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Levels, Trends, and Factors Associated with Under-5 Excess Mortality among Twins in Sub-Saharan Africa: Studies of National Surveys from 42 Countries

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ABSTRACT

BACKGROUND

Twin children are more likely to die than singletons. In sub-Saharan African countries, this is an additional burden, as child mortality levels are already higher than anywhere else.

OBJECTIVE

This article presents under-5 mortality rates (U5MR) for twins and singletons in sub-Saharan Africa from 1986 to 2016. It describes the geographical variations and changes over time. It also describes the variation of twins' excess mortality according to age, between 0 and 5 years old. Moreover, it analyses the factors associated with twins' excess mortality.

METHODS

We have used data from 156 national surveys (Demographic and Health Surveys & Multiple Indicator Cluster Survey) from 42 countries.

RESULTS

The findings show that U5MR are, on average, 3 times higher among twins compared to singletons. The multivariate results show that, all else being equal, the adjusted Hazard Ratio (HRa) of twins is 3.2 times higher (2.9 -3.3; $p < 0.001$) than that of singletons. The main factors associated with excess mortality risks among twins are a set of biomedical and nutritional features, composed of birthweight, caesarean section, antenatal visits and breastfeeding. Among these factors, non-breastfeeding is associated with 4 times higher mortality risks for twins than for singletons; and caesarean delivery is associated with lower mortality risks for twins than for singletons.

CONCLUSION

In sub-Saharan Africa, the health of twin children is a major health challenge.

CONTRIBUTION

The geographical variations and changes over time in twins' excess mortality in sub-Saharan Africa analysed here is a new contribution to the literature.

KEYWORDS

Twins, Under-five mortality, Excess mortality, Associated factors, Socio-cultural status, Sub-Saharan

RESUME

Niveaux, tendances et facteurs associés à la surmortalité infanto-juvénile des jumeaux en Afrique subsaharienne : analyses d'enquêtes nationales de 42 pays

Les enfants jumeaux sont confrontés à des risques de décès plus importants que les singletons. En Afrique subsaharienne cela constitue un fardeau supplémentaire sachant que les niveaux de mortalité des enfants y sont les plus élevés au monde. Le présent article présente les quotients de mortalité infanto-juvénile des jumeaux et des singletons en Afrique subsaharienne entre 1986 et 2016 en utilisant les données de 156 enquêtes nationales provenant de 42 pays. Il décrit leurs variations géographiques et leurs évolutions dans le temps. Il décrit aussi la variation de la surmortalité gémellaire selon l'âge entre 0 et 5 ans. Par ailleurs, en se servant de 25 enquêtes les plus récentes dans 25 pays distincts, il analyse les facteurs associés à la surmortalité gémellaire. Les résultats montrent que les jumeaux ont des quotients de mortalité infanto-juvéniles qui sont en moyenne 3 fois plus élevés que les singletons. Les résultats multivariés montrent que, toutes choses étant égales par ailleurs, les jumeaux ont des Hazard Ratios de mortalité infanto-juvénile 3,2 fois plus importants (2,9-3,3 ; $p < 0,001$). Ils montrent également que c'est un ensemble de facteurs biomédicaux et nutritionnels (poids à la naissance, accouchement par césarienne, visites prénatales et allaitement maternel) qui expliqueraient en grande partie cette surmortalité gémellaire. Parmi ces facteurs, la non pratique de l'allaitement maternel est associé à 4 fois plus de risques de mortalité chez les jumeaux que chez les singletons ; et l'accouchement par césarienne est associé à des risques de mortalité plus faibles chez les jumeaux que chez les enfants singletons.

Mots clés : *Jumeaux, Mortalité infanto-juvénile, Surmortalité, Facteurs associés, Statut social, Afrique subsaharienne*

1. Introduction

Twins are, compared to singletons, exposed to precarious health conditions and higher mortality rates, at least in the early periods of life (Ouedraogo 2020a). Indeed, twins are more likely to be premature and/or to have low birthweight (Schenker & al., 1981 ; Pison, 2000 ; Blondel, 2009 ; Bjerregaard-Andersen et al., 2014 ; Boubkraoui et al., 2016). In addition, compared to singleton deliveries, twin deliveries are more often prone to complications, which contributes to increased mortality of twin new-borns (Santana et al. 2018). Consequently, the under-five mortality rates (U5MR) are 2 to 3 times higher among twins than singletons (Morten Bjerregaard-Andersen et al., 2012 ; Blondel, 2009).

In the context of developing countries such as those in sub-Saharan Africa, where child mortality is still very high (e.g., “in 2017, half of all deaths under 5 years of age took place in sub-Saharan Africa”, WHO, 2018), twins' health is an additional challenge, the more so because this area has also the world's highest rates of twin births (Smits and Monden 2011). According to Guo & Grummer-Strawn (1993), in the developing countries, the death probabilities of twins were (at the end of the 1980s) almost 9 times higher in the first day of life compared to singletons. More recently, studying 60 developing countries in Africa, America,

Asia and Europe, Bellizzi & al. (2018) showed that in 2014 (all else being equal) twins were nearly 8 times more likely to die during their first week of life compared to singletons. After the first months of life, the difference in mortality between twins and singletons decreases, but seems to be maintained throughout childhood (Guo & Grummer-Strawn, 1993 ; Pison, 2000). According to the study of 30 countries in sub-Saharan Africa by Monden & Smits (2017), U5MR levels have declined sharply over the past 20 years. However, the relative differences in mortality rates between twins and singletons seem to be increasing over time, disfavoring twins. Indeed, over the period 1995–2014, the ratio between twins' U5MR and that of singletons in sub-Saharan Africa increased from 2.5 (328‰ vs. 129‰) to 3.4 (213‰ vs. 66‰). These findings reflect the poor health status of twins in the continent.

Nevertheless, the studies mentioned above have only rarely carried out analyses on the temporal dynamics of twins' excess mortality, including cross-country and sub-regional comparisons. This is the first aim of our approach. This work will also lead us to study how the under-5 excess mortality of sub-Saharan twins varies over age. Moreover, this study aims to make an in-depth analysis the factors associated with twins' excess mortality, considering the important role of biological and nutritional factors such as prematurity, weight and breastfeeding. In addition, there are other factors related to the socio-cultural status. Indeed, twin births can be influenced by some beliefs. For example, in Africa, some ethnic groups attribute a divine power to these children and they treat their coming as a source of happiness (Adler, 1973 ; Pison, 1989 ; Pons & al., 2007). Others, in contrast, see twin births as a curse and mistreat them or even go so far (formerly) as to eliminate them. (Pison, 1989 ; Mama, 2013). This can lead to disparities in the care provided to twins (Pison, 1989). For this reason, our analysis will lead us subsidiarily to investigate whether there are still ethnic disparities in twin mortality that would be dependent on their socio-cultural status?

2. Background

2.1. Some factors influencing twins' excess mortality

Here we review in more detail the main factors influencing twins' under-5 excess mortality: low birthweight, prematurity, insufficient breastfeeding, financial "extra cost" and the place of twins in society.

✚ Births often of low weight

Children weighing less than 2,5 kilograms at birth are classified as low birthweight (OMS, 2007). Twin births are the most concerned by low weight at birth (Daguet, 2002 ; INSERM,

2011 ; Hu et al., 2015); the survival probability of low-birthweight infants is highly compromised. Indeed, low birthweight (whose main factors are prematurity and foetal growth restriction) have health risks on children such as growth deficiency, susceptibility to infections, respiratory problems, neurological problems and behavioural disorders (Wardlaw et al, 2004; Almond et al, 2005). As a result, their risks of morbidity, disability and mortality are increased, especially in the early months of life (Wardlaw, World Health Organization, and UNICEF 2004).

Births that are frequently premature

Any birth occurring before 37 weeks of pregnancy is considered to be premature (Chiwanga et al., 2014 ; Quinn et al., 2016 ; Chabra, 2016 ; WHO, 2018). Twin births are undeniably subject to greater risks of prematurity than singletons (Chauhan et al., 2010 ; Makrydimas & Sotiriadis, 2014). For example, out of 137,085 twins born in 2006 in the USA, 58% were preterm births compared to 11% for singletons (Chauhan et al., 2010). According to Couvert (2011), this high frequency of preterm birth in twins may be explained by constraints of space, contiguity and relative position imposed by the simultaneous development of two fetuses in the uterus. This makes prematurity one of the main causes of perinatal death, morbidity and, in the long term, neurological deficiencies, especially in twins (Althabe et al, 2012 ; Makrydimas & Sotiriadis, 2014 ; Hu et al., 2015). For example, a child born in the 25th week of pregnancy has 50% more risk (than a child born in the 37th week) to die in his or her first few months of life (Costeloe et al., 2000), and nearly 50% of those who survive may face serious disabilities in childhood (Marlow et al., 2005).

Unfortunately, due to lack of information in our data, prematurity will not be particularly analysed in this study.

A difficult breastfeeding

Twins weakened by low birthweight or prematurity may not always have the strength to breastfeed. This leads to insufficient or inadequate breastfeeding, which makes them even more susceptible to infections (Mabiala-Babela et al., 2008). Moreover, in the event of deterioration in the health status of the mother and/or children resulting from, for example, a complicated delivery, mothers of twins are not always able to practice a correct breastfeeding (Guo and Grummer-Strawn 1993). Therefore, they sometimes resort to artificial breastfeeding, which is associated with a high risk of morbidity and mortality for twins (Mabiala-Babela et al., 2008). These children are then frequently deprived of exclusive breastfeeding, which is an important

source of antibodies and essential nutrients against infections and nutritional deficiencies (Hendrik van der POL 1989).

Children involving financial "extra costs"

Many health resources are needed, particularly in sub-Saharan Africa, for the care of twins. These include: rapid diagnosis of the twin pregnancy, proper antenatal care, safe delivery and special post-natal care for preterm and low birthweight children and their mothers (Luke et al., 2003 ; Jahn et al., 2006 ; Morten Bjerregaard-Andersen et al., 2012 ; Akaba et al., 2013). These actions are financially expensive for society (Almond et al., 2005). Moreover, for parents, a twin birth generates a doubling (or even more) of the health and non-health expenses usually incurred for the care of a new-born (Bernat, 2010). However, health and non-health care (whether individual or institutional) are more difficult to achieve in low-income countries, where poverty is one of the causes of high child mortality (Rao et al., 1983). Not only do the health systems in these countries lack the necessary resources to carry out these tasks, but also the people do not usually make diligent use of the health services that can help anticipating possible complications of twin pregnancies.

A socio-cultural status that can cause discriminations

As explained in the introduction, beliefs and traditions related to twin births can lead to their rejection. Therefore, the socio-cultural status of the twin (which can be understood through ethnic customs and beliefs towards the twin) is seen as a factor that can create discriminations in health care, nutrition and "parental protection" (Pison, 1989).

2.2. Two types of twins that DHS does not allow to make a distinction

There are two main types of twins: monozygotic (MZ) or identical twins and dizygotic (DZ) or fraternal twins (Hall, 2003). Monozygotic twins are the product of the fertilization of a single egg by a single sperm, the egg splitting in two in the first days after fertilization. These twins are necessarily of the same sex and have an identical genotype. The MZ twinning rate is constant around 3.5 to 4%, regardless of the woman's age, birth rank (birth order number) and geographical or ethnical origin (Pison, 2000; Long & Ferriman, 2016). Dizygotic twins, on the contrary, are the product of the fertilization of two different eggs by two distinct spermatozoa. Unlike monozygotic twins, dizygotic twins are almost like any two brothers and sisters, in that they have the same sex (or not) in the same proportion as any couple of brothers and sisters. The frequency of deliveries of dizygotic twins varies under the influence of several factors,

mainly the mother's age, birth order, and geographical area (Bulmer, 1970 ; Pison, 1989). Sterility treatments also have an effect on dizygotic twin rates (Pison et al., 2015).

The literature shows that there is a difference in mortality between these two types of twins (van den Berg and Drepper 2018). Unfortunately, DHS data do not allow a distinction to be made between fraternal and identical twins. Consequently, this work cannot take into account a possible difference in excess mortality between fraternal and identical twins (relative to singletons) in sub-Saharan Africa.

3. Materials and Methods

3.1. Data

3.1.1. Data sources

This article uses data from national surveys carried out between the years 1986 and 2016 in 42 sub-Saharan African countries¹ (the list of countries and surveys is available in **Appendix I**). These data come from two sources. The first source is the Demographic and Health Surveys (DHS). The DHS program is coordinated by the United States Agency for International Development (*USAID*). The second data source is the Multiple Indicator Cluster Survey (MICS), conducted by the United Nations Children's Fund (UNICEF). In total, data from 156 surveys were used (including 140 DHS and 16 MICS); and depending on the country, the number of surveys (DHS and MICS combined) used ranged from 1 to 10. The DHS and MICS are all retrospective cross-sectional surveys with national coverage. They collect information that can be used to reconstruct the reproductive histories of the women of childbearing age (15-49), as well as information on the health and survival of their children. A variable specifying twin births exists in almost all the databases. However, in cases where this variable is not available, we have created it using a matching method that uses the IDs, years, months, and days of births of children and their mothers.

3.1.2. Description of data use

There were two main uses of the data: the computation of under-5 mortality rates and the multivariate analysis of twins' excess mortality associated factors. The U5MRs were computed for all 156 surveys. This computation included (for each survey) all the deaths before the age of 5 years old that occurred during the 5 years prior to the data collection. It should be noted

¹ List of sub-Saharan African countries for which no surveys were available: Botswana, Cape Verde, Equatorial Guinea, Eritrea, Mauritius, and Seychelles.

that a selection based on the 10 years preceding the survey was another possible choice. However, we chose 5-years preceding the survey option because, on the one hand, this choice allows us to have U5MRs that are closer to the real mortality level at the time of the survey. On the other hand, given that these are retrospective surveys, we believe that the longer the period considered, the greater the risk of omissions and under-reporting of deaths. Thus, the dataset we have selected included 2,425,072 children of which 3.47% (84,047) were born from twin pregnancies and 0.06% (1,491) are triplets or more. In total, 10.93% of the children had died before the age of five; of these, 11.58% corresponded to singletons, 28.85% to twins and 58.95% to triplets & more.

To enrich our analysis of the dynamics of twins' excess mortality, we also constructed age-specific mortality curves between ages 0 and 5 over different time periods. The aim of the approach was to observe the evolution of twins' excess mortality by age over time. The periods compared were the 1990s (1990-1999), the 2000s (2000-2009) and the 2010s (2010-2016). For this purpose, we selected countries that had carried out at least one survey in each of the three defined periods. This allows us to analyse (for each of these countries and also on an aggregated basis) the changes from one decade to the next. This approach involved 72 surveys from 24 countries, i.e., 3 surveys per country (one survey per decade and per country).

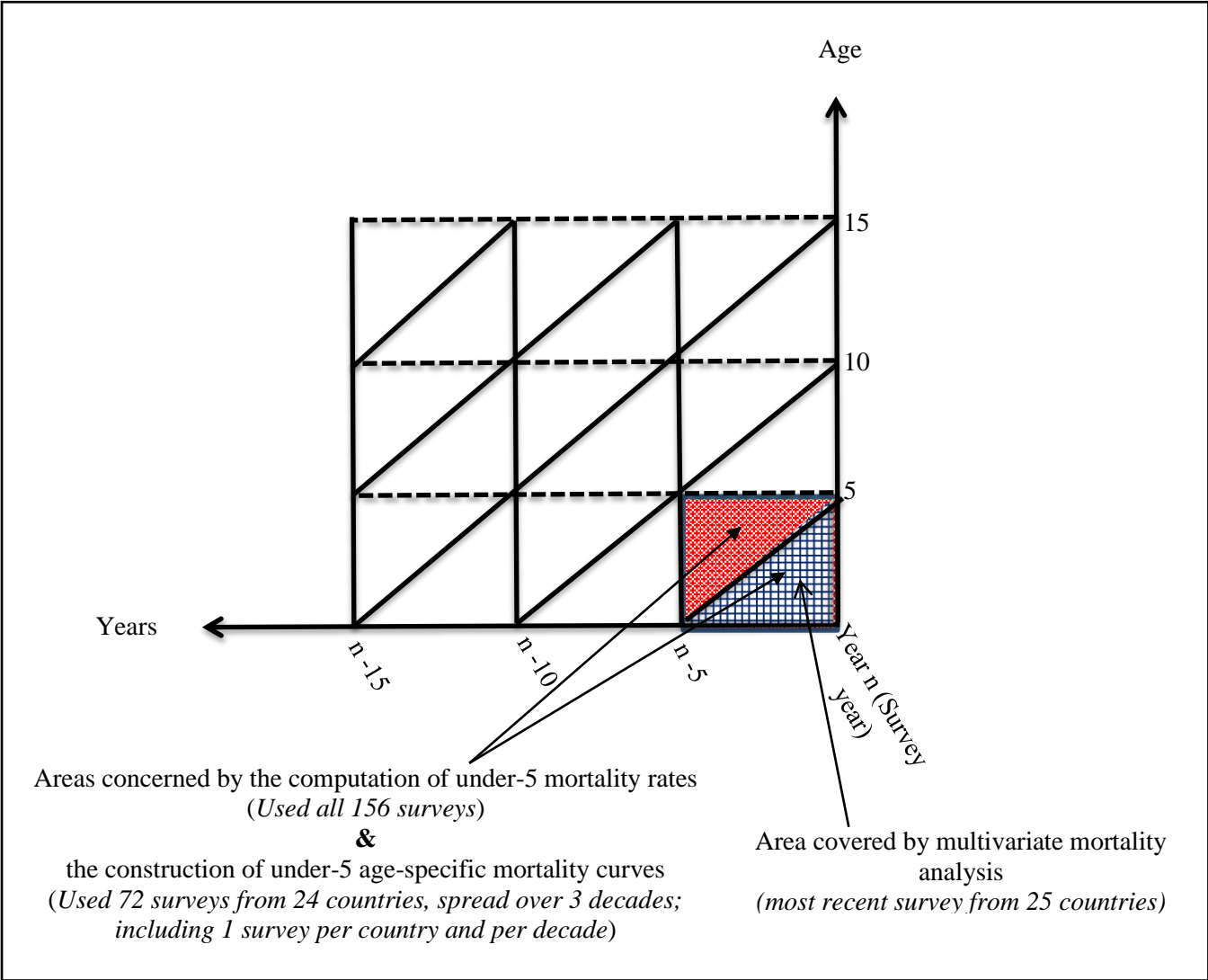
The multivariate analysis of the factors associated with twins' excess mortality involved part of the 156 surveys. In fact, it included only the most recent survey in each country. This analysis therefore involved 25 separate surveys in 25 countries² for which information on the mother's ethnicity and on a number of biomedical variables (birthweight in particular) is available. In order to be able to include a large number of variables, we decided to restrict the number of surveys included in the multivariate analysis. Thus, the surveys considered were all carried out between 2010 and 2016. It should also be noted that this multivariate analysis concerned the deaths before the age of 5 years, occurring within the generation of children born during the 5 years preceding the survey (generational cut). Indeed, the biomedical variables (birthweight, antenatal visits, caesarean section, etc.) are only collected by DHS and MICS on the births that occurred in the 5 years preceding each survey. Hence the limitation to the generation of children born during the 5 years preceding each survey. A total of 278,706 children were involved in

² Benin 2014, Burkina Faso 2010, Cameroon 2014, Chad 2014, Congo 2011, Congo DR 2013, Cote d'Ivoire 2011, Gabon 2012, Gambia 2013, Ghana 2014, Guinea 2012, Guinea-Bissau 2014, Kenya 2014, Liberia 2013, Malawi 2015, Mali 2012, Mauritania 2011, Mozambique 2011, Nigeria 2016, Uganda 2011, Sao Tome 2014, Senegal 2016, Sierra Leone 2013, Togo 2013, Zambia 2013.

this analysis, including 268,032 singletons and 10,674 twins, with 17,133 (6.4%) deaths among singletons and 2,362 (22.1%) deaths among twins.

The Lexis diagram below (Figure 1) is a schematic representation of all the deaths covered by the two main types of analysis described above.

Figure 1: Lexis diagram explaining the deaths concerned by each analysis



Source: authors' construction.

3.1.3. Overview on data quality

One of the major challenges in carrying out quantitative studies using data from several countries, particularly in sub-Saharan Africa, is the quality of the collected data.

The DHS in particular have many data quality problems in terms of the accuracy of some of the information collected (current age, age at death, etc.) and the presence of many missing data. Such problems are known in all the DHS and particularly in the DHS of sub-Saharan African

countries. This is why this work should be classified as a study carried out in a context of imperfect data. Consequently, the computation of mortality rates has used a method (DHS measure method) that is built to be adapted to this context of imperfect data (see part 3.2.1 below for more information). The presence of important missing data is another DHS data quality problem. For this reason, we have, in the analytical part of the study, adopted a treatment that takes into account their importance in the analysis model (see part 3.2.2 below for more information).

In addition, in order to assess more the data quality, we evaluated the following issues: the reporting of age at death; the reporting of the twin births; and the lack of information on stillbirths in the data.

The age-at-death accuracy assessment consisted in the analysis of age heaping at specific ages at death (12 months, 24 months, 36 months and 48 months). It enabled us to note the existence of peaks of deaths at the relevant ages at death. These peaks are greater among singletons than twins, but these differences are not likely to make a significant impact on the quality of the comparative analysis between twins and singletons.

In order to assess the accuracy of the reporting of twin births, we used a matching method. Indeed, starting from the principle that (in our data) two children with the same mother ID and the same birth dates (or birth dates a few days apart) are twins, we built a second 'twin' variable (the first one being provided by the survey). Then, we compared the numbers of twin births resulting from this second variable with those provided by the surveys. In this way, we were able to confirm the good reporting of twinning statement.

Furthermore, it should be noted that DHS and MICS do not collect information on stillbirths. This leads to an underestimation of mortality rates and an underestimation of twins' excess mortality. Indeed, the proportion of twin births is probably slightly higher among stillbirths than among live births (Smits and Monden 2011). However, this situation is not likely to compromise child mortality studies using DHS data (Monden & Smits, 2017).

3.2. Methods

3.2.1. Estimation of the mortality rates

To estimate the mortality rates, we used a method proposed by Measure DHS (the project that coordinates the technical component of the DHS program). First of all, it should be noted that the under-5 mortality rate (U5MR) is defined as the probability that a new-born dies before reaching age 5 (Tabutin 1977). The method proposed by Measure DHS to estimate the U5MR

is an adaptation of Rutstein's (1984). According to this method, the U5MR is obtained by combining the death probabilities from the following 8 age intervals: less than 1 month, 1-2 months, 3-5 months, 6-11 months, 12-23 months, 24-35 months, 36-47 months and 48-59 months. It defines the probability of death for any given age interval as the ratio between the number of deaths among children who were exposed to die (within that age interval) and the total number of children of that age interval (Rutstein 1984).

Pragmatically, we used a SAS macro built by Atwood & Thomson (2012) which is the adaptation of another macro created by Keith Purvis (from Measure DHS) in 1995 and a STATA programme created in 2010 by Kenneth Hill (from the Harvard School of Public Health). Using Rutstein's (1984) method presented above, Atwood & Thomson's macro SAS called DHS_U5M (DHS under 5 mortality) calculates the probability of survival for each sub-interval and aggregates them to get the U5MR using the following formula:

$${}_{(n)}q(x) = 1 - \prod_{i=x}^{i=x+n} (1 - q(i))$$

where ${}_{(n)}q(x)$ is the mortality rate between ages x and $x+n$ (i.e., the U5MR if age is between 0 and 5 years), and $q(i)$ is the subinterval probability of death (Atwood and Thomson 2012).

However, the method presented above is only suitable for calculating mortality rates for the following periods: neonatal (less than one month), post-neonatal (1-12 months), infant (0-12 months), juvenile (12-60 months) and under-five (0-60 months). It is not suitable for estimating mortality rates by age. Consequently, to construct age-specific mortality curves for ages 0-5, we used the actuarial life table method. This method allows us to determine for a given age interval, $[x; x+n[$ (x = age and n = interval length), the probability for an individual living at the beginning of the interval to die before the end of the interval. This allows us to have mortality rates by age. Ideally, these age-specific mortality curves would have been constructed using the month as the unit of measure of age. However, the numbers were very low (especially for twins), so we opted for the year.

3.2.2. *Methods for analysing the factors associated with twins' excess mortality*

The basic principle underlying our analysis of the factors associated with twins' excess mortality (between 0 and 5 years of age), is to determine which variables would 'account for' the difference in mortality risks between twins and singletons. Several methods can help answering this question. Among them, regression methods involving a dependent qualitative variable (e.g., logistic regressions, Cox regression) are more appropriate. Our dependent variable is the death

or not of the child before the 5th birthday. Among the independent variables, the child profile variable (twin/singleton), which is the main variable of interest, can be introduced first in the model. Then, by sequentially adding the other variables or groups of variables, we can see their effects on the differential of mortality risk ratio³ between twins and singletons. Naturally, the statistical relevance⁴ of each step model must be better than the previous one to be valid. Thus, it is possible to know which variables or group of variables have an independent effect on the variable of interest (twin/singleton), all else being equal.

It should be noted that interaction effects between the explanatory variable of interest and the other explanatory variables constitute another approach to study the factors associated with twins' excess mortality. This approach was combined with the one described above.

For the present study, we opted for Cox regression, which is a survival analysis that fits our data. Here, it expresses the probability of death in a small interval of time, Δt , just after t , knowing that the death had not occurred up to t (in our Cox model, the time is expressed in months)⁵.

Regarding the choice of the explanatory variables, there are three important steps to consider. The first is the flat sorting stage (univariate analysis). It allows us to know what information is available on each variable and to know what kind of coding or re-coding of these variables is to be expected. The second stage consists of cross-sorting (bivariate analyses) between the dependent variable and each of the potential explanatory variables. This makes it possible to highlight the "primary" links between the dependent variable and each variable being explored. For this, we used "bivariate" Cox regressions, i.e., a Cox regression between each explanatory variable taken separately and the dependent variable. The effects obtained at this stage were so-called unadjusted effects (unadjusted HR). It is also during this second stage that we validated the proportionality hypothesis of the Cox model. The third and last stage in the choice of our explanatory variables is the selection stage. This selection is made according to a step-by-step bottom-up procedure, based on the Akaike information criterion (AIC). Besides the main explanatory variable of interest (twin/singleton), the other explanatory variables selected (control variables) are divided into four groups: biomedical and nutritional variables (birthweight, caesarean section, antenatal visits and breastfeeding), demographic variables

³ Odds Ratio (OR) if it is a logistic regression and Hazard Ratio (HR) if it is a Cox regression.

⁴ This relevance can be measured by a lower Akaike information criterion (AIC) or by a smaller -2 Log L ($-2 \text{ Log-likelihood}$).

⁵ For more details on the Cox model, see the following article:
<https://www.sciencedirect.com/topics/mathematics/cox-model>

(mother's age, birth order, child's sex, mother's marital status, sub-region and child's year of birth), socio-economic variables (household's wealth quintile and urban/rural residence) and socio-cultural variables (mother's education level, the desirability of the pregnancy and the socio-cultural status of the twin according to the mother's ethnicity ⁶).

Furthermore, in the implementation of the model, missing values were treated in two ways. The first consisted in removing them when we assumed that these represented a very small share. The second consisted in keeping them as a separate category in the variables where the share of missing values is substantial (see **Table 1**).

4. Main Results

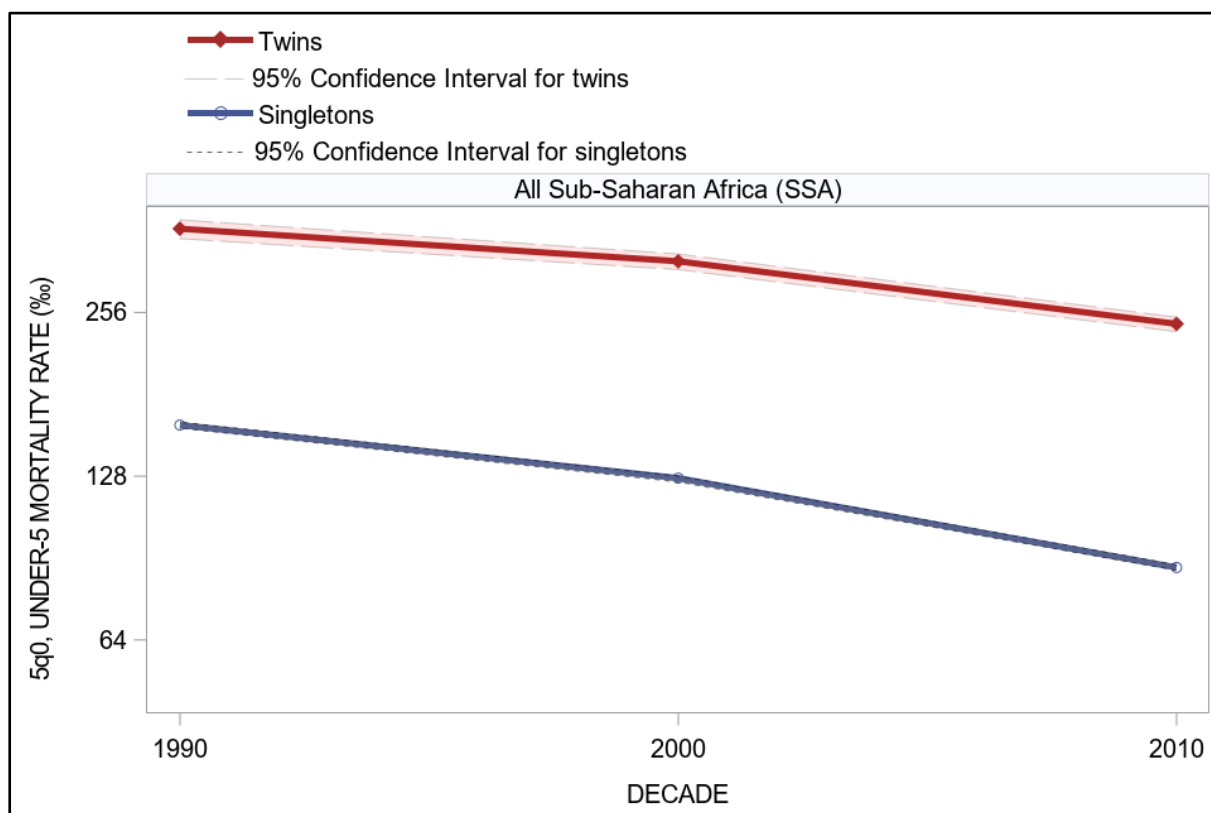
4.1. Spatial and temporal variations in the differential of U5MR between twins and singletons in sub-Saharan Africa

Aggregate results show that between 1990 and 2010, U5MRs fell considerably in sub-Saharan Africa, for both twins and singletons. In fact, during that period, they were divided by 1.8, from 166‰ to 93‰. However, the ratio between twins' U5MR and that of singletons (i.e., twins' excess mortality) has not decreased. It has even increased over time, rising from 2.3 (365‰ ÷ 159‰; CI=2.2 - 2.4) in the 1990s to 2.8 (244‰ ÷ 87‰; CI=2.7 - 2.9) in 2010s (see **Figure 2**).

⁶ The variable 'socio-cultural status of the twin' was based mainly on work by Gilles Pison (1987), which categorised ethnic groups in sub-Saharan Africa into three groups according to their traditional behaviour towards twins: (i) those who appreciated them, (ii) those who rejected them, and (iii) those who accepted them but feared them (ambivalent). We then conducted a literature search to generalise this classification across all the ethnic groups present in our analyses (see **Appendix 2**).

⁷ 95% confidence interval.

Figure 2: Change from 1990 to 2010 in U5MR in sub-Saharan Africa - aggregated data from 42 countries

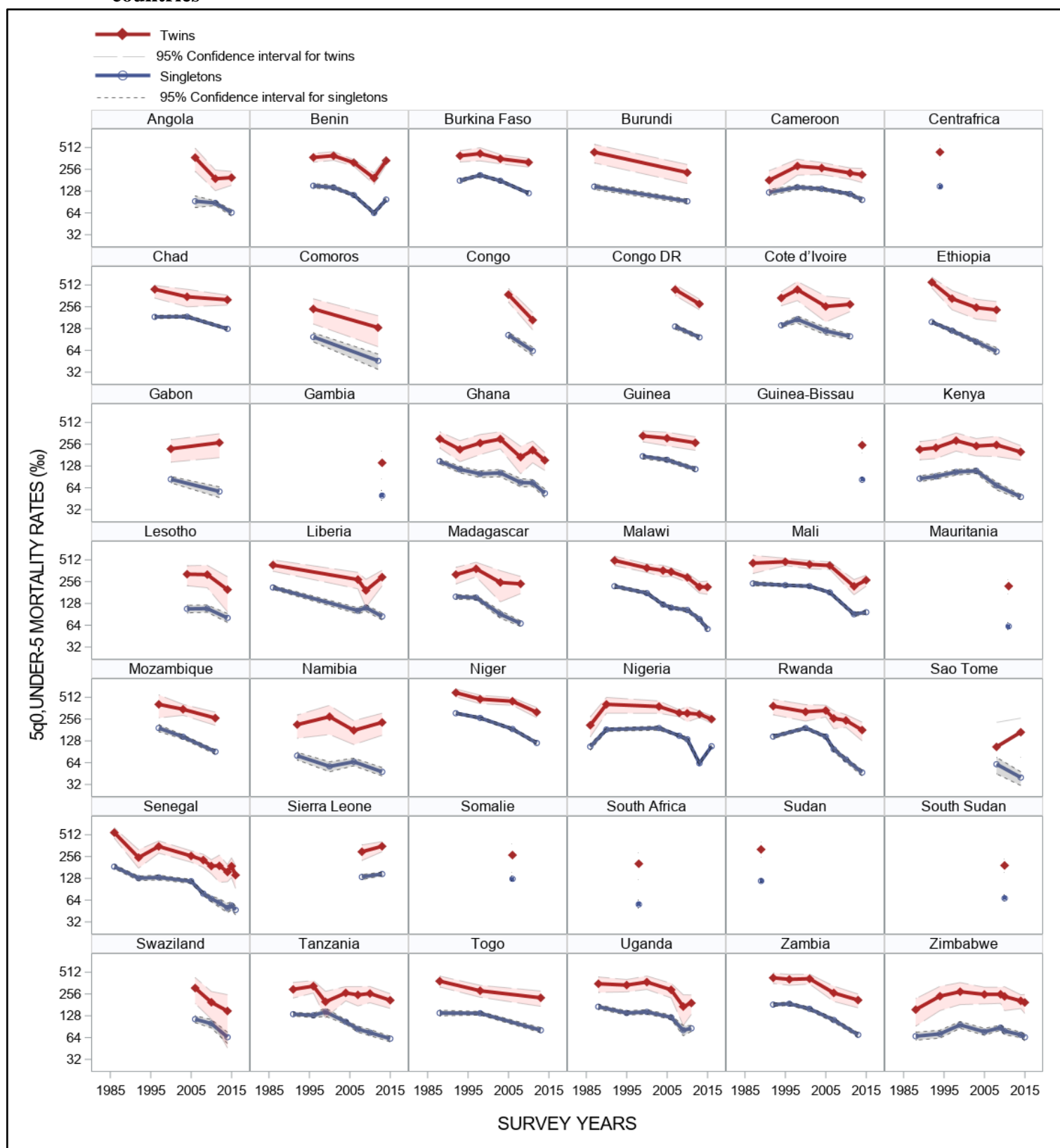


Source: DHS & MICS; author's construction.

The disaggregated results (by country) confirm the aggregate results by showing that, even if U5MRs have decreased significantly between the 1990s and 2010s, their levels remain very high. However, compared to singletons, twin children, have U5MRs that are on average three times higher. Moreover, this excess mortality among twins is increasing in almost all countries. Figures 3 and 4 below (see also **Appendix I**) illustrate this point by presenting, for each country, the evolution of twin and singleton mortality rates (

Figure 3) and also the changes in the ratio of twins' U5MR to that for singletons (**Figure 4**). It is important to note that twins' excess mortality is not necessarily a function of mortality levels, but rather of the importance of the differences in the mortality rates between twins and singletons. When the ratio of twins' mortality rate to that for singletons is greater than unity, there is excess mortality among twins; when it is below unity, there is an under-mortality of twins; when it is equal to unity, there is no difference in mortality between twins and singletons.

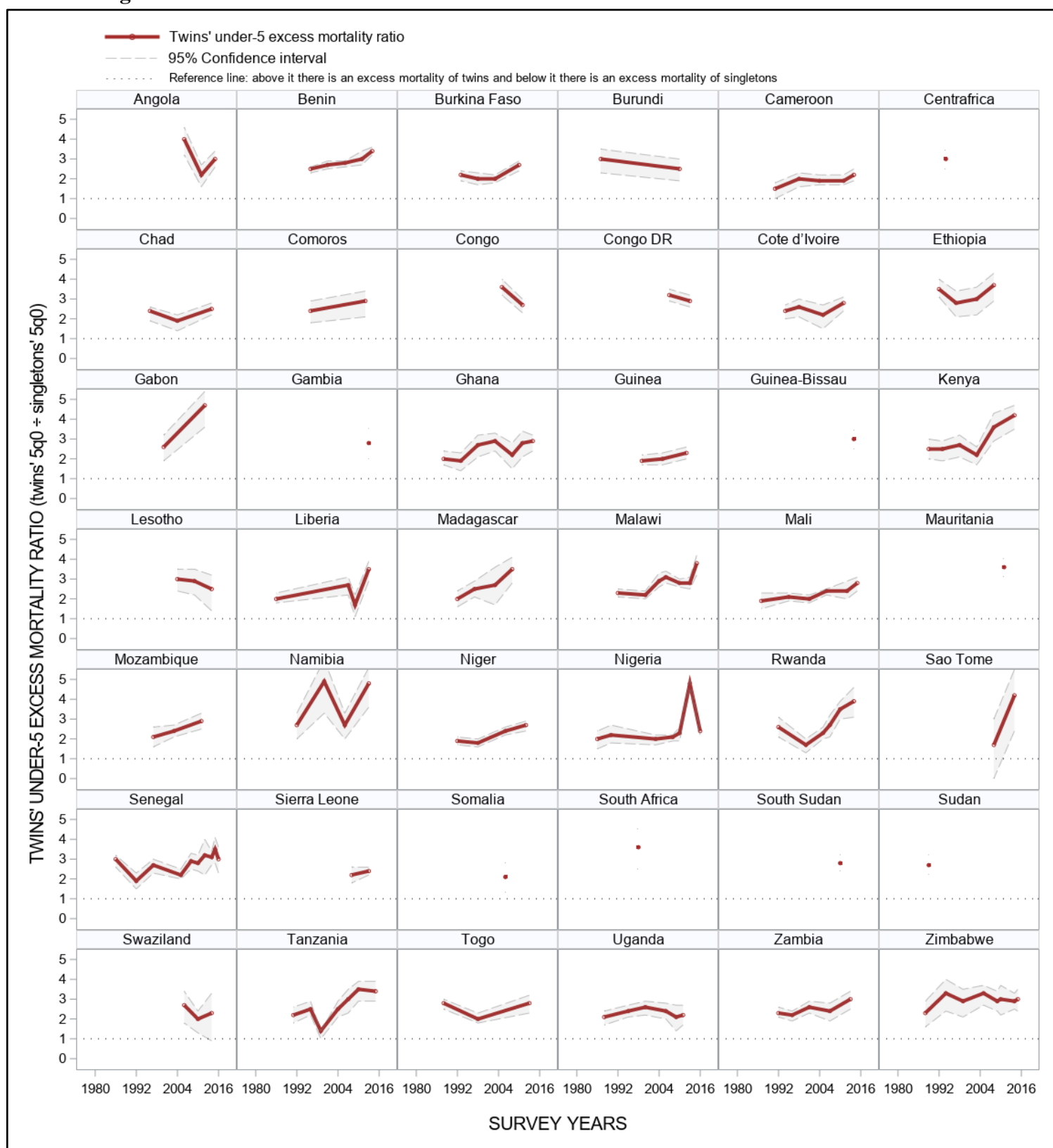
Figure 3: Spatial and temporal variations in U5MR in 42 sub-Saharan African countries^a



^a The unique points concern countries that have only one survey in our data.

Source: DHS & MICS; author's construction.

Figure 4: Spatial and temporal variations in the ratio of twins' U5MR to that for singletons in 42 sub-Saharan African countries ^a



^a The unique points concern countries that have only one survey in our data.

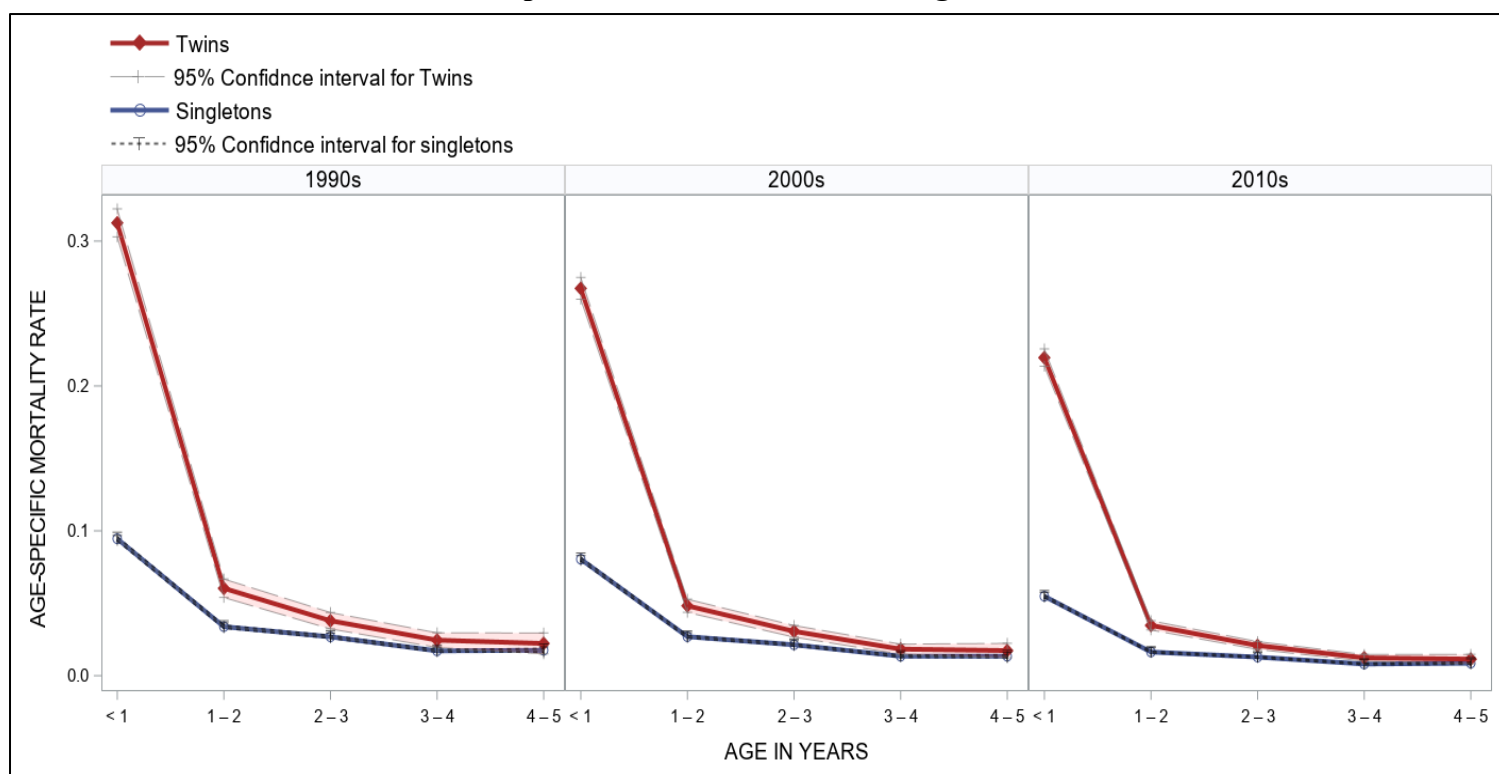
Source: DHS & MICS; author's construction.

4.2. Under-five age-specific mortality curves in sub-Saharan Africa

Using only national surveys conducted during the decades of 1990, 2000 and 2010, and considering only those countries that have carried out at least one survey during each of these three decades, here we describe the evolution of the mortality rates by age (between ages 0 and 5). This analysis covers 24 countries⁸ and here we present the aggregated results (Figure 5). The specific ages at death analysed are: <12 months old, 12-24 months old, 24-36 months old, 36-48 months old and 48-60 months old.

Figure 5 shows that the difference in mortality rates between twins and singletons is very large at the very early stage of life, but it decreases fast with age. After the second year of life, the differences become very small, without disappearing completely. From one decade to the next, the mortality level decreases at all ages for both twins and singletons. However, the amplitude of the differences in mortality by age between twins and singletons seems to remain unchanged from one decade to the next.

Figure 5: Age-specific mortality curves between ages 0 and 5 in sub-Saharan Africa: comparison between twins and singletons



Source: DHS & MICS; author's construction.

⁸ Benin, Burkina Faso, Cameroon, Chad, Cote d'Ivoire, Ethiopia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

4.3. Factors associated with excess mortality among twins between ages 0 and 5

The results of the univariate, bivariate and multivariate analysis of the factors associated with twins' excess mortality are presented in **Table 1**.

Table 1: Factors associated with twins' excess mortality. Results of the univariate, bivariate and multivariate analyses

Variables	Number		Bivariate (unadjusted) HR		HR adjusted with:							
					(1) = Twinning variable + biomedical and nutritional variables		(2) = (1) + demographic variables		(3) = (2) + socio- economic variables		(4) = (3) + socio- cultural variables	
					N	%	HR	95% CI	HR	95% CI	HR	95% CI
Twinning												
Twin	10 674	4	3.9***	3.7 – 4.0	3.15***	2.97 – 3.33	3.09***	2.91 – 3.27	3.12***	2.94 – 3.30	3.12***	2.94 – 3.31
Singleton	268 032	96	ref		ref		ref		ref		ref	
Birthweight												
<2.5 Kg	1 101	0.4	4.6***	4.0 – 5.4	2.93***	2.54 – 3.38	2.88***	2.50 – 3.32	2.92***	2.53 – 3.37	2.97***	2.57 – 3.43
≥2.5 Kg	114 503	41	ref		ref		ref		ref		ref	
Missing values ^{keep}	163 102	59										
Caesarean section												
Yes	10 712	4	1.13***	1.1 – 1.2	1.28***	1.18 – 1.38	1.35***	1.24 – 1.46	1.39***	1.28 – 1.51	1.41***	1.30 – 1.52
No	220 881	79	ref		ref		ref		ref		ref	
Missing values ^{keep}	47 113	17										
Ante-natal care												
No ante-natal visit	13 246	5	1.6***	1.5 – 1.7	1.22***	1.14 – 1.32	1.16***	1.07 – 1.25	1.13**	1.05 – 1.22	1.13**	1.04 – 1.21
1 or 2 visits	23 006	8	1.2***	1.1 – 1.3	1.12***	1.07 – 1.19	1.09***	1.03 – 1.16	1.08*	1.01 – 1.15	1.06*	1.00 – 1.13
3 or more ante-natal	141 502	51	ref		ref		ref		ref		ref	
Missing values ^{keep}	100 952	36										
Breastfeeding												
Yes	269 999	97	ref		ref		ref		ref		ref	
No	8 333	3	7.9***	7.6 – 8.2	7.01***	6.72 – 7.31	6.83***	6.55 – 7.13	6.87***	6.59 – 7.16	6.70***	6.42 – 7.00
Missing values ^{supp}	374	0.1										
(Twinning) x (Caesarean section)												
Twin vs Singleton / (when caesarean section = no)					3.15***	2.97 – 3.33	3.08***	2.90 – 3.27	3.12***	2.94 – 3.30	3.10***	2.90 – 3.31

Twin vs Singleton / (when caesarean section = yes)			1.72***	1.44 – 2.05	1.72***	1.44 – 2.04	1.74***	1.46 – 2.07	1.75***	1.47 – 2.08
(Twinning) x (Breastfeeding)										
Twin vs Singleton / (when breastfeeding = yes)			3.14***	2.97 – 3.30	3.10***	2.90 – 3.30	3.11***	2.90 – 3.30	3.12***	2.95 – 3.31
Twin vs Singleton / (when breastfeeding = no)			3.80***	3.47 – 4.16	3.79***	3.46 – 4.16	3.88***	3.54 – 4.25	3.90***	3.56 – 4.28
Mother's age										
< 20 years old	46 145	17	ref		ref		ref		ref	
20 - 25 years old	73 983	27	0.8***	0.7 – .83	0.80***	0.76 – 0.84	0.81***	0.77 – 0.85	0.82***	0.78 – 0.86
25 - 30 years old	69 027	25	0.7***	0.7 – 0.8	0.64***	0.61 – 0.68	0.66***	0.63 – 0.70	0.68***	0.64 – 0.72
30 - 35 years old	48 119	17	0.8***	0.7 – 0.8	0.60***	0.56 – 0.64	0.62***	0.58 – 0.66	0.65***	0.61 – 0.69
>=35 years old	41 432	15	0.9**	0.9 – 1.0	0.63***	0.59 – 0.67	0.66***	0.61 – 0.70	0.69***	0.64 – 0.74
Birth order										
1	57 444	21	0.8***	0.8 - 0.8	0.66***	0.62 - 0.70	0.70***	0.65 - 0.74	0.72***	0.67 - 0.77
2	51 116	18	0.7***	0.6 – 0.7	0.58***	0.55 – 0.62	0.61***	0.57 – 0.64	0.62***	0.59 – 0.66
3	43 968	16	0.7***	0.6 – 0.7	0.62***	0.58 – 0.65	0.64***	0.60 – 0.67	0.65***	0.61 – 0.69
4	36 881	13	0.7***	0.6 – 0.7	0.66***	0.63 – 0.70	0.67***	0.64 – 0.71	0.68***	0.65 – 0.72
5	29 202	10	0.8***	0.7 – 0.8	0.76***	0.72 – 0.81	0.77***	0.73 – 0.81	0.77***	0.73 – 0.82
>=6	60 095	22	ref		ref		ref		ref	
Child's sex										
Male	141 190	51	1.2***	1.1 – 1.2	1.20***	1.16 – 1.23	1.20***	1.16 – 1.23	1.20***	1.16 – 1.23
Female	137 516	49	ref		ref		ref		ref	
Mother's marital status										
Never married/union	13 934	5	0.9	0.8 – 1.0	1.04	0.97 – 1.12	1.06	0.99 – 1.15	1.13**	1.05 – 1.22
Married/union	246 270	88	ref		ref		ref		ref	
Widowed or divorced	18 453	7	1.1**	1.0 – 1.2	1.24***	1.17 – 1.31	1.23***	1.18 – 1.32	1.27***	1.21 – 1.34
Missing values ^{supp}	49	0								
Sub-region										
Western Africa	146 142	52	ref		ref		ref		ref	
Eastern Africa	59 448	21	0.7***	0.6 – 0.7	0.74***	0.70 – 0.78	0.73***	0.70 – 0.76	0.77***	0.73 – 0.81
Central Africa	62 014	22	1.0	0.9 – 1.0	0.90***	0.87 – 0.93	0.91***	0.87 – 0.94	0.89***	0.86 – 0.93
Southern Africa	11 102	4	1.0	0.9 – 1.0	1.05	0.97 – 1.12	1.04	0.97 – 1.12	0.98	0.92 – 1.06
Year of birth										
Year	278 706	100	1.0*	0.9 – 1.0	1.03***	1.02 – 1.04	1.03***	1.02 – 1.04	1.03***	1.02 – 1.04
Wealth quintile										
1st quintile	71 548	26	1.4***	1.4 – 1.5			1.07*	1.01 – 1.14	1.03	0.97 – 1.09
2nd quintile	61 732	22	1.5***	1.4 – 1.5			1.15***	1.08 – 1.21	1.11***	1.05 – 1.18

3rd quintile	54 458	20	1.4***	1.3 – 1.4			1.12***	1.06 – 1.18	1.09**	1.03 – 1.16
4th quintile	49 040	18	1.2***	1.2 – 1.3			1.09**	1.04 – 1.16	1.07*	1.02 – 1.13
5th quintile	41 928	15	ref				ref		ref	
Urban/Rural area of residence										
Urban	84 512	30	ref				ref		ref	
Rural	194 194	70	1.3***	1.2 – 1.3			1.09***	1.05 – 1.13	1.05*	1.01 – 1.09
Socio-cultural status of twins										
Favourable	52 907	19	ref						ref	
Unfavourable	14 363	5	0.6***	0.5 – 0.7					0.85***	0.77 – 0.93
Ambivalent/other	200 419	72	1.0***	1.0 – 1.0					1.07**	1.03 – 1.11
Missing values ^{keep}	11 017	4								
Mother's education level										
None	115 012	41	1.6***	1.5 – 1.6					1.13***	1.07 – 1.18
Elementary school	99 459	36	1.3***	1.3 – 1.4					1.13***	1.08 – 1.18
Middle school or more	64 218	23	ref						ref	
Missing values ^{supp}	17	0								
Desired pregnancy										
Yes	185 970	67	ref						ref	
No, have another later	46 067	17	0.8***	0.8 – 0.9					0.94**	0.90 – 0.98
No, unwanted pregnancy	12 883	5	0.8***	0.7 – 0.9					0.81***	0.75 – 0.87
Missing values ^{keep}	33 786	12								
-2 Log-Likelihood (-2 Log L)					467742.29	466619.51	466536.92	466536.92		
Akaike information criterion (AIC)					467766.29	466672.51	466602.92	466602.92		

HR =Hazard Ratio; CI= Confidence Interval; ***=1%, **=1% et *=5 %; ref = reference parameter; ^{keep}: missing values retained as a modality of the variable; ^{supp}: removed missing values.

Source: DHS et MICS; authors' calculation.

4.3.1. *Sample description*

As indicated before, the sample used to analyse the factors associated with twins' excess mortality involved a total of 278,706 children, including 4% of twins and 96% of singletons. The percentage of deceased children was 7% overall. However, it was 22% among twins and 6.4% among singletons. The sample's description regarding the other covariates is provided below (see also **Table 1**).

Biomedical and nutritional covariates

Regarding birthweight, 41% of the children in the sample weighed more than 2.5 kg, 0.4% weighed less than 2.5 kg, and missing values represented 59% (kept in the model). Concerning birth by caesarean section, it concerned 4% of the children in our sample; 79% of the children were born by vaginal births and missing values represented 17% (kept in the model). Moreover, 97% of the children were breastfed, compared to 3% who were not. Regarding antenatal care, 51% of the mothers reported having at least 3 antenatal visits; 5% had no visits; 8% had 1 or 2 visits; and 36% were missing values (kept in the model).

Demographic covariates

In the sample, 49% of the children were female; 45% were of birth order higher than 3; 43% were children whose mothers were under 25 years old; 88% were children of women in union; 4% of the children were from Southern Africa, 22% from Central Africa, 22% from East Africa and 52% from West Africa.

Socio-economic covariates

The sample consisted 48% of children living in very low or low-income households, those living in high or very high-income households represented 33%. In terms of place of residence, 70% of the sample was constituted of children living in rural areas.

Socio-cultural covariates

Regarding desirability, 67% of the children were desired by their mothers, 17% were desired for later, 5% were unwanted and 12% were missing values (kept in the model). Concerning the mothers' education level, 41% of the children were from mothers with no education, 36% from mothers with primary education level, and 23% from mothers with secondary or higher education level. Regarding the socio-cultural status of twins, 72% of the children in our sample had mothers from ethnic groups that used to be ambivalent towards twins (accepting them with great fear). The proportion was 5% for children whose mothers belonged to ethnic groups that

traditionally abhorred twins; it was 19% for children whose mothers belonged to ethnic groups that worshipped twins; and 4% were missing values (kept in the model).

4.3.2. *Factors associated with twins' excess mortality*

Child mortality risk factors (twins as well as singletons)

Our results (presented in **Table 1**) show that the following factors are associated with significant risks of under-five death in sub-Saharan Africa (years 2010)⁹: being a twin (HRa¹⁰=3.1; p<0.001); birthweight under 2.5 kg (HRa=3.0; p<0.001); caesarean delivery (HRa=1.4; p<0.001); no antenatal visits (HRa=1.13; p<0.01); no breastfeeding (HRa=6.7; p<0.001); male children (HRa=1.2; p<0.001); high birth order (HRa of order 6 or more is 28% higher than that of order 1; p<0.001); a very young mother (HRa of mothers under 20 years of age is at least 20% higher than that of mothers in other age groups; p<0.001); a single mother (HRa=1.13; p<0.01) or divorced/widowed (HRa=1.27; p<0.001); living in West Africa (HRa is at least 10% higher); living in a very low-income household (HRa=1.11; p<0.001); a mother with primary education level or less (HRa=1.13; p<0.001).

Factors associated with twins' excess mortality in sub-Saharan Africa

The results of the Cox model (see **Table 1**) show that in sub-Saharan Africa in the 2010's (2010-2016), twin children compared to singletons had very high mortality risks. Indeed, for twins, the Hazard Ratio (HR) was 3.9 times higher than that of singletons (Confidence Interval, CI = 3.7 - 4.0, p<0.001). After adjustment in the group of biomedical and nutritional variables (birthweight, caesarean section, antenatal visits and breastfeeding), this ratio changed significantly, dropping to 3.15 (CI=2.9 - 3.3). The gradual inclusion of the other groups of covariates in the model no longer significantly changed twins' HR. This confirms that the group of biomedical and nutritional covariates is the predominant group of factors associated with twins' excess mortality.

The interaction effects introduced in the model (between the twinning variable and the other covariates) show that, within the biomedical and nutritional variables, the absence of Caesarean section and of breastfeeding are particularly and independently associated with the excess mortality of twins. Indeed, although caesarean birth is generally associated with a high risk of mortality, among twins it is the non-use of caesarean section that is associated with a higher risk of mortality. Thus, when the delivery was not by caesarean section, the HRa for twins is 3

⁹ As a reminder, the multivariate analysis focused on surveys carried out in the years 2010.

¹⁰ HRa = Adjusted Hazard Ratio.

times higher than that for singletons (CI= 2.9 - 3.3; $p < 0.001$); and when the delivery was by caesarean section, it drops to 1.75 (CI= 1.5 - 2.1; $p < 0.001$). This interesting result could be understood by the fact that for non-twins, a caesarean section delivery is usually performed following complications of the pregnancy, whereas for a pregnancy of twins (at least those who have been medically attended), the choice of a caesarean section delivery is a planned and generalised practice whose aim is to avoid any complications that could be caused by a vaginal delivery.

Regarding breastfeeding, our results show that the HRa of non-breastfed twins is 4 times higher than that of non-breastfed singletons (CI= 3.6 - 4.3; $p < 0.001$); if the children were breastfed, this HRa drops to 3.12 (CI= 2.95 - 3.28; $p < 0.001$). This makes the absence of breastfeeding a more important risk factor for mortality among twins than singletons.

Furthermore, with regard to the effect of socio-cultural status on twins' excess mortality, two aspects should be noted. Firstly, taking into account the twins' socio-ethnic status in the Cox model (presented in **Table 1**) does not contribute to variation in the HRa of twins. This indicates that twins' socio-cultural status (in society) has no independent effect on their excess death risks. But, are there any differences in mortality among twins only, depending on their status in society? The answer is no, according to our results. Indeed, in a second step, by carrying out a Cox model using only a sample of twin children (see **Appendix 3**), we did not find socio-ethnic disparities in mortality risks among twins themselves, which would depend on how these ethnic groups receive twins (worshiped, hated, or ambivalent). All these elements seem to demonstrate that the socio-ethnic status of twins in sub-Saharan Africa does not (or no longer) influence their mortality or their excess mortality compared to singletons. However, we must be cautious in this statement, as it cannot be excluded that this result is the consequence of deliberate omissions of twin deaths among ethnic groups that were traditionally unfavourable to them.

5. Discussion and conclusion

Our analyses show that child mortality remains at high levels in sub-Saharan African countries, and that it is more pronounced when it comes to twins. Indeed, a sub-Saharan twin has an overall under-five mortality rate (U5MR) that is three times higher than that of a singleton. Our findings also show that, from the 1990s to the 2010s, U5MR decreased significantly in sub-Saharan African countries. However, this decrease remains relatively less significant for twins compared to singletons. In addition, the multivariate analysis showed that, all else being equal, twins are 3.2 times more likely to die before their 5th birthday compared to singletons

($p < 0.001$). Biomedical and nutritional variables in general, and the absence of breastfeeding and the non-caesarean section delivery in particular, are the main factors associated with higher mortality risks among twins than singletons. However, this analysis did not demonstrate the existence of socio-ethnic disparities in mortality risks between twins and singletons that would be dependent on the ethno-cultural beliefs and attitudes towards twins in society.

The high mortality rates among twins observed here are in line with the results of several previous studies, the most recent of which are those of Monden & Smits (2017) and Bellizzi et al. (2018). The first showed that the ratio of U5MR of twins to that of singletons was 3.4 in sub-Saharan Africa in 2014. These authors also found a greater decrease in mortality for singletons compared to twins, as demonstrated by our results. As for Bellizzi et al. (2018), they found that in 60 developing countries, including those of sub-Saharan Africa, twins' mortality risks are almost 8 times higher than those of singletons in the first week of life. Similarly, albeit to a lesser extent, our results showed that in the first month of life, the risks of death are almost 5 times higher among twins than singletons.

This study is not exempt from limitations in terms of data quality, heterogeneity of countries studied, and over-representation of some countries or some sub-regions in the sample of surveys studied. Firstly, we acknowledge that the ages declared in the national surveys that we used could have problems of accuracy. This could have an impact on the robustness of the estimated mortality rates. Secondly, the heterogeneity of the demographic contexts of the countries included in our study constitutes another limitation. Indeed, from east to west and from centre to south, the demographic contexts of the sub-Saharan countries are plural. As a result, the interpretation of some of our results as those of a 'sub-Saharan African level' hide disparities between these countries. Finally, we note that the over-representation of West African countries in the multivariate analysis can affect the HR estimated for the geographical area and socio-ethnic variables. Nevertheless, weighting the data contributed to correct this limitation.

Despite some of the limitations noted above, the results of this study confirm the fact that in sub-Saharan Africa, the health of twin children is a major challenge. Thus, targeted actions need to be taken to consolidate the important changes that are gradually taking place. These actions should concern the medical field, in particular the development of obstetrical and paediatric services needed to manage the frequent complications related to twin births. Moreover, they should also involve the social services, which must implement actions to counter possible social threats that would still hang over the health of twins in sub-Saharan Africa. We have already

addressed these threats in previous work dealing with socio-cultural changes in the perceptions and attitudes towards contemporary sub-Saharan twins ¹¹.

6. References

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¹¹ Perceptions, knowledge and attitudes regarding twin births in sub-Saharan Africa: the case of Burkina Faso and Senegal (Original title: *Perceptions, connaissances et attitudes concernant les naissances gémellaires en Afrique subsaharienne : le cas du Burkina Faso et du Sénégal*), (Ouedraogo 2020b).

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7. Appendices

Appendix 1: Under-5 Mortality Rate from 42 sub-Saharan African countries ^a

Country	Survey years	Period used for rates calculation	Data source	Under-5 mortality rate ($\leq Q_0$), by ‰ and 95% Confidence interval (CI)									
				Singletons	95% CI	Twins	95% CI	Triplets or more	95% CI	All	95% CI	Twins/Singletons	95% CI
Angola	2015-16	2011 – 2015	Standard DHS	65.0	58 – 71	197.0	154 – 240	–	–	68	62 – 74	3.0	2.6 – 3.4
	2011	2007 – 2011	MIS	88.0	81 – 94	190.0	130 – 251	–	–	91.0	83 – 99	2.2	1.6 – 2.7
	2006-07	2002 – 2006	MIS	93.0	76 – 110	372.0	241 – 502	–	–	105.0	87 – 123	4.0	3.2 – 4.6
Benin	2014	2010 – 2014	MICS	98.0	92 – 104	338.0	297 – 379	–	–	114.0	107 – 120	3.4	3.2 – 3.6
	2011-12	2007 – 2011	Standard DHS	64.0	60 – 68	194.0	159 – 229	336	0 – 1661	70.0	66 – 74	3.0	2.7 – 3.4
	2006	2002 – 2006	Standard DHS	113.0	108 – 119	317.0	283 – 350	583	319 – 847	125.0	120 – 130	2.8	2.6 – 2.9
	2001	1997 – 2001	Standard DHS	144.0	134 – 155	395.0	341 – 450	788	493 – 1083	160.0	150 – 170	2.7	2.5 – 2.9
	1996	1992 – 1996	Standard DHS	152.0	142 – 163	374.0	321 – 426	870	594 – 1146	166.0	156 – 176	2.5	2.3 – 2.6
Burkina Faso	2010	2006 – 2010	Standard DHS	120.0	115 – 125	320.0	275 – 365	–	–	129.0	123 – 134	2.7	2.4 – 2.9
	2003	1999 – 2003	Standard DHS	178.0	169 – 187	358.0	305 – 412	–	–	184.0	175 – 193	2.0	1.8 – 2.2
	1998	1994 – 1998	Standard DHS	213.0	203 – 224	423.0	335 – 510	1000	1000–1000	29.0	207 – 231	2.0	1.7 – 2.3
	1993	1989 – 1993	Standard DHS	179.0	168 – 190	394.0	324 – 463	–	–	187.0	176 – 198	2.2	1.9 – 2.4
Burundi	2010	2006 – 2010	Standard DHS	93.0	86 – 100	231.0	163 – 299	1000	1000–1000	96.0	89 – 103	2.5	1.9 – 3.0
	1987	1983 – 1987	Standard DHS	148.0	135 – 160	442.0	314 – 567	–	–	152.0	141 – 164	3.0	2.3 – 3.5
Cameroon	2014	2010 – 2014	MICS	97.0	89 – 105	216.0	168 – 264	229	10 – 448	102.0	94 – 110	2.2	1.9 – 2.5
	2011	2007 – 2011	Standard DHS	117.0	110 – 123	228.0	187 – 268	704	488 – 919	122.0	115 – 129	1.9	1.7 – 2.2
	2004	2000 – 2004	Standard DHS	138.0	129 – 146	267.0	216 – 319	463	98 – 827	144.0	135 – 152	1.9	1.7 – 2.2
	1998	1994 – 1998	Standard DHS	145.0	134 – 156	284.0	213 – 354	–	–	151.0	138 – 164	2.0	1.6 – 2.3
	1991	1987 – 1991	Standard DHS	123.0	111 – 135	181.0	116 – 246	–	–	125.0	113 – 138	1.5	1.0 – 1.8

Centrafrica	1994-95	1990 – 1994	Standard DHS	149.0	140 – 159	443.0	344 – 542	–	–	158.0	146 – 169	3.0	2.5–3.4
Chad	2014-15	2010 – 2014	Standard DHS	127.0	121 – 133	320.0	270 – 371	993	979 – 1008	133.0	127 – 139	2.5	2.2–2.8
	2004	2000 – 2004	Standard DHS	187.0	179 – 199	352.0	256 – 447	–	–	191.0	177 – 204	1.9	1.4–2.2
	1996-97	1992 – 1996	Standard DHS	186.0	176 – 195	447.0	338 – 505	1000	1000–1000	194.0	184 – 205	2.4	1.9–2.6
Comoros	2012	2008 – 2012	Standard DHS	46.0	35 – 57	132.0	72 – 193	–	–	50.0	41 – 59	2.9	2.1–3.4
	1996	1992 – 1996	Standard DHS	98.0	84 – 112	239.0	148 – 330	–	–	104.0	93 – 115	2.4	1.8–2.9
Congo	2011-12	2007 – 2011	Standard DHS	63.0	54 – 71	168.0	123 – 214	1000	1000–1000	68.0	60 – 76	2.7	2.3–3.0
	2005	2001 – 2005	Standard DHS	104.0	94 – 114	377.0	297 – 457	–	–	117.0	106 – 127	3.6	3.2–4.0
Congo DR	2013-14	2009 – 2013	Standard DHS	97.0	91 – 103	280.0	233 – 327	241	0 – 554	104.0	98 – 111	2.9	2.6–3.2
	2007	2003 – 2007	Standard DHS	137.0	126 – 147	442.0	366 – 519	–	–	148.0	136 – 160	3.2	2.9–3.5
Cote d'Ivoire	2011-12	2007 – 2011	Standard DHS	100.0	92 – 108	277.0	219 – 335	611	0 – 1244	108.0	99 – 117	2.8	2.4–3.1
	2005	2001 – 2005	AIS	119.0	105 – 133	259.0	158 – 360	–	–	125.0	110 – 140	2.2	1.5–2.7
	1998-99	1994 – 1998	Standard DHS	172.0	152 – 191	442.0	312 – 573	–	–	181.0	157 – 204	2.6	2.1–3.0
	1994	1990 – 1994	Standard DHS	142.0	134 – 151	339.0	264 – 414	648	0 – 1400	150.0	141 – 158	2.4	2.0–2.7
Ethiopia	2008	2004 – 2008	Standard DHS	62.0	55 – 70	232.0	161 – 303	1000	1000–1000	67.0	61 – 73	3.7	2.9–4.3
	2003	1999 – 2003	Standard DHS	84.0	78 – 91	250.0	173 – 326	–	–	88.0	81 – 95	3.0	2.2–3.6
	1997	1993 – 1997	Standard DHS	120.0	112 – 128	332.0	233 – 431	–	–	123.0	115 – 133	2.8	2.1–3.4
	1992	1988 – 1992	Standard DHS	158.0	150 – 165	559.0	465 – 653	1000	1000–1000	166.0	156 – 176	3.5	3.1–4.0
Gabon	2012	2008 – 2012	Standard DHS	57.0	47 – 66	269.0	167 – 358	176	0 – 433	65.0	55 – 74	4.7	3.6–5.4
	2000	1996 – 2000	Standard DHS	84.0	75 – 92	221.0	145 – 296	–	–	89.0	81 – 96	2.6	1.9–3.2
Gambia	2013	2009 – 2013	Standard DHS	50.0	42 – 58	142.0	83 – 202	–	–	54.0	46 – 61	2.8	2.0–3.5
Ghana	2014	2010 – 2014	Standard DHS	54.0	47 – 62	154.0	111 – 197	1000	1000–1000	60.0	52 – 67	2.9	2.4–3.2
	2011	2007– 2011	MICS	75.0	67 – 83	212.0	142 – 283	499	0 – 1062	82.0	73 – 92	2.8	2.1–3.4
	2008	2004 – 2008	Standard DHS	76.0	66 – 86	170.0	100 – 240	–	–	80.0	69 – 91	2.2	1.5–2.8
	2003	1999 – 2003	Standard DHS	103.0	91 – 115	302.0	221 – 382	333	0 – 667	111.0	100 – 123	2.9	2.4–3.3
	1998	1994 – 1998	Standard DHS	100.0	89 – 110	266.0	184 – 349	486	102 – 870	108.0	95 – 120	2.7	2.1–3.2

	1993	1989 – 1993	Standard DHS	115.0	103 – 127	217.0	147 – 287	–	–	119.0	108 – 130	1.9	<i>1.4–2.3</i>
	1988	1984 – 1988	Standard DHS	149.0	137 – 161	304.0	228 – 380	–	–	155.0	143 – 167	2.0	<i>1.7–2.4</i>
Guinea	2012	2008 – 2012	Standard DHS	116.0	108 – 124	268.0	211 – 325	–	–	123.0	114 – 132	2.3	<i>2.0–2.6</i>
	2005	2001 – 2005	Standard DHS	156.0	146 – 166	310.0	243 – 376	–	–	163.0	154 – 173	2.0	<i>1.7–2.3</i>
	1999	1995 – 1999	Standard DHS	175.0	161 – 181	334.0	276 – 391	1000	1000–1000	177.0	166 – 188	1.9	<i>1.7–2.2</i>
Guinea Bissau	2014	2010 – 2014	MICS	83.0	75 – 90	249.0	191 – 307	1000	1000–1000	89.0	81 – 96	3.0	<i>2.5–3.4</i>
Kenya	2014	2010 – 2014	Standard DHS	48.0	44 – 52	200.0	154 – 245	1000	1000–1000	52.0	48 – 57	4.2	<i>3.5–4.7</i>
	2008-09	2004 – 2008	Standard DHS	69.0	60 – 77	251.0	173 – 330	–	–	74.0	65 – 82	3.6	<i>2.9–4.3</i>
	2003	1999 – 2003	Standard DHS	110.0	101 – 119	242.0	176 – 307	–	–	115.0	105 – 125	2.2	<i>1.7–2.6</i>
	1998	1994 – 1998	Standard DHS	106.0	96 – 115	287.0	206 – 367	–	–	111.0	101 – 122	2.7	<i>2.1–3.2</i>
	1993	1989 – 1993	Standard DHS	92.0	84 – 101	229.0	162 – 296	–	–	96.0	87 – 105	2.5	<i>1.9–2.9</i>
	1989	1985 – 1989	Standard DHS	86.0	78 – 94	217.0	156 – 279	1000	1000–1000	90.0	82 – 98	2.5	<i>2.0–3.0</i>
Lesotho	2014	2010 – 2014	Standard DHS	81.0	70 – 93	199.0	98 – 300	1000	1000–1000	85.0	72 – 99	2.5	<i>1.4–3.2</i>
	2009	2005 – 2009	Standard DHS	109.0	97 – 122	321.0	211 – 431	1000	1000–1000	117.0	105 – 128	2.9	<i>2.2–3.5</i>
	2004	2000 – 2004	Standard DHS	108.0	95 – 121	325.0	225 – 425	–	–	113.0	101 – 125	3.0	<i>2.4–3.5</i>
Liberia	2013	2009 – 2013	Standard DHS	85.0	76 – 94	296.0	224 – 368	883	687 – 1080	94.0	85 – 103	3.5	<i>2.9–3.9</i>
	2009	2005 – 2009	MIS	112.0	100 – 123	194.0	113 – 276	586	0 – 1218	114.0	102 – 127	1.7	<i>1.1–2.2</i>
	2007	2003 – 2007	Standard DHS	102.0	92 – 112	274.0	204 – 345	786	543 – 1030	110.0	99 – 120	2.7	<i>2.2–3.1</i>
	1986	1982 – 1986	Standard DHS	213.0	200 – 227	435.0	357 – 513	–	–	222.0	209 – 236	2.0	<i>1.8–2.3</i>
Madagascar	2008-09	2004 – 2008	Standard DHS	68.0	62 – 74	239.0	175 – 303	–	–	72.0	67 – 77	3.5	<i>2.8–4.1</i>
	2003-04	1999 – 2003	Standard DHS	91.0	80 – 102	250.0	135 – 364	1000	1000–1000	94.0	84 – 104	2.7	<i>1.7–3.6</i>
	1997	1993 – 1997	Standard DHS	154.0	144 – 165	386.0	298 – 475	–	–	159.0	149 – 169	2.5	<i>2.1–2.9</i>
	1992	1988 – 1992	Standard DHS	159.0	147 – 170	321.0	238 – 404	–	–	163.0	151 – 174	2.0	<i>1.6–2.4</i>
Malawi	2015-16	2011 – 2015	Standard DHS	57.0	53 – 62	216.0	171 – 261	–	–	64.0	59 – 69	3.8	<i>3.2–4.2</i>
	2013	2009 – 2013	MICS	78.0	72 – 84	217.0	178 – 256	841	658 – 1024	85.0	79 – 90	2.8	<i>2.5–3.1</i>
	2010	2006 – 2010	Standard DHS	104.0	97 – 111	293.0	250 – 336	638	383 – 893	112.0	107 – 118	2.8	<i>2.6–3.0</i>

	2006	2002 – 2006	MICS	112.0	107 – 118	351.0	304 – 398	734	537 – 941	121.0	115 – 128	3.1	2.8–3.4
	2004	2000 – 2004	Standard DHS	124.0	117 – 131	365.0	299 – 431	–	–	133.0	126 – 141	2.9	2.6–3.3
	2000	1996 – 2000	Standard DHS	178.0	169 – 188	396.0	343 – 450	840	685 – 995	189.0	180 – 197	2.2	2.0–2.4
	1992	1988 – 1992	Standard DHS	222.0	209 – 234	503.0	428 – 577	1000	1000–1000	234.0	219 – 248	2.3	2.1–2.5
Mali	2015b	2011 – 2015	MICS	97.0	91 – 102	269.0	222 – 316	837	614 – 1061	103.0	97 – 109	2.8	2.4–3.1
	2012-13	2008 – 2012	Standard DHS	91.0	85 – 96	221.0	169 – 274	704	311 – 1096	95.0	88 – 102	2.4	2.0–2.9
	2006	2002 – 2006	Standard DHS	182.0	174 – 190	429.0	378 – 481	–	–	191.0	182 – 199	2.4	2.2–2.5
	2001	1997 – 2001	Standard DHS	222.0	213 – 231	444.0	385 – 502	859	562 – 1156	229.0	220 – 238	2.0	1.8–2.2
	1995-96	1991 – 1995	Standard DHS	229.0	220 – 238	483.0	427 – 540	1000	1000–1000	238.0	229 – 246	2.1	1.9–2.3
	1987	1983 – 1987	Standard DHS	242.0	225 – 260	462.0	332 – 592	–	–	247.0	231 – 263	1.9	1.5–2.3
Mauritania	2011	2007 – 2011	MICS	62.0	55 – 68	222.0	172 – 271	291	0 – 586	68.0	62 – 73	3.6	3.1–4.0
Mozambique	2011	2007 – 2011	Standard DHS	91.0	84 – 97	265.0	210 – 320	–	–	97.0	89 – 104	2.9	2.5–3.3
	2003	1999 – 2003	Standard DHS	146.0	136 – 155	350.0	289 – 410	–	–	152.0	143 – 162	2.4	2.1–2.7
	1997	1993 – 1997	Standard DHS	193.0	172 – 214	410.0	266 – 553	1167	1033–1300	201.0	181 – 221	2.1	1.6–2.6
Namibia	2013	2009 – 2013	Standard DHS	48.0	42 – 55	231.0	153 – 309	1000	1000–1000	54.0	47 – 61	4.8	3.6–5.6
	2006-07	2002 – 2006	Standard DHS	66.0	58 – 74	179.0	114 – 244	–	–	69.0	61 – 77	2.7	2.0–3.3
	2000	1996 – 2000	Standard DHS	57.0	48 – 66	277.0	157 – 397	–	–	62.0	53 – 72	4.9	3.3–6.0
	1992	1988 – 1992	Standard DHS	80.0	70 – 89	215.0	139 – 292	–	–	84.0	75 – 93	2.7	2. – 3.3
Niger	2012	2008 – 2012	Standard DHS	120.0	114 – 127	319.0	268 – 371	588	0 – 1469	127.0	121 – 134	2.7	2.4–2.9
	2006	2002 – 2006	Standard DHS	187.0	177 – 196	452.0	397 – 507	962	888 – 1036	198.0	188 – 207	2.4	2.2–2.6
	1998	1994 – 1998	Standard DHS	266.0	255 – 277	484.0	418 – 549	547	227 – 867	274.0	264 – 284	1.8	1.6–2.0
	1992	1988 – 1992	Standard DHS	309.0	298 – 321	594.0	520 – 668	–	–	318.0	306 – 331	1.9	1.7–2.1
Nigeria	2016-17	2012 – 2016	MICS	108.0	104 – 112	256.0	226 – 286	465	0 – 954	114.0	110 – 118	2.4	2.2–2.6
	2013	2009 – 2013	Standard DHS	63.0	60 – 66	300.0	269 – 330	809	510 – 1109	128.0	123 – 133	4.8	4.5–5.0
	2010	2006 – 2010	MIS	135.0	124 – 146	309.0	234 – 384	761	458 – 1064	143.0	133 – 153	2.3	1.9–2.6
	2008	2004 – 2008	Standard DHS	151.0	146 – 155	311.0	277 – 344	761	564 – 959	157.0	152 – 161	2.1	1.9–2.2

	2003	1999 – 2003	Standard DHS	193.0	180 – 206	382.0	308 – 457	1000	1000–1000	201.0	189 – 212	2.0	<i>1.7 – 2.2</i>
	1990	1986 – 1990	Standard DHS	184.0	174 – 193	410.0	309 – 511	1000	1000–1000	193.0	182 – 204	2.2	<i>1.8 – 2.7</i>
	1986	1982 - 1986	Special –Ondo	107.0	96 – 117	211.0	146 – 275	–	–	111.0	99 – 122	2.0	<i>1.5 – 2.4</i>
Rwanda	2014-15	2010 – 2014	Standard DHS	47.0	42 – 51	181.0	128 – 233	96	30 – 162	50.0	46 – 55	3.9	<i>3.1 – 4.6</i>
	2010	2006 – 2010	Standard DHS	71.0	65 – 76	246.0	197 – 296	–	–	76.0	71 – 81	3.5	<i>3.0 – 3.9</i>
	2007-08	2003 – 2007	Interim DHS	98.0	90 – 106	262.0	189 – 335	–	–	103.0	94 – 112	2.7	<i>2.1 – 3.2</i>
	2005	2001 – 2005	Standard DHS	147.0	139 – 155	337.0	274 – 399	–	–	152.0	143 – 161	2.3	<i>2.0 – 2.6</i>
	2000	1996 – 2000	Standard DHS	193.0	183 – 203	323.0	240 – 406	333	0 – 667	196.0	187 – 206	1.7	<i>1.3 – 2.0</i>
	1992	1988 – 1992	Standard DHS	147.0	138 – 155	388.0	294 – 482	–	–	151.0	141 – 161	2.6	<i>2.1 – 3.1</i>
Sao Tome	2014	2010 – 2014	MICS	40.0	31 – 48	169.0	74 – 264	1000	1000–1000	44.0	33 – 54	4.2	<i>2.4 – 5.5</i>
	2008-09	2004 – 2008	Standard DHS	61.0	45 – 76	106.0	0 – 231	–	–	63.0	47 – 78	1.7	<i>0 – 3.0</i>
Senegal	2016	2012 – 2016	Continuous	47.0	40 – 53	142.0	93 – 192	375	0 – 846	51.0	45 – 57	3.0	<i>2.3 – 3.6</i>
	2015	2011 – 2015	Continuous	54.0	47 – 61	189.0	131 – 247	333	0 – 764	59.0	52 – 66	3.5	<i>2.8 – 4.1</i>
	2014	2009 – 2014	Continuous	50.0	43 – 58	157.0	115 – 198	333	0 – 778	54.0	48 – 61	3.1	<i>2.7 – 3.4</i>
	2012-13	2008 – 2012	Continuous	59.0	51 – 67	191.0	113 – 268	1000	1000–1000	65.0	57 – 73	3.2	<i>2.2 – 4.0</i>
	2010-11	2006 – 2010	Standard DHS	67.0	61 – 73	190.0	148 – 232	38	6 – 69	72.0	66 – 77	2.8	<i>2.4 – 3.2</i>
	2008-09	2004 – 2008	MIS	79.0	74 – 84	229.0	182 – 276	490	0 – 999	85.0	79 – 90	2.9	<i>2.5 – 3.3</i>
	2005	2001 – 2005	Standard DHS	117.0	109 – 124	261.0	214 – 308	201	0 – 505	121.0	114 – 129	2.2	<i>2.0 – 2.5</i>
	1997	1993 – 1997	Standard DHS	132.0	122 – 142	354.0	285 – 422	268	2 – 534	139.0	130 – 148	2.7	<i>2.3 – 3.0</i>
	1992-93	1988 – 1992	Standard DHS	129.0	119 – 138	248.0	177 – 319	–	–	132.0	123 – 140	1.9	<i>1.5 – 2.3</i>
	1986	1982 – 1986	Standard DHS	186.0	174 – 198	549.0	459 – 639	–	–	195.0	183 – 206	3.0	<i>2.6 – 3.2</i>
Sierra Leone	2013	2009 – 2013	Standard DHS	147.0	139 – 156	355.0	299 – 412	658	312 – 1005	156.0	149 – 163	2.4	<i>2.2 – 2.6</i>
	2008	2004 – 2008	Standard DHS	134.0	123 – 145	298.0	226 – 371	–	–	140.0	130 – 150	2.2	<i>1.8 – 2.6</i>
Somalia	2006	2002 – 2006	MICS	126.0	117 – 135	269.0	154 – 383	–	–	127.0	118 – 136	2.1	<i>1.3 – 2.8</i>
South Africa	1998	1994 – 1998	Standard DHS	56.0	49 – 63	204.0	121 – 286	–	–	59.0	52 – 67	3.6	<i>2.5 – 4.5</i>
Sudan	1989-90	1985 – 1989	Standard DHS	118.0	110 – 125	321.0	244 – 397	1000	1000–1000	124.0	116 – 131	2.7	<i>2.2 – 3.2</i>

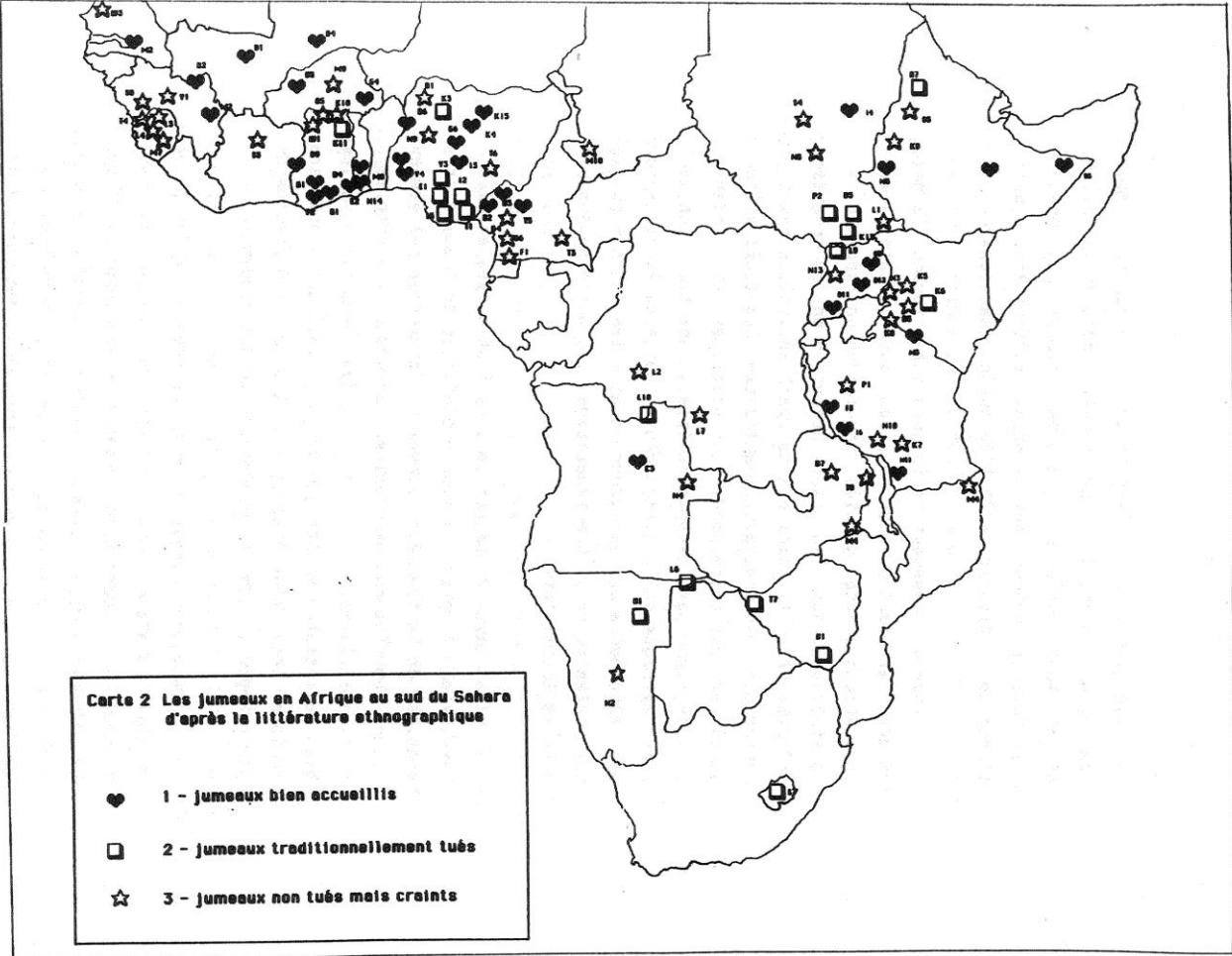
South Sudan	2010	2006–2010	MICS	68.0	62–74	193.0	151–236	–	–	72.0	67–78	2.8	<i>2.4–3.2</i>
Swaziland	2014	2010–2014	MICS	65.0	53–76	149.0	46–251	–	–	67.0	54–81	2.3	<i>0.9–3.3</i>
	2010	2006–2010	MICS	100.0	87–114	197.0	115–278	1000	1000–1000	104.0	89–118	2.0	<i>1.3–2.4</i>
	2006-07	2002–2006	Standard DHS	115.0	103–	310.0	189–432	–	–	120.0	105–135	2.7	<i>1.8–3.4</i>
Tanzania	2015-16	2011–2015	Standard DHS	62.0	56–67	210.0	162–259	–	–	67.0	61–74	3.4	<i>2.9–3.9</i>
	2010	2006–2010	Standard DHS	75.0	68–83	260.0	194–325	–	–	81.0	74–88	3.5	<i>2.9–3.9</i>
	2007-08	2003–2007	AIS	84.0	76–92	249.0	175–324	1000	1000–1000	91.0	83–100	3.0	<i>2.3–3.5</i>
	2004-05	2000–2004	Standard DHS	106.0	98–113	265.0	206–324	733	350–1115	112.0	104–120	2.5	<i>2.1–2.9</i>
	1999	1995–1999	Standard DHS	145.0	126–164	200.0	120–279	1000	1000–1000	147.0	129–165	1.4	<i>1.0–1.4</i>
	1996	1992–1996	Standard DHS	130.0	121–138	329.0	264–393	–	–	136.0	127–145	2.5	<i>2.2–2.9</i>
	1991-92	1997–1991	Standard DHS	135.0	127–143	297.0	225–370	–	–	141.0	131–151	2.2	<i>1.8–2.6</i>
Togo	2013-14	2009–2013	Standard DHS	81.0	75–88	227.0	173–282	–	–	88.0	81–95	2.8	<i>2.3–3.2</i>
	1998	1994–1998	Standard DHS	139.0	131–147	284.0	231–338	825	551–1099	146.0	137–156	2.0	<i>1.8–2.3</i>
	1988	1984–1988	Standard DHS	140.0	128–	386.0	320–453	1000	1000–1000	155.0	141–168	2.8	<i>2.5–3.0</i>
Uganda	2011	2007–2011	Standard DHS	86.0	78–94	192.0	134–249	–	–	90.0	83–97	2.2	<i>1.7–2.7</i>
	2009	2004–2009	MIS	81.0	68–94	172.0	94–250	–	–	86.0	74–98	2.1	<i>1.4–2.7</i>
	2006	2002–2006	Standard DHS	122.0	114–131	293.0	226–360	–	–	128.0	120–135	2.4	<i>2.0–2.8</i>
	2000-01	1996–2000	Standard DHS	145.0	135–156	375.0	296–454	414	0–1129	151.0	141–162	2.6	<i>2.2–2.9</i>
	1995	1991–1995	Standard DHS	140.0	131–150	340.0	274–406	–	–	147.0	138–157	2.4	<i>2.1–2.7</i>
	1988-89	1985–1989	Standard DHS	171.0	158–183	355.0	269–441	1000	1000–1000	177.0	164–190	2.1	<i>1.7–2.4</i>
Zambia	2013-14	2009–2013	Standard DHS	70.0	65–75	211.0	165–256	526	156–896	75.0	69–80	3.0	<i>2.5–3.4</i>
	2007	2003–2007	Standard DHS	112.0	104–119	265.0	202–329	1000	1000–1000	119.0	111–126	2.4	<i>1.9–2.8</i>
	2001-02	1997–2001	Standard DHS	160.0	151–168	416.0	351–482	–	–	168.0	159–177	2.6	<i>2.3–2.9</i>
	1996	1992–1996	Standard DHS	188.0	178–199	408.0	338–478	–	–	197.0	186–207	2.2	<i>1.9–2.4</i>
	1992	1988–1992	Standard DHS	183.0	173–192	428.0	358–498	–	–	191.0	182–200	2.3	<i>2.1–2.6</i>
	2015	2011–2015	Standard DHS	65.0	58–72	196.0	138–253	–	–	69.0	62–76	3.0	<i>2.4–3.5</i>

Zimbabwe	2014	2010 – 2014	MICS	70.0	64 – 76	206.0	161 – 250	1000	1000–1000	75.0	69 – 80	2.9	2.5 – 3.3
	2010-11	2006 – 2010	Standard DHS	79.0	70 – 88	237.0	151 – 323	1433	979 – 1887	84.0	75 – 93	3.0	2.2 – 3.7
	2009	2005 – 2009	MICS	88.0	81 – 95	254.0	190 – 318	–	–	94.0	85 – 102	2.9	2.4 – 3.4
	2005-06	2001 – 2005	Standard DHS	77.0	69 – 86	253.0	187 – 318	–	–	82.0	74 – 91	3.3	2.7 – 3.7
	1999	1995 – 1999	Standard DHS	96.0	86 – 107	276.0	183 – 369	–	–	102.0	90 – 114	2.9	2.1 – 3.5
	1994	1990 – 1994	Standard DHS	72.0	63 – 81	239.0	151 – 327	–	–	77.0	67 – 87	3.3	2.4 – 4.0
	1988	1984 – 1988	Standard DHS	67.0	59 – 76	156.0	92 – 221	1000	1000–1000	71.0	62 – 79	2.3	1.6 – 2.9
All Sub-Saharan Africa (SSA)	2010	–	ALL	87.0	86 – 88	244.0	236 – 251	560	500 – 620	93.0	92 – 94	2.8	2.7 – 2.9
	2000	–	ALL	127.0	125 – 128	318.0	307 – 328	668	600–736	133.0	132 – 135	2.5	2.5 – 2.6
	1990	–	ALL	159.0	157 – 161	365.0	350 – 379	701	621 – 782	166.0	164 – 168	2.3	2.2 – 2.4

^a Countries not included because lack of data: Botswana, Cape Verde, Djibouti, Equatorial Guinea, Eritrea, Mauritius, and Seychelles.

Source: DHS et MICS; authors' calculation.

Appendix 2: Socio-ethnic Status of Twins in Sub-Saharan Africa



Source : Pison (1987).

Appendix 3: Analysis of the effect of the socio-ethnic status of twins on their under-5 mortality risk

Variables	Crude Hazard Ratio (HR)		Adjusted HR	
	HR	95% CI	HR	95% CI
Socio-cultural status of twins				
Favourable	ref		ref	
Unfavourable	0.69**	0.53 – 0.90	0.92	0.71 – 1.21
Ambivalent/other	1.07	0.95 – 1.17	1.05	0.94 – 1.17
Missing values ^{keep}				
Birthweight				
<2.5 Kg			2.16***	1.67 – 2.78
>=2.5 Kg			ref	
Missing values ^{keep}				
Caesarean section				
Yes			0.77**	0.65 – 0.91
No			ref	
Missing values ^{keep}				
Ante-natal care				
No ante-natal visit			1.28	0.96 – 1.68
1 or 2 visits			1.28*	1.06 – 1.54
3 or more ante-natal visits			ref	
Missing values ^{keep}				
Breastfeeding				
Yes			ref	
No			7.98***	7.23 – 8.81
Missing values ^{supp}				
Maternal age				
< 20 years old			ref	
20 - 25 years old			0.77**	0.66 – 0.91
25 - 30 years old			0.61***	0.51 – 0.72
30 - 35 years old			0.56***	0.46 – 0.67
>=35 years old			0.59***	0.48 – 0.72
Birth order				
1			0.90***	0.73 - 1.12
2			0.70***	0.59 – 0.82
3			0.70***	0.60 – 0.81
4			0.70***	0.61 – 0.80
5			0.75***	0.66 – 0.86
>=6			ref	
Child's sex				
Male			1.22***	1.12 – 1.32
Female			ref	
Mother's marital status				
Never married/union			0.80	0.62 – 1.04
Married/union			ref	
Widowed or divorced			1.12	0.96 – 1.31
Missing values ^{supp}				
Sub-region				
Western Africa			ref	
Eastern Africa			0.79***	0.68 – 0.90
Central Africa			0.84**	0.75 – 0.95

Southern Africa		0.98	0.79 – 1.21
Year of birth			
Year of birth		1.02*	1.00 – 1.04
Wealth quintile			
1st quintile		1.03	0.87 – 1.22
2nd quintile		1.16*	0.98 – 1.37
3rd quintile		1.15*	0.98 – 1.36
4th quintile		1.18*	1.01 – 1.37
5th quintile			ref
Urban/Rural area of residence			
Urban			ref
Rural		1.22***	1.08 – 1.37
Mother's educational level			
None		1.13	0.99 – 1.29
Elementary school		1.08	0.95 – 1.23
Middle school or more			ref
Missing values ^{supp}			
Desired pregnancy			
Yes			ref
No, have another later		1.01	0.90 – 1.14
No, unwanted pregnancy		0.76**	0.62 – 0.92
Missing values ^{keep}			

CI= Confidence Interval; ***=1%, **=1% et *=5 %; ref = reference parameter; ^{keep}: missing values retained as a modality of the variable; ^{supp}: removed missing values.

Source: DHS et MICS; authors' calculation.