; Huisman & Smits, 2015). These variables 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).

## **5. Results**

### ***5.1 Descriptive statistics***

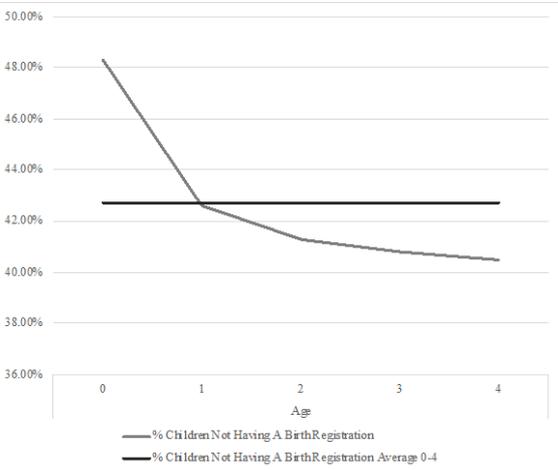
Figure 2 depicts that 42.7% of the children aged 0-4 in this research do not have a birth registration. During the timespan of this research (2005-2018), the non-registration of children was highest among children aged 0 and 2 and lowest among children aged 4. Accordingly, birth registration rates seem to increase with age, which is in accordance with the perception that having a birth registration is more

valuable when becoming older. Moreover, 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.

The descriptive statistics of table 1 demonstrate that households have an average IWI of 32.09 and a phone in 61.4% of the cases. 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. 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. 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, most people are Muslim (29.2%) or Christian. These households live especially in rural communities (70.4%) within developing countries, explaining the average IWI of the community (32.09), years of education of fathers in the community (4.79), the number of prenatal checkup visits (4.62), the average GDP per capita (1276.67), the fertility- (5.18) and the under-five mortality rate (88.34). Nevertheless, most countries have birth registration legislation (92.1%), meaning that the content can probably explain most of the variation.

With regards to care, 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%), although only about 30% of the women also visit prenatal checkups at least 4 times. Moreover, 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.

Although multicollinearity is unlikely to be an issue given that the enormous size of the dataset, the correlation matrix in appendix 3 is used to remove variables that show the same phenomenon (O’Brien, 2007). For the variables that are not necessarily needed for the empirical analysis (due to dummy variable adjustments), a choice between variables that show the same phenomenon will be made.



**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 community level</b>					
<b><i>Socio-economic and demographic</i></b>					
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>					
<b><i>Socio-economic and demographic</i></b>					
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>				

First, the variable parents missing will not be included in the empirical analysis if mother and father missing are included. The latter are preferred since these variables can provide detail on whether sex of parent can have an influence on the birth registration decision. Second, the variable postnatal check will be used instead of prenatal check since the former can actually lead to a birth registration as the baby is born. Thirdly, prenatal care location will be preferred over prenatal care personnel. The location of the prenatal care can implicitly indicate whether a mother knows where to register a birth, since registration offices are located in/near health facilities, and by whom a mother was seen (Adi et al., 2015). Fourthly, the IWI of the community will be removed from the analysis since this variable correlates with the IWI of the household and with the urbanization level of the community. 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).

### **5.2 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 4 shows that all variables are significant except for some subcategories of a variable. Thus, all the independent variables used for these bivariate analyses will be selected for the multilevel logistic analyses as well. First, the results of the intercept only models are shown in table 2. Model 1 and 2 show that there is indeed variation, among countries and communities 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. 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 differences between communities. As a result, 65% of the variation is caused by differences within communities. Thus, most of the variance is found at the household level, where the decision is made.

**Table 2:** Intercept only models with the national level effects (Model 1) and the national and community 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
Community 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	
Community	-		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:

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

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.

Table 3 shows that most of the household level factors have an expected effect: 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. Nevertheless, the effect of the missing mother becomes significantly negative in model 2, meaning that the effect depends on other factors added to the model. The position of women in the household is in itself important, however. 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. Moreover, the variable joint decision in contraception is significantly positive. 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 4 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, it can be concluded that 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 an indirect negative effect.

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 4), the variable prenatal care at home was also significantly negative. 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 in early life increases the odds of a birth registration.

**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
Community 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>Community level</b>				
<i>Socio-economic and demographic</i>				
Average years of education father	-0.012**	0.988	-0.021**	0.979
Urban	0.028**	1.028	0.018	1.018
Average number of visits prenatal care	0.043**	1.044	0.026**	1.026
<b>National level</b>				
<i>Socio-economic and demographic</i>				
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 5.

Regarding the community level, 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. 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 with the assumption that most parents grew up and were educated in the region they live in now but as migration is common in developing countries, the assumption might not have been upheld (Bequele, 2005). As a result, a better socio-

economic and demographic situation at the community level increases the odds of having a birth registration with regards to the availability of health facilities and urbanization.

With respect to the national level, 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. Moreover, a centralized birth registration system decreases the odds of having a birth registration with 33%. 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. Also, the variable fee is 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.

Next to the content of birth registration legislation, the rule of law, the fertility rate, the mortality rate of children under 5, and the number of conflicts of a country have proven to be important for birth registration. However, the effects of the variables rule of law and under-five mortality were not as expected. The reason for these result might be 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, while a high mortality rate can cause an incentive instead of a disincentive to register births as registration gives 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. Moreover, an extra conflict significantly decreases the odds of a child aged 0-4 having a birth registration with 0.3%.

All in all, although the development of a country 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.

### ***5.3 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. 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.

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. Moreover, the negative effects of a missing mother, having a mother that has given birth before the age of 18, and the partner being the main decisionmaker regarding contraception (only for the ethnic group containing 10-30% of the people) are compensated if belonging to these groups instead of to an ethnic majority. Hence, socio-economic and demographic determinants at the household level seem to be less important for these groups as expected.

Considering traditional religions, 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 stronger compared to all other religions. This indicates that these variables can compensate for belonging to a traditional religion. However, the negative effects of a missing mother and having a mother that has given birth before the age of 18 are less negative if the household of the child belongs to a traditional religion as well. All in all, the effects of socio-economic and demographic determinants at the household level can be mitigated by whether the household belongs to an ethnic minority, middle-sized ethnic group or a traditional religion. However, it should be noted that variables representing awareness are increasing the odds of having a birth registration for traditional religions, indicating that that is the main problem for those groups.

The results show that the effects of some socio-economic and demographic household-level determinants are influenced by the community level. The effect of IWI and years of education of the father are less strong in communities in which the average years of education of fathers 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, creating awareness surrounding birth registration. 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 are the same for the availability of health facilities, 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 community 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,

**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</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 5.

this is also the case for years of education of the mother. Accordingly, there is an accumulation of positive effects.

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.

Also, national factors influence the socio-economic and demographic household-level determinants of birth registration. 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, making other factors less important.

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: 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. When longer time periods are allowed, the positive effect of phone 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 can be that the identification of both parents is needed to perform a birth registration for example (UNICEF Data, n.d.). 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. 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.).

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. 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, favorable socio-economic and demographic household-level determinants do not compensate for all disadvantageous situations, but it can in many 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.

With regards to the variation among care variables, the availability of health care in the community influences the effect of the care variables. If the average number of visits of prenatal care 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 not getting health care while availability of health facilities in the community is higher is a deliberate decision 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, there are higher chances that professional guidance is received during delivery at home. Consequently, the results indicate there is a compensation effect taking place.

Care variables can also depend on the availability of educational facilities in the community. The negative effects of the care variables on the odds of having a birth registration are weaker if the household lives in a community with higher average years of education of fathers. For example, if no awareness for birth registration had been created since no prenatal care was received, a higher educational availability can have spillover effects and still create awareness (Mohanty & Gebremedhin, 2018). Hence, more educational availability can compensate for the loss of awareness when not getting or receiving professional health care.

## **6. 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). The focus of these papers is 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 communities, and 34 countries. Furthermore, this paper is the first to make an enquiry into the interrelation of determinants at different levels by means of interactions.

The following research question is answered accordingly: *To what extent and in which ways is the birth registration of SSA children influenced by factors at the household, community and national level?* By answering this question, 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. Moreover, the framework has investigated how risk factors could depend on context factors. The theoretical framework was tested by multilevel logistic models 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 intercept only models 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. 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. Also, the demographics of the household are important, especially age: for every time the age of the child increases with 1 year, the odds of having a birth registration are 2.1% higher. 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.

Moreover, 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.

Nevertheless, there is variation among communities and countries as well. The results indicate that, similar to the household level, the socio-economic and demographic determinants the availability of health facilities and urbanization increase the odds that a child has a birth registration. Although the variation at the national level is not as expected for every variable, some important insights have been found. The GDP per capita of the country and birth registration legislation presence and content can significantly increase the odds of having a birth registration. 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. Only for traditional religions, variables that can increase awareness surrounding birth registration do improve the odds of having a birth registration, indicating that a lack of knowledge 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 community and national context. Furthermore, all disadvantageous environments can be compensated by at least one favorable economic or demographic household-level variable. 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 the effects 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, all household, community, 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. Moreover, 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 very complex and context specific. 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 include national determinants while looking 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 at the community level, the education of the father and mother, the IWI, age of the child, and place of delivery are similar to the results found in previous research of for example Mohanty & Gebremedhin (2018). Nevertheless, there are differences as well, such as the effect of the mortality rate, the availability of education, and the effect of religion and ethnicity for example. Therefore, it is recommended that further research is done to verify the results found in this paper. Especially validation of unexpected results is recommended.

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, community, 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 the community 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.

### ***6.1 Policy recommendations***

With respect to the determinants of birth registration, the empty models 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 communities and countries as well. Hence, policy should focus on the community 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. 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.

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## 8. 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

Variables	IWI	Phone	Age	Years edu fa	Missing edu fa	Years edu mo	Missing 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	0.32	0.185	-0.021	1										
Missing years education father	0.048	-0.01	0.025	-0.014	1									
Years of education mother	0.373	0.222	-0.044	0.57	0.118	1								
Missing years education mother	0.017	-0.01	-0.002	-0.002	0.36	-0.01	1							
Father not present	0.039	-0.015	0.025	-0.013	0.976	0.121	0.361	1						
Mother not present	0.013	-0.01	0.172	0.002	0.364	-0.01	0.967	0.373	1					
No parent present	0.008	-0.012	0.16	-0.006	0.416	-0.009	0.893	0.426	0.573	1				
Age at first birth	-0.048	-0.039	0.122	-0.063	0.19	-0.107	0.563	0.196	0.529	0.529	1			
Decisionmaker contraception	0.105	0.079	0.002	0.205	-0.164	0.224	-0.136	0.168	-0.137	-0.19	-0.19	1		
Ethnicity majority/minority	-0.008	-0.022	-0.016	0.041	-0.045	0.005	-0.086	-0.041	-0.086	-0.083	-0.079	-0.047	1	
Religion	0.096	0.025	-0.014	-0.131	-0.048	-0.173	-0.078	-0.052	-0.085	-0.083	-0.075	-0.076	0.397	1
Prenatal check visits	0.084	0.039	0.449	0.072	0.078	0.063	0.282	0.078	0.288	0.265	0.293	-0.043	-0.072	-0.066
Prenatal care by whom	0.091	0.058	-0.494	0.085	-0.04	0.13	-0.323	-0.042	-0.328	-0.303	-0.381	0.148	0.019	0.025
Prenatal care location	0.1	0.119	-0.439	0.075	-0.026	0.125	-0.287	-0.029	-0.292	-0.269	-0.34	0.173	-0.026	-0.025
Place of delivery	0.221	0.115	0.112	0.142	0.226	0.17	0.488	0.228	0.498	0.459	0.486	-0.03	-0.145	-0.124
Delivery assistance	0.113	0.071	-0.178	0.126	-0.158	0.16	-0.541	-0.163	-0.549	-0.507	-0.633	0.217	0.076	0.06
Baby postnatal check within 2 months	0.023	-0.089	0.38	0.004	0.066	0.001	0.241	0.068	0.245	0.226	0.254	-0.072	-0.023	0.006
Vaccination	0.121	0.093	0.021	0.083	0.088	0.122	0.178	0.089	0.183	0.169	0.15	0.076	-0.151	-0.148
Vitamin A	0.041	-0.055	0.156	0.046	0.176	0.041	0.414	0.178	0.42	0.388	0.448	-0.08	-0.094	-0.086
IWI region	0.745	0.445	-0.01	0.228	0.082	0.29	0.011	0.07	0.009	0.007	-0.039	0.074	-0.011	0.139
Average years education fathers region	0.318	0.148	-0.009	0.538	0.109	0.583	0.031	0.108	0.037	0.037	-0.031	0.187	0.069	-0.179
Average number of visits prenatal care region	0.298	0.145	-0.007	0.251	0.098	0.306	0.065	0.097	0.068	0.063	0.008	0.048	0.011	0.037
Urban or rural area	0.573	0.274	-0.011	0.284	0.052	0.313	0.003	0.043	0.002	-0.002	-0.037	0.069	0.027	0.086
GDP cap	0.276	0.204	-0.009	0.132	0.094	0.182	0.048	0.09	0.046	0.044	0.031	-0.022	0.085	0.037
Birth registration legislation	0.137	0.15	0	0.044	0.024	0.039	0.007	0.022	0.007	0.003	0.022	-0.028	-0.052	0.064
Legislation updated	-0.006	-0.046	-0.004	0.019	0.02	0.063	-0.015	0.02	-0.015	-0.009	-0.046	0.089	-0.045	-0.061
Organizational structure	-0.058	-0.086	-0.002	-0.246	-0.074	-0.285	-0.042	-0.078	-0.046	-0.046	-0.042	-0.062	0.003	0.082
Time allowed registration	0.068	0.145	0.004	0.111	0.035	0.162	0.018	0.04	0.024	0.024	0.033	0.023	-0.081	-0.169
Fee	-0.197	-0.231	-0.005	0.034	-0.063	0.011	-0.024	-0.058	-0.022	-0.024	-0.028	-0.006	0.051	-0.173
Rule of law	0.087	0.122	0.003	-0.093	0.044	-0.02	0.016	0.041	0.014	0.019	0.002	0.056	-0.121	-0.127
Government effectiveness	0.118	0.134	0.002	-0.052	0.059	0.038	0.02	0.057	0.019	0.026	-0.009	0.071	-0.13	-0.147
Fertility rate	-0.18	-0.186	-0.006	-0.149	-0.151	-0.268	-0.073	-0.151	-0.078	-0.08	-0.003	-0.162	0.154	-0.015
Mortality rate	-0.159	-0.234	-0.002	-0.146	-0.11	-0.226	0	-0.108	-0.005	-0.014	0.059	-0.187	0.2	0.186
Number of conflicts	-0.1	-0.012	0.004	0.132	-0.056	0.087	-0.028	-0.052	-0.027	-0.028	-0.012	-0.034	0.258	0.063
Colonized	0.091	0.018	-0.004	0.02	0.016	0.056	0.002	0.013	-0.001	0.001	-0.007	-0.009	-0.011	-0.074

Variables	Prenatal visits	Prenatal peris	Prenatal loc	Place delivery	Delivery ass	Postnatal check	Vaccination	Vitamin A	IWI region	Avrenvisits	Urban	GDP cap	Legislation	Update	Organization	Time	Fee	Rule of law	Goveff	Fertility	Mortality	Conflicts	Colonized	
IWI																								
Phone																								
Age																								
Years of education father																								
Missing years education father																								
Years of education mother																								
Missing years education mother																								
Father not present																								
Mother not present																								
No parent present																								
Age at first birth																								
Decisionmaker contraception																								
Ethnicity majority/minority																								
Religion																								
Prenatal check visits	1																							
Prenatal care by whom	-0.603	1																						
Prenatal care location	-0.543	0.669	1																					
Place of delivery	0.392	-0.25	-0.229	1																				
Delivery assistance	-0.395	0.499	0.43	-0.339	1																			
Baby postnatal check within 2 months	0.622	-0.593	-0.671	0.338	-0.259	1																		
Vaccination	0.196	0.006	0.008	0.353	-0.125	0.152	1																	
Vitamin A	0.31	-0.28	-0.277	0.488	-0.492	0.305	0.247	1																
IWI region	0.071	0.083	0.103	0.208	0.109	0.014	0.114	0.027	1															
Average years education fathers region	0.087	0.077	0.075	0.179	0.119	0	0.085	0.078	0.427	1														
Average number of visits prenatal care region	0.163	0.055	0.072	0.179	0.057	0.048	0.102	0.106	0.401	0.469	1													
Urban or rural area	0.062	0.076	0.058	0.179	0.117	0.096	0.06	0.053	0.371	0.52	0.371	1												
GDP cap	0.04	-0.012	0.021	0.049	-0.015	-0.049	0.001	0.053	0.371	0.25	0.267	0.199	1											
Birth registration/legislation	0.03	-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										
Legislation updated	-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									
Organizational structure	-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								
Time allowed registration	-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							
Fee	-0.013	0.017	-0.042	-0.03	0.033	0.068	0.007	0.044	-0.265	0.064	0.013	-0.039	-0.21	-0.627	0.459	0.261	0.364	1						
Rule of law	0.019	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					
Government effectiveness	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	0.072	0.023	0.894	1				
Fertility rate	-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	-0.285	-0.401	1			
Mortality rate	-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	0.24	0.216	-0.431	-0.502	0.577	1		
Number of conflicts	-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	0.005	-0.254	-0.237	0.245	0.102	0.577	1	
Colonized	0.028	0.014	-0.013	0.06	0.05	0.074	0.028	0.052	0.122	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	0.577	1

## APPENDIX 4

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	Model 26	Model 27	Model 28
	Birth registration and time allowed for registration	Birth registration and fee registration	Birth registration and rule of law	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	Model 30	Model 31
	Birth registration and mortality rate children under 5	Birth registration and number of conflicts	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 5

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><b>Socio-economic and demographic</b></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><b>Care</b></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><b>Ethnicity missing</b></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><b>Religion missing</b></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><b>Education father missing</b></i>				
GDP per capita	-	-	0.000004**	1.000004
Centralized	-	-	-0.033**	0.968
Time within 1 month	-	-	-0.011**	0.989
<i><b>Education mother missing</b></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><b>Age at first birth missing</b></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	-	-	-0.009**	0.991
<b><i>Postnatal checkup missing</i></b>				
Average years education father	-	-	0.014**	1.014
Average number of visits prenatal care	-	-	-0.007**	0.993
<b><i>Vaccination missing</i></b>				
Average years education father	-	-	-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	-	-	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).