# Twin Births in Sub-Saharan Africa: Frequency, Trends, and Associated Factors

Adama OUEDRAOGO[✱◆], Gilles PISON[✱◊], Sophie Le Cœur[✱], and Abdramane B. SOURA[⟠]

✱ Institut national d'études démographiques (INED), France

◆ Université Paris 1 Panthéon Sorbonne

◊ Muséum national d'histoire naturelle, France

⟠ Université de Ouagadougou

**Contact**: adama.ouedraogo@ined.fr

## Twin Births in Sub-Saharan Africa: Frequency, Trends and Associated Factors


### SUMMARY

*Since the 1970s, twin birth rates have increased sharply in developed countries. In Africa, where the rate was apparently the highest in the world, its evolution is poorly known. This article determines twinning rate in sub-Saharan Africa over the period of 1986–2016, using 174 national surveys from 42 countries, describing its spatial and temporal variations. Based on a sample of births between 2000 and 2010 from 25 countries, it analyses the factors associated with twin births. Our results indicate an overall sub-Saharan twinning rate of 17‰; with a maximum in Benin (27‰) and a minimum in Somalia (6‰). Twinning rates also vary according to maternal age and birth rank. Explanatory analyses show an increased risk of twin births with maternal age and birth rank. This risk also varies according to ethnicity, sub-region and household wealth.*



***Keywords**: Twins, Twin births, Twinning rate, associated factors, sub-Saharan Africa*

## 1. Introduction

The twin birth rate, or twinning rate, varies considerably from one continent to another. Sub-Saharan Africa is the area with the highest twinning rates in the world, with between 17 and 20 twin births per thousand (‰) births (Pison, 1989; Smits & Monden, 2011; Gebremedhin, 2015). In the 1980s and 1990s, the twinning rate in sub-Saharan Africa was 4 to 5 times higher than in Asia and almost twice as high as in Europe (Pison, 1989). Today, these gaps, although narrowing, remain significant (Pison et al., 2017).

There are several spatial and temporal variations that contribute to twinning rates. In developed countries, for example, twin birth rates doubled between 1970 and 2010, from less than 8‰ to almost 16‰ (Pison et al., 2014; Pison et al., 2015). This significant increase is the double result of the increase in fertility treatments and the increase of motherhood age (Terzera, 2002; Pison & Couvert, 2004; Pison, et al., 2014); given that the chances of twin births increase at higher maternal ages. In developing countries, and particularly in sub-Saharan Africa, where twin birth rates are particularly high, fertility treatments are presumptively very rare. But, other factors such as a high birth rate, a high number of births at later ages, a high fertility rate, as well as genetic factors, could contribute to maintaining these high twinning rates.

In sub-Saharan African countries, statistics on twinning are scarce and the variations of the twinning rate from one region or country to another remain poorly known. The effects of the main factors known to influence twinning, such as maternal age and birth rank, as well as other possible factors, are rarely documented. The first goal of this work is to provide the rates of twin births in

42 countries on the African continent over the period of 1986–2016 and analyse their spatial variations and their change over time. Secondly, by limiting the analysis to data on births that happened between 2000 and 2010 in 25 Sub-Saharan African countries, this study will seek to identify factors associated with a high risk of twin births. The decision be limited to births that took place between 2000 and 2010 was made because many surveys were conducted in 2010 or shortly after 2010. This makes it possible to select a sample of births that happened during the same period, thus reducing any effect due to the heterogeneity of the survey periods.

## 2. Background

### *2.1. Two types of twins*

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 and geographical or ethnical origin (Pison, 2000; Long & Ferriman, 2016). This constant rate of monozygotic births can be observed in almost all mammals (Duchesne and Institut de la statistique du Québec, 2001).

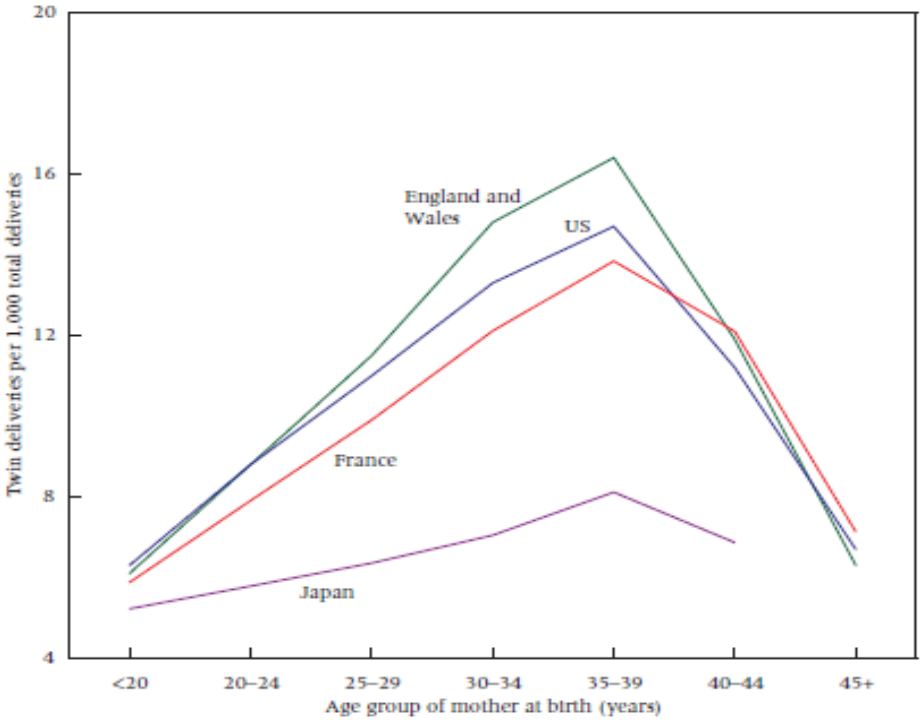
Dizygotic twins, on the contrary, are the product of the fertilization of two different eggs by two distinct spermatozoa. Unlike monozygotic twins, dizygotic twins are almost like any two brothers and sisters, in that they have the same sex (or not) in the same proportion as any couple of brothers and sisters. The

frequency of deliveries of dizygotic twins varies under the influence of several factors, mainly the mother's age, birth rank, and geographical area (Bulmer, 1970; Pison, 1989). Sterility treatments also have an effect on dizygotic twin rates (Pison et al., 2015). In this article, we will not make a distinction according to the type of twin in our analyses (data constraint).

### *2.2.Twinning rate variation factors*

#### Maternal age

Many studies have shown that the probability of a twin birth increases with the mother's age (Bulmer, 1970; Gabler and Voland, 1994; Sear et al., 2001; Satija et al., 2008; Blondel, 2009; Pison et al., 2015). For example, Pison et al (2015), focusing on the 1960s (years before the spread of assisted reproductive technology), produced ***Figure 1*** below which shows the variation in the twinning rate by maternal age. The authors found that the maternal age range of 35–39 years has the highest twinning rates in Japan, England and Wales, France, and the USA.




NOTES: Averages for 1965–69 (England and Wales, France), 1965–68 (US), 1960–67 (Japan). United States, France, and Japan: twin births only; England and Wales: all multiple births (including triplets, quadruplets, etc.).
SOURCES: National statistical offices; authors' calculations.

**Figure 1:** Pison et al.'s (2015) graph of twinning rates by age group of mother at birth in the 1960s in England and Wales, the United States, France, and Japan

*Source:* Pison et al., 2015

According to Bomsel-Helmreich and Al Mufti (2005), the increase of the twin birth rate with maternal age can be explained by the action of the follicle stimulating hormone (FSH), whose concentration in the blood increases with age. Also called follicular growth hormone, FSH is necessary for the development of the follicle and its peak helps to trigger ovulation. When the hormone's average rate increases, the probability of double ovulation and double fertilization in the same cycle also increases (Couvert, 2011).

### Birth rank

Another maternal characteristic that influences the probability of twin births is the birth rank. This link has been the subject of several studies, including those conducted by the Scottish physician James Matthews Duncan in 1865 (Bulmer, 1970). His work demonstrated that the number of twin pregnancies in women increases with the mother's age and the number of children she has. Bulmer (1970) went in the same direction, explaining that despite the obvious correlation between maternal age and birth rank, each of these factors has an independent effect on the probability of twin births. Daguet (2002) and Couvert (2011) in their respective studies also pointed out that at the same maternal age, women with a high birth rank are more likely to give birth to twins, compared to nulliparous women or women who have had a small number of births.

### Assisted Reproductive Technology

Assisted reproductive technology (ART) is "a major 'new' factor influencing twinning rates across the globe" (Smits & Monden, 2011:2). When ART is performed, several embryos are usually implanted in order to increase the chances of success of the operation. This practice significantly increases the likelihood of multiple births (Terzera, 2002; Pison & Couvert, 2004; Vitthala et

al., 2009). In industrialized countries, this progress in human reproductive technology is currently the main factor behind the strong growth in the twinning rate, in association with delayed maternity (Pison, et al., 2014). In sub-Saharan Africa, human reproductive technology is still poorly developed (Bonnet, 2016) and its current impact on the level of twinning rates, although not well known, is probably very low.

### Geographical and ethnical factors

As mentioned in the introduction, there is a high geographical variability in the frequency of twin births. In Africa, there are large disparities between sub-regions. Pison (1989) showed that the twinning rate was higher in countries bordering the Gulf of Guinea, increasing from inland to the coast. More recently, Smits & Monden (2011) have shown that this African area with a high incidence of twin births is spreading in some central and eastern African countries. These authors also showed that Benin was the country with the highest national twinning rate, with a rate of around 28‰, while the lowest rate of around 10.6‰ was observed in Madagascar.

But what can explain the high twinning rates in Africa? In addition to the local context of a high birth rate, the high twinning rate may reflect a genetic predisposition of women from particular ethnic groups. The geographical distribution of these ethnic groups could thus explain the regional disparities in twinning rates. For example, Bomsel-Helmreich and Al Mufti (2005) showed that Yoruba women had a much higher concentration of FSH in their blood than women in Aberdeen (Scotland), which may explain the higher rate of twin births among Yoruba women compared to other ethnic groups.

## 3. Data and methods

The first part of this paper, devoted to the calculation of twinning rates, is based on the analysis of data from 174 national surveys conducted between 1986 and 2016 in 42 countries in sub-Saharan Africa (list of countries and surveys attached in ***Appendix 1***). The number of surveys varied from 1 to 11 depending on the country. These data come from two sources: 1) surveys coordinated by The Demographic and Health Surveys Program of the United State Agency for International Development (USAID) which include standard Demographic and Health Surveys (DHS), Malaria Indicator Surveys (MIS) and AIDS Indicators Survey (AIS); 2) The Multiple Indicator Cluster Survey (MICS) managed by the United Nations Children's Fund (UNICEF, 2018). The DHS, like the MICS, are all retrospective cross-sectional surveys and have national coverage. They collect information that make it possible to reconstruct the reproductive histories of women of childbearing age (15–49 years). A specific variable on twin births exists in almost all databases (see an extract of the questionnaire in ***Appendix 2***). In cases where this variable did not exist, we created it by using a matching technique with the identification and date variables from women and their children.

To calculate the twinning rates we used data from the 174 surveys. For each woman (mother) surveyed, her reproductive history was constructed. For each survey, all births that took place in the 10 years preceding the survey (between *t* and *t-10* years, where *t* is the survey year) were selected. This 10-year selection is to compensate for the low annual number of twin births in our data. The twinning rate was then calculated for each survey by applying the following calculation formula:

$$\text{Twinning rate (for survey year)} = \left( \frac{\boldsymbol{Number\ of\ multiple\ births\ between\ t\ and\ t-10\ years}}{\boldsymbol{All\ births\ between\ t\ and\ t-10\ years}} \right) * \mathbf{1000}$$

As the twinning rate depends on maternal age (Smits & Monden, 2011), we choose to standardize it by using the standard age distribution of births from women aged 15–49 in sub-Saharan Africa from 2000–2010, based on estimates done by the United Nations (2017). Standardization makes it possible to eliminate the variation of the twinning rate (between periods and between countries) due to differences in the maternal age distribution of births, in order to show only the parts due to other factors. For each country we also produced a standardized average of twinning rate covering the period from its first to its last survey.

To calculate the twinning rate for all 42 countries and its distribution by sub-region, a weight was applied. It was done by calculating the share (weight) of each country's births in the total births of the 42 countries.

The analytical part (logistic regression) of the article uses only data from the DHS and MICS surveys conducted after 2009, keeping only one survey per country, preferably those conducted in 2010 or close to 2010. This choice was made in order to have a sample of births that took place in a more restricted time interval (2000–2010). This led to a sample of 37 surveys from 37 different countries. In the end, only 25 of these 37 surveys were analysed because 12 of them did not collect information on the mother's ethnicity, which is an important variable for our analysis. In total, we have a sample of 488,083 births, including 9,160 multiple births (18.8‰) and 478,923 single births.

To determine the factors associated with multiple births, we conducted univariate and bivariate analyses and then a multivariate logistic regression. The variables explored and retained are: maternal age, birth rank, mother's ethnic group, household wealth quintile, geographical sub-region of the country, and year of childbirth. Only factors associated with twinning in the bivariate analysis with a *p*-value of less than 5% were considered in the multivariate model. The variables were selected in the multivariate analysis using a bottom-up, step-by-step procedure, based on the Akaike Criterion (AIC). We also compared the respective contribution of maternal age and birth rank to the decrease of the AIC criterion. The variable whose removal from the adjusted model contributed to the largest increase in the AIC criterion was then considered to have the largest effect. All analyses were performed using SAS software version 9.4. Since the analysis is cross-sectional, we applied the "cluster" option to the woman's identification variable in the implementation of the logistic regression to take into account the fact that the same woman could have several births in our data.

It should be noted that triplets and more births were counted with twins here. Because of their very low frequency (0.21‰), this does not modify the results found. In their work on twinning in developing countries, Smits & Monden (2011) found that “the triplet rate is 285 per million births in the high twinning countries of Africa, 155 per million births in the other African countries, 68 per million births in South and South East Asia and 83 per million births in Latin America without Caribbean.” (Smits & Monden, 2011:3). As a result, in African countries with high twinning rates, the triplet birth rate would be 0.285‰ (285/1,000,000), which confirms that taking into account triplets among twins is equivalent to an almost negligible impact on the twinning rate.

# 4. Results

## *4.1. Twinning rate*

The average of the standardized twinning rate over the period of 1986–2016 is 17.4‰ for all 42 countries studied. In almost all of these countries (except Madagascar at 10.6‰, Somalia at 5.5‰, and Burundi at 10.6‰), the twinning rate is higher than the world average of 11.3‰ for 2010 (Pison et al., 2017). For all 42 countries, the median twinning rate (the rate where 21 countries are below and 21 are above) is 18.2‰. The African country with the highest twinning rate is Benin (more than 27‰). ***Table 1*** below presents the average twinning rates by sub-region in sub-Saharan Africa. West Africa has the highest average twinning rate (20‰), while Southern Africa has the lowest average rate (13‰). Details of the twinning rates by survey and country are presented in ***Appendix 1***.

**Table 1: Variation of twinning rate by sub-region in sub-Saharan Africa**

| | *Twinning rate average (‰)* |
|---|---|
| ***Sub-regions (classic grouping)*** | |
| West Africa | ***19.8*** |
| East Africa | ***15.3*** |
| Central Africa | ***18.6*** |
| Southern Africa | ***12.9*** |
| ***Sub-regions (specific grouping)***[1] | |
| Sahel | ***17.6*** |
| Gulf of Guinea | ***19.8*** |
| East Africa | ***15.5*** |
| Southern Africa & Madagascar | ***13.0*** |

**Source:** DHS & MICS; authors' calculation

[1] **Sahel:** Burkina Faso, Mali, Mauritania, Niger, Senegal, Chad; **Gulf of Guinea**: Angola, Benin, Cameroon, Congo, Cote d'Ivoire, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Nigeria, DR Congo, Sao Tome, Sierra Leone, Togo; **East Africa**: Burundi, Comoros, Kenya, Malawi, Mozambique, Uganda, Rwanda, South Sudan, Tanzania, Zambia; **Southern Africa & Madagascar**: Lesotho, Madagascar, Namibia, Swaziland, Zimbabwe.

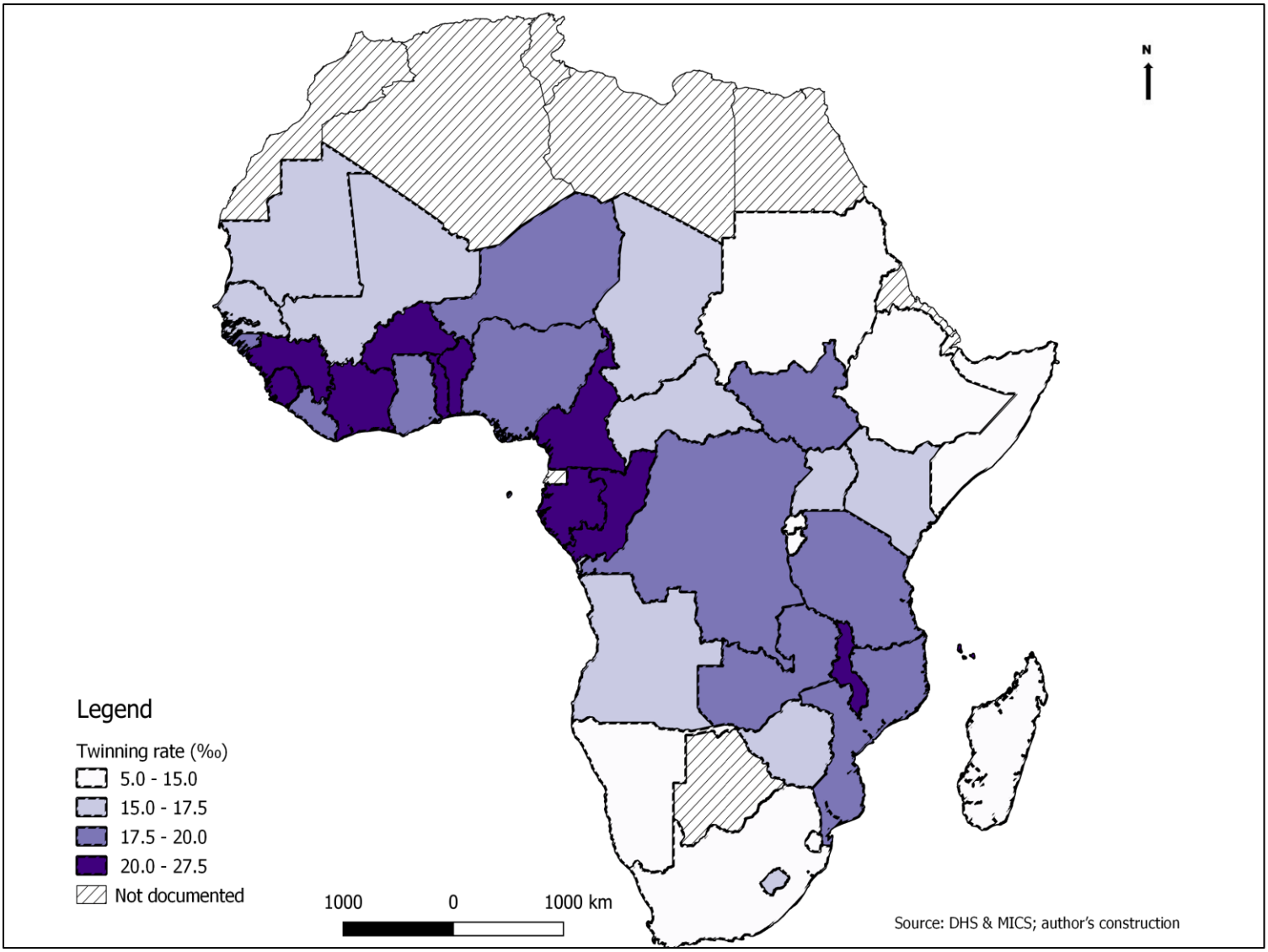



**Figure 2: Map of the twinning rate[2] (average) in sub-Saharan Africa**

[2] Maternal age standardized twinning rates

The map (***Figure* 2** above) shows a high twinning rate area around the Gulf of Guinea with an extension in a band crossing Africa from Congo in the west to Tanzania and Mozambique in the east. In addition, by observing the variations in twin birth rates in each country over time (see ***Figure 3*** below), we can see that in almost all of these countries, the rates increased relatively little, starting in the 2000s (see also ***Appendix 1***).

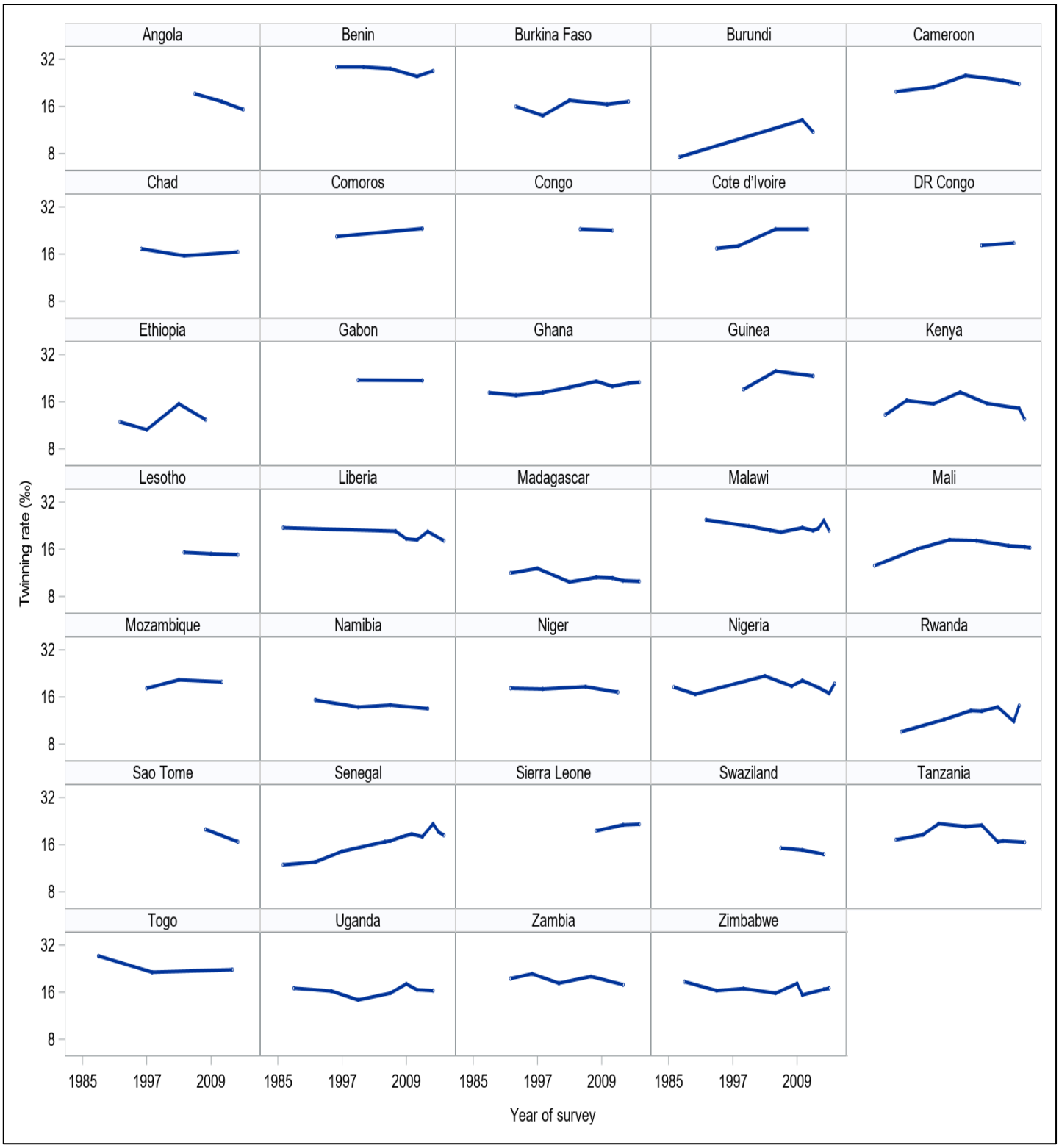



**Figure 3: Trends of the standardised rate of twinning in sub-Saharan African countries**

**Source:** DHS & MICS; authors' calculation

### *4.2.Twin birth associated factors in sub-Saharan Africa*

In our sample, 47% of births were from women under-25 (see Table 2 below). In addition, 43% of births were above a  of 3 births. Nearly 50% of births were in countries around the Gulf of Guinea. Nearly 50% of births were among women living in poor or very poor households, and 32% of births were among the ethnic Bantu people.

Maternal age and  are the main factors associated with twinning. ***Figure 4*** illustrates the increase of twinning rate by maternal age until it reaches its maximum around 39–43 years of age with a rate of more than 32‰, then it gradually decreases towards a rate of almost zero at age 50. An independence test of Rao-Scot's Chi-2 demonstrates the association between maternal age (recoded into an age group) and twinning ($p$-value <0.0001).

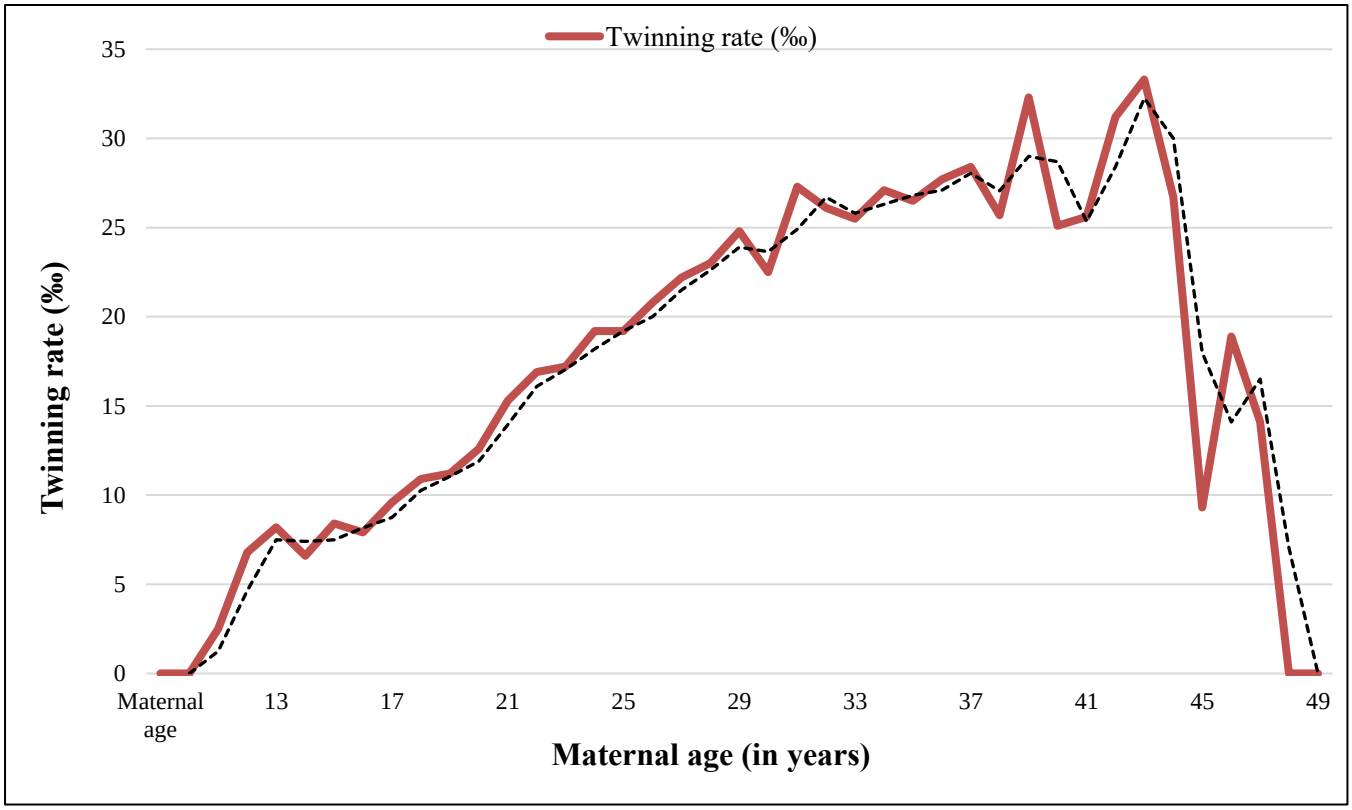



**Figure 4: Twinning rate by maternal age**[3]

**Source:** DHS & MICS; authors' construction.

[3] – – – The black dotted line curve was obtained by smoothing the red line using the moving average method.

Similarly, there is an association between twinning and birth rank, recoded as a qualitative variable ($p$<0.0001) (***Figure 5***). The rate is more than 36‰ at the birth rank 10 births and above, compared to 8‰ for first births.

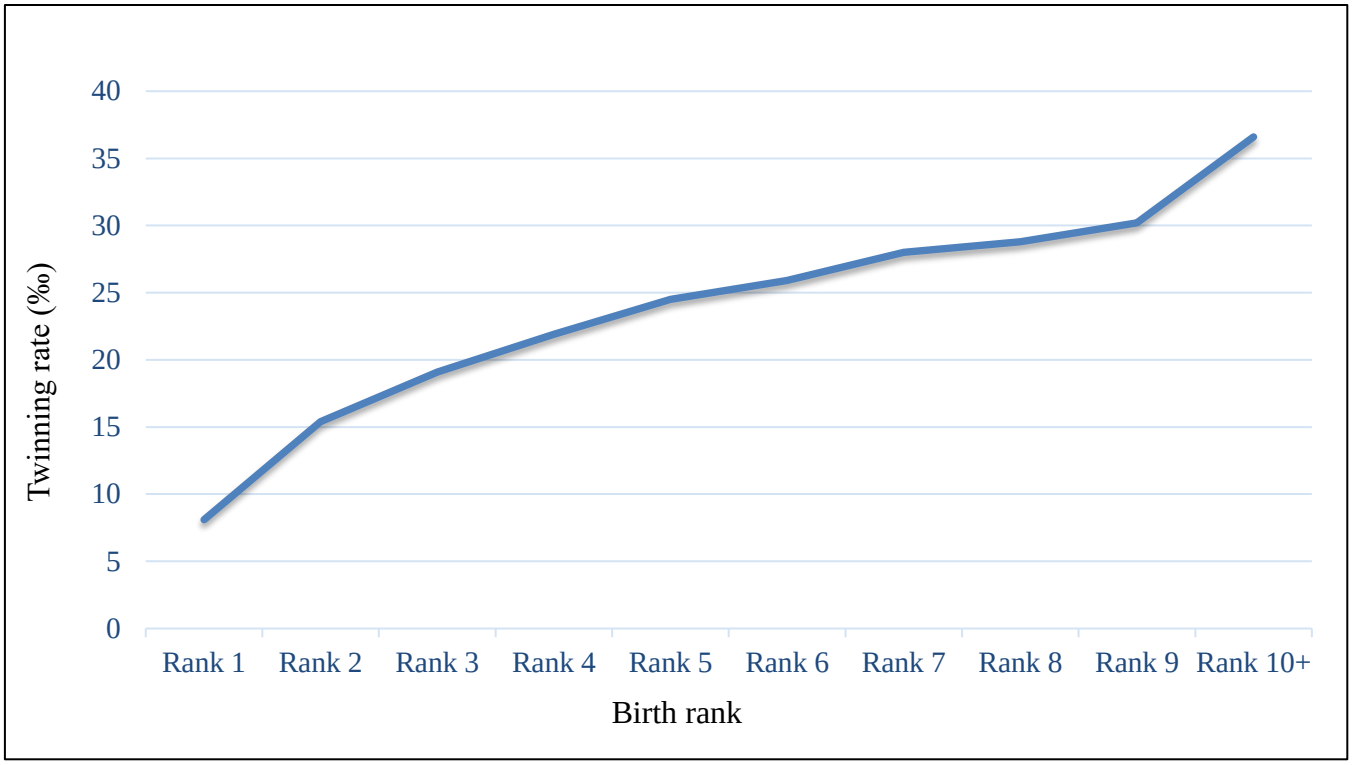



**Figure 5: Twinning rate by birth rank**

**Source:** DHS & MICS; author's construction. Rank 10+: Rank 10 to 16.

The bi-varied results also show that there is an association between the twinning rate and other explanatory variables such as the country's geographical sub-region ($p$-value <0.0001), the household wealth quintile ($p$-value =0.02) and the mother's ethnic group ($p$-value <0.0001).

The results of the logistic regression (see ***Table 2*** below) show that, all else being equal, the probability of giving birth to twins is significantly higher among older women, regardless of their birth rank. Unadjusted odds ratios show that, compared to women aged 20–25 years, the risk of twin births is 1.8 times higher among women in the 35 and over age group. After adjusting for the other co-variables, this risk remains 1.16 times higher. With regard to the birth rank, unadjusted odds ratios show that the risk of twin births is 3.5 times higher for births of rank 6 or higher compared to first births. After adjustment, this risk remains 2.91 times higher.

The effect of birth rank on the probability of twin births appears to be greater than that of maternal age, given its lower unadjusted AIC criterion and its greater contribution to lowering the AIC criterion in the adjusted model. The birth rank, compared to maternal age, has an almost 15-fold higher contribution to the parsimony of the final model (table in ***Appendix 3)***.

For the other co-variables, the risk of twin births is significantly higher among women belonging to Bantu ethnic groups compared to women from the following ethnic groups: Arabs and Related, Fulani and Related, Saharans, Mandes, and Ubangian-Adamaouans. The probability of twin births increases with the household's wealth quintile. It is also highest in the countries bordering the Gulf of Guinea. There is also a low positive correlation between twin births

and year of birth, reflecting a slightly increased probability of a twin birth over time.

**Table 2: Factors associated with twin births: univariate and multivariate analysis**

| Variables & modalities | Number of births | | Unadjusted OR | | Adjusted OR | |
|---|---|---|---|---|---|---|
| | N | % | OR | 95% CI | OR | 95% CI |
| **Maternal age (in years; Median=25.4, Q1=20.9 and Q3=31.0)** | | | | | | |
| < 20 | 95,035 | 19.47 | 0.63 *** | 0.574–0.699 | 0.882 * | 0.788–0.987 |
| 20–25 | 137,139 | 28.10 | ref | | ref | |
| 25–30 | 114,618 | 23.48 | 1.408 *** | 1.309–1.514 | 1.115 ** | 1.030–1.208 |
| 30–35 | 81,661 | 16.73 | 1.709 *** | 1.583–1.845 | 1.185 *** | 1.078–1.302 |
| >= 35 | 59,630 | 12.22 | 1.803 *** | 1.660–1.958 | 1.159 ** | 1.040–1.292 |
| **Birth rank (Median=rank 3, Q1=rank 2 and Q3=rank 5)** | | | | | | |
| Rank 1 | 104,992 | 21.51 | ref | | ref | |
| Rank 2 | 93,643 | 19.19 | 1.926 *** | 1.730–2.144 | 1.774 *** | 1.582–1.991 |
| Rank 3 | 79,125 | 16.21 | 2.297 *** | 2.068–2.551 | 2.006 *** | 1.775–2.267 |
| Rank 4 | 64,533 | 13.22 | 2.804 *** | 2.521–3.120 | 2.484 *** | 2.181–2.828 |
| Rank 5 | 49,666 | 10.18 | 3.077 *** | 2.754–3.438 | 2.587 *** | 2.251–2.973 |
| Ran 6 or more | 96,124 | 19.69 | 3.506 *** | 3.178–3.869 | 2.917 *** | 2.543–3.346 |
| **Geographical area** | | | | | | |
| Sahel | 121,196 | 24.83 | 1.002 | 0.929–1.081 | 1.111 * | 1.000–1.233 |
| Gulf of Guinea | 232,299 | 47.59 | 1.202 *** | 1.126–1.282 | 1.265 *** | 1.161–1.379 |
| East Africa | 134,588 | 27.57 | ref | | ref | |
| **Wealth quintile** | | | | | | |
| 1st quintile | 130,199 | 26.68 | ref | | ref | |
| 2nd quintile | 108,734 | 22.28 | 1.099 * | 1.018–1.186 | 1.107 ** | 1.026–1.195 |
| 3rd quintile | 98,275 | 20.13 | 1.124 ** | 1.038–1.217 | 1.149 *** | 1.061–1.244 |
| 4th quintile | 86,232 | 17.67 | 1.098 * | 1.011–1.193 | 1.165 *** | 1.071–1.267 |
| 5th quintile | 64,643 | 13.24 | 1.052 | 0.962–1.151 | 1.200 *** | 1.094–1.315 |
| **Mother's ethnic group[4]** | | | | | | |
| Arab & related groups | 22,083 | 4.52 | 0.792 ** | 0.690–0.910 | 0.749 *** | 0.639–0.878 |
| Fulani & related groups | 40,786 | 8.36 | 0.928 | 0.841–1.025 | 0.821 *** | 0.731–0.921 |
| Saharan groups | 9,126 | 1.87 | 0.746 * | 0.587–0.949 | 0.665 ** | 0.515–0.857 |
| Sudanese groups | 26,083 | 5.34 | 0.859 * | 0.753–0.980 | 0.883 | 0.772–1.011 |
| Mande groups | 54,326 | 11.13 | 0.943 | 0.861–1.033 | 0.839 ** | 0.752–0.936 |
| Voltaic groups | 44,844 | 9.19 | 1.013 | 0.921–1.114 | 0.905 | 0.807–1.016 |
| Ubangian-Adamaouans groups | 17,903 | 3.67 | 0.890 | 0.744–1.064 | 0.795 * | 0.66–0.957 |
| Atlantic groups | 73,601 | 15.08 | 1.126 ** | 1.042–1.216 | 0.985 | 0.895–1.084 |
| Bantu groups | 157,200 | 32.21 | ref | | ref | |
| Other groups | 42,131 | 8.63 | 0.960 | 0.960–0.865 | 0.900 * | 0.805–1.006 |
| **Year of delivery (continuous variable)** | | | | | | |
| Year of delivery | 488,083 | 100 | 1.020 *** | 1.011–1.029 | 1.013 ** | 1.003–1.022 |

[4] The construction of these ethnic groups is an adaptation of the basic linguistic division of the peoples of sub-Saharan Africa: https://fr.wikipedia.org/wiki/Langues_d%27Afrique#/media/Fichier:LanguesAfrique.jpg.

*OR =Odds Ratio; IC= Confidence Interval; ***=p-value<0.0001, **= p-value<0.001 and *= p-value<0.051; ref = reference parameter*

**Source:** DHS & MICS; authors' calculation.

## 5. Discussion

The average of the twinning rate in sub-Saharan Africa was 17.4‰ during the period of 1986–2016 with little change over time. The rate increases with the mother's age and the birth rank, with the birth tank having a greater effect (see ***Appendix 3***). It also varies according to the mother's ethnicity, geographical sub-region and household wealth.

The analysis of associated factors in twin births (the most important of which remain the rank of birth and maternal age), is an important aspect of our study, since it is rarely studied in Europe. However, the absence of data on stillbirths is the main limitation of our study. This lack may have caused an underestimation of twinning rates. The shortage of information on the mother's ethnic group in some countries led us to eliminate 12 surveys in the multivariate part of the study. However, we verified that any consideration of these data would not have changed the meaning of the estimated odds ratios.

Our study confirms the high twinning rates in Africa. The rates obtained for each country are relatively similar to those found by Smits & Monden in 2011 with pre-2006 DHS data. In addition, our results on the geographical distribution of the twinning rate are similar to those found by Pison in 1989 and Smits & Monden in 2011. According to these results, the rate of twin births is higher around the Gulf of Guinea and in some central and eastern African countries such as Southern Sudan, Malawi, Mozambique, Comoros, Zambia, and

Tanzania. The average twinning rate of 17.4‰ that we obtained for the overall level of all 42 countries over the period of 1986–2016 is very similar to that found by Smits & Monden in 2011 for a total of 36 sub-Saharan African countries (period: 1987–2006). It is also very close to the rate (17.1‰) found by Gebremedhin in 2015 from a set of 25 Sub-Saharan African countries (period: 2008–2014). However, this rate is significantly lower than the 20‰ rate estimated by Pison in 2000. These various results seem to attest to a slight change of the twinning rate in sub-Saharan Africa, particularly from the 2000s onwards. This slight change in the twinning rate could be explained by a kind of equilibrium resulting from the decline in births at very young ages and also at older ages. If the decline of the birth rate on the continent outweighs the increase of the average age of motherhood, a real decline of the twinning rate is to be expected in the coming years. Assisted reproductive technology (ART), which could contribute to an increase of the twinning rate, is used by only a very small fraction of the sub-Saharan population and has therefore probably not had any influence so far (Bonnet, 2016).

Our results also show that the birth rank appears to be the main factor associated with twin births, unlike the maternal age mentioned by Couvert (2011) for France. In addition to the demonstration made with logistic regression, the two figures in ***Appendix 3*** provide more information, showing that, overall, in the same maternal age group, the twinning rate increases significantly with the birth rank. However, for the same birth rank, the twinning rate increases with maternal age, but only if the birth rank is less than 4. From a birth rank 4 and more, the twinning rate within the same birth rank no longer increases with maternal age. We believe that the difference between our results and those found by Couvert

(2011) lies in the birth rates of the countries studied. Because birth rate levels in sub-Saharan African countries are 3 to 4 times higher than those in France, it seems to us that in countries with a high birth rate, the birth rank is more strongly associated with the probability of twin births. Nevertheless, the birth rank would not be a factor per se, but the association would come from an effect of selecting the most fertile women, who are predisposed to have several births and therefore more exposed to the risk of multiple births (Pison & Couvert, 2004; Couvert, 2011).

## 6. Conclusion

To conclude, we believe that our results are of interest for informing health policies, since the high level of twin birth rates in sub-Saharan Africa creates public health challenges in terms of developing obstetric services. Twin children are much more fragile than singleton children because of their lower birth weight and their frequent prematurity, which leads to more obstetric complications and higher risks of foetal and neonatal mortality.

Our other ongoing work, addressing the excessive mortality rate of twins in sub-Saharan Africa, will allow us to further clarify the level of the health challenge created by twin births on the continent.

## 7. References


Blondel, B., 2009. Augmentation des naissances gémellaires et conséquences sur la santé. *J. Gynécologie Obstétrique Biol.* Reprod. 38, S7–S17.

Bomsel-Helmreich, O., Al Mufti, W., 2005. *Multiple Pregnancy: Epidemiology, Gestation & Perinatal Outcome.* Taylor & Francis, London; New York.

Bonnet, D. (Ed.), 2016. *Procréation médicale et mondialisation: expériences africaines, Anthropologies & médecines*. L'Harmattan, Paris.

Bulmer, M.G., 1970. *The Biology of Twinning in Man.* Oxf. Univ. Press.

Couvert, N., 2011. *Un siècle de démographie des jumeaux en France : Fréquence,mortalité et parcours de vie.* Université Paris 1 Panthéon Sorbonne - Ecole doctorale de géographie, Paris, France.

Daguet, F., 2002. *Un siècle de fécondité française: caractéristiques et évolution de la fécondité de 1901 à 1999*. INSEE résultats Société. Inst. National de la Statistique et des Etudes Economiques, Paris.

Duchesne, L., Institut de la statistique du Québec, 2001. *Les naissances: les jumeaux, le poids des nouveaux-nés et la mortalité infantile.* Institut de la statistique du Québec, Québec.

Gabler, S., Voland, E., 1994. Fitness of Twinning. Hum. Biol. 66, 699–713.

Gebremedhin, S., 2015. Multiple Births in Sub-Saharan Africa: Epidemiology, Postnatal Survival, and Growth Pattern. Twin Res. Hum. Genet. 18, 100–107. https://doi.org/10.1017/thg.2014.82

Hall, J.G., 2003. Twinning. The Lancet 362, 735–743. https://doi.org/10.1016/S0140-6736(03)14237-7

Long, E., Ferriman, E., 2016. Twin pregnancy. Obstet. Gynaecol. Reprod. Med. 26, 38–45. https://doi.org/10.1016/j.ogrm.2015.11.010

United Nations, 2017. World Population Prospects, the 2017 Revision [WWW Document]. Popul. UN. URL https://population.un.org/wpp/ (accessed 1.1.18).

Pison, G., 2000. Près de la moitié des jumeaux naissent en Afrique. Popul. Sociétés Bull. Mens. D'information L'Institut Natl. D'études Démographiques 4.

Pison, G., 1989. Les jumeaux en Afrique au sud du Sahara: fréquence, statut social et mortalité, in: Mortalité et Société En Afrique Au Sud Du Sahara. Institut national d'études démographiques, Paris, pp. 245–269.

Pison, G., Couvert, N., 2004. La fréquence des accouchements gémellaires en France: La triple influence de la biologie, de la médecine et des comportements familiaux. Population 59, 877. https://doi.org/10.3917/popu.406.0877

Pison, G., Monden, C., Smits, J., 2017. How many twins are born on earth?

Pison, G., Monden, C., Smits, J., 2015. Twinning rates in developed countries: Trends and explanations. *Popul. Dev.* Rev. 41, 629–649.

Pison, G., Monden, C., Smits, J., 2014. Is the twin-boom in developed countries coming to an end?

Satija, M., Sharma, S., Soni, R.K., Sachar, R.K., Singh, G.P.I., 2008. Twinning and Its Correlates: Community-Based Study in a Rural Area of India. *Hum. Biol*. 80, 611–621.

Sear, R., Shanley, D., Mcgregor, I.A., Mace, R., 2001. The fitness of twin mothers: evidence from rural Gambia. *J. Evol. Biol.* 14, 433–443. https://doi.org/10.1046/j.1420-9101.2001.00287.x

Smits, J., Monden, C., 2011. Twinning across the Developing World. PLoS ONE 6, e25239. https://doi.org/10.1371/journal.pone.0025239

Terzera, L., 2002. The evolution of multiple births in Italy. *Genus* 58, 159–181.

UNICEF, 2018. Surveys - UNICEF MICS [WWW Document]. UNICEF MICS. URL http://mics.unicef.org/surveys (accessed 7.31.18).

USAID, n.d. The DHS Program - Quality information to plan, monitor and improve population, health, and nutrition programs [WWW Document]. DHS ProgramDemographic Health Surv. URL https://dhsprogram.com/ (accessed 7.31.18).

Vitthala, S., Gelbaya, T.A., Brison, D.R., Fitzgerald, C.T., Nardo, L.G., 2009. The risk of monozygotic twins after assisted reproductive technology: a systematic review and meta-analysis. *Hum. Reprod. Update* 15, 45–55. https://doi.org/10.1093/humupd/dmn045

## 8. Appendices

**Appendix 1: Twinning rate in 42 countries[5] of Sub-Saharan Africa–Data: standard DHS[6], MIS[7], AIS[8] et MICS[9]**

| Country | Survey years | Period used for rates calculation | Data source | All births | Twin births | Twinning rate (‰) | | Country average standardized rate[10] |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Crude rate[11] | Standardized rate[12] | |
| Angola | 2015–16 | 2006–2015 | Standard DHS | 25,131 | 369 | ***14.7*** | ***15.3*** | ***17.3*** |
| | 2011 | 2002–2011 | MIS | 13,832 | 223 | ***16.1*** | ***17.2*** | |
| | 2006–07 | 2001–2007* | MIS | 2,878 | 54 | ***18.8*** | ***19.3*** | |
| Benin | 2014 | 2005–2014 | MICS UNICEF | 23,624 | 657 | 27.8 | 27.0 | ***27.4*** |
| | 2011–12 | 2002–2011 | Standard DHS | 25,681 | 640 | 24.9 | 24.9 | |
| | 2006 | 1997–2006 | Standard DHS | 30,027 | 841 | 28.0 | 27.9 | |
| | 2001 | 1992–2001 | Standard DHS | 10,093 | 292 | 28.9 | 28.6 | |
| | 1996 | 1987–1996 | Standard DHS | 9,758 | 288 | 29.5 | 28.6 | |
| Burkina Faso | 2014 | 2008–2014* | MIS | 8,703 | 150 | ***17.2*** | ***17.2*** | ***20.3*** |
| | 2010 | 2001–2010 | Standard DHS | 28,956 | 531 | ***18.3*** | ***16.5*** | |
| | 2003 | 1994–2003 | Standard DHS | 20,848 | 372 | ***17.8*** | ***17.5*** | |
| | 1998–99 | 1989–1998 | Standard DHS | 11,568 | 164 | ***14.2*** | ***14.0*** | |
| | 1993 | 1984–1993 | Standard DHS | 11,196 | 175 | ***15.6*** | ***16.0*** | |

[5] *Countries not included because lack of data: Botswana, Cape Verde, Djibouti, Equatorial Guinea, Eritrea, Mauritius, and Seychelles.*

[6] *Demographic and Health Survey*

[7] *Malaria Indicators Survey*

[8] *AIDS Indicators Survey*

[9] *Multiple Indicator Cluster Surveys*

[10] *By dividing the sum of a country's standardized rates by the number of its surveys.*

[11] *Number of double births per 1000 deliveries*

[12] *Given to the positive correlation between twinning and maternal age, rates were standardized using the age distribution of births of women aged 15-49 in Sub-Saharan Africa from 2000 – 2010 (source: United Nations).*

** Data with possible bias: short period (less than 10 years) and reproductive histories limited to 5 entries (5 deliveries) per woman.*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Burundi | 2012 | 2006–2012* | MIS | 5,466 | 61 | ***11.2*** | ***11.0*** | ***10.6*** |
| | 2010 | 2001–2010 | Standard DHS | 13,776 | 182 | ***13.2*** | ***13.1*** | |
| | 1987 | 1978–1987 | Standard DHS | 7,055 | 57 | ***8.1*** | ***7.6*** | |
| Cameroon | 2014 | 2005–2014 | MICS UNICEF | 13,839 | 303 | ***21.9*** | ***22.3*** | ***21.4*** |
| | 2011 | 2002–2011 | Standard DHS | 21,680 | 492 | ***22.7*** | ***23.5*** | |
| | 2004 | 1995–2004 | Standard DHS | 14,860 | 351 | ***23.6*** | ***25.2*** | |
| | 1998 | 1989–1998 | Standard DHS | 7,700 | 157 | ***20.4*** | ***21.3*** | |
| | 1991 | 1982–1991 | Standard DHS | 6,276 | 117 | ***18.6*** | ***19.9*** | |
| Central Africa | 1994–95 | 1985–1994 | Standard DHS | 9,186 | 130 | ***14.2*** | ***15.4*** | ***15.4*** |
| Chad | 2014–15 | 2005–2014 | Standard DHS | 37,372 | 579 | ***15.5*** | ***16.5*** | ***16.5*** |
| | 2004 | 1995–2004 | Standard DHS | 10,967 | 164 | ***15.0*** | ***15.6*** | |
| | 1996–97 | 1987–1996 | Standard DHS | 13,938 | 227 | ***16.3*** | ***17.3*** | |
| Comoros | 2012 | 2003–2012 | Standard DHS | 5,967 | 144 | ***24.1*** | ***23.3*** | ***22.0*** |
| | 1996 | 1987–1996 | Standard DHS | 3,922 | 82 | ***20.9*** | ***20.7*** | |
| Congo | 2011–12 | 2002–2011 | Standard DHS | 16,804 | 375 | ***22.3*** | ***22.7*** | ***22.9*** |
| | 2005 | 1996–2005 | Standard DHS | 8,597 | 194 | ***22.6*** | ***23.1*** | |
| DR Congo | 2013–14 | 2004–2013 | Standard DHS | 33,620 | 628 | ***18.7*** | ***18.8*** | ***18.5*** |
| | 2007 | 1998–2007 | Standard DHS | 16,144 | 293 | ***18.1*** | ***18.2*** | |
| Cote d'Ivoire | 2011–12 | 2002–2011 | Standard DHS | 14,503 | 326 | ***22.5*** | ***23.1*** | ***20.4*** |
| | 2005 | 1996–2005 | AIS | 6,814 | 145 | ***21.3*** | ***23.1*** | |
| | 1998-99 | 1989–1998 | Standard DHS | 3,818 | 66 | ***17.3*** | ***18.0*** | |
| | 1994 | 1985–1994 | Standard DHS | 13,472 | 222 | ***16.5*** | ***17.4*** | |
| Ethiopia | 2008 | 1999–2008 | Standard DHS | 21,201 | 266 | ***12.5*** | ***12.3*** | ***12.6*** |
| | 2003 | 1994–2003 | Standard DHS | 23,221 | 359 | ***15.5*** | ***15.5*** | |
| | 1997 | 1988–1997 | Standard DHS | 19,955 | 204 | ***10.2*** | ***10.6*** | |
| | 1992 | 1983–1992 | Standard DHS | 21,329 | 257 | ***12.0*** | ***11.9*** | |
| Gabon | 2012 | 2003–2012 | Standard DHS | 10,885 | 228 | ***20.9*** | ***21.9*** | ***21.9*** |
| | 2000 | 1991–2000 | Standard DHS | 8,230 | 169 | ***20.5*** | ***22.0*** | |
| Gambia | 2013 | 2004–2013 | Standard DHS | 14,699 | 236 | ***16.1*** | ***16.1*** | ***16.1*** |
| | 2016 | 2011–2016* | MIS | 3,649 | 82 | ***22.5*** | ***21.3*** | ***19.7*** |
| | 2014 | 2005–2014 | Standard DHS | 11,111 | 249 | ***22.4*** | ***21.0*** | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ghana | 2011 | 2002–2011 | MICS UNICEF | 14,830 | 336 | ***22.7*** | ***20.1*** | |
| | 2008 | 1999–2008 | Standard DHS | 5,702 | 128 | ***22.4*** | ***21.6*** | |
| | 2003 | 1994–2003 | Standard DHS | 7,269 | 152 | ***20.9*** | ***19.8*** | |
| | 1998 | 1989–1998 | Standard DHS | 6,427 | 123 | ***19.1*** | ***18.3*** | |
| | 1993 | 1984–1993 | Standard DHS | 7,045 | 126 | ***17.9*** | ***17.6*** | |
| | 1988 | 1979–1988 | Standard DHS | 7,544 | 139 | ***18.4*** | ***18.3*** | |
| Guinea | 2012 | 2003–2012 | Standard DHS | 13,696 | 307 | ***22.4*** | ***23.4*** | ***22.5*** |
| | 2005 | 1996–2005 | Standard DHS | 12,940 | 326 | ***25.2*** | ***25.1*** | |
| | 1999 | 1990–1999 | Standard DHS | 11,784 | 223 | ***18.9*** | ***19.2*** | |
| Guinea Bissau | 2014 | 2005–2014 | MICS UNICEF | 14,373 | 262 | ***18.2*** | ***18.4*** | ***18.4*** |
| Kenya | 2015 | 2010–2015* | MIS | 3,962 | 46 | ***11.6*** | ***12.4*** | ***15.1*** |
| | 2014 | 2005–2014 | Standard DHS | 41,973 | 599 | ***14.3*** | ***14.5*** | |
| | 2008–09 | 1999–2008 | Standard DHS | 11,392 | 172 | ***15.1*** | ***15.6*** | |
| | 2003 | 1994–2003 | Standard DHS | 10,866 | 186 | ***17.1*** | ***18.4*** | |
| | 1998 | 1989–1998 | Standard DHS | 11,026 | 166 | ***15.1*** | ***15.5*** | |
| | 1993 | 1984–1993 | Standard DHS | 12,175 | 193 | ***15.9*** | ***16.3*** | |
| | 1989 | 1980–1989 | Standard DHS | 13,292 | 173 | ***13.0*** | ***13.2*** | |
| Lesotho | 2014 | 2005–2014 | Standard DHS | 5,906 | 80 | ***13.5*** | ***14.8*** | ***15.1*** |
| | 2009 | 2000–2009 | Standard DHS | 7,095 | 98 | ***13.8*** | ***15.0*** | |
| | 2004 | 1995–2004 | Standard DHS | 6,828 | 101 | ***14.8*** | ***15.3*** | |
| Liberia | 2016 | 2011–2016* | MIS | 3,314 | 58 | ***17.5*** | ***18.2*** | ***19.8*** |
| | 2013 | 2004–2013 | Standard DHS | 15,146 | 307 | ***20.3*** | ***20.8*** | |
| | 2011 | 2004–2011* | MIS | 3,848 | 69 | ***17.9*** | ***18.4*** | |
| | 2009 | 2000–2009 | MIS | 7,705 | 140 | ***18.2*** | ***18.7*** | |
| | 2007 | 1998–2007 | Standard DHS | 10,914 | 225 | ***20.6*** | ***20.9*** | |
| | 1986 | 1977–1986 | Standard DHS | 9,670 | 201 | ***20.8*** | ***22.0*** | |
| Madagascar | 2016 | 2011–2016* | MIS | 7,555 | 72 | ***9.5*** | ***10.0*** | ***10.6*** |
| | 2013 | 2007–2013* | MIS | 6,319 | 64 | ***10.1*** | ***10.1*** | |
| | 2011 | 2004–2011* | MIS | 6,908 | 72 | ***10.4*** | ***10.5*** | |
| | 2008–09 | 1999–2008 | Standard DHS | 24,887 | 255 | ***10.2*** | ***10.6*** | |
| | 2003–04 | 1994–2003 | Standard DHS | 10,595 | 100 | ***9.4*** | ***9.9*** | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1997 | 1988–1997 | Standard DHS | 11,268 | 131 | ***11.6*** | ***12.1*** | |
| | 1992 | 1983–1992 | Standard DHS | 9,794 | 112 | ***11.4*** | ***11.3*** | |
| Malawi | 2015–16 | 2006–2015 | Standard DHS | 33,738 | 683 | ***20.2*** | ***21.1*** | ***22.2*** |
| | 2014 | 2008–2014* | MIS | 2,380 | 50 | ***21.0*** | ***24.4*** | |
| | 2013 | 2004–2013 | MICS UNICEF | 37,508 | 769 | ***20.5*** | ***21.8*** | |
| | 2012 | 2005– 2012 | MIS | 2,618 | 54 | ***20.6*** | ***21.1*** | |
| | 2010 | 2001–2010 | Standard DHS | 37,823 | 791 | ***20.9*** | ***22.0*** | |
| | 2006 | 1997–2006 | MICS UNICEF | 44,683 | 853 | ***19.1*** | ***20.6*** | |
| | 2004 | 1995–2004 | Standard DHS | 19,444 | 380 | ***19.5*** | ***21.2*** | |
| | 2000 | 1991–2000 | Standard DHS | 21,437 | 453 | ***21.1*** | ***22.5*** | |
| | 1992 | 1983–1992 | Standard DHS | 8,489 | 203 | ***23.9*** | ***24.7*** | |
| Mali | 2015b | 2006–2015 | MICS UNICEF | 31,795 | 518 | ***16.3*** | ***16.4*** | ***16.4*** |
| | 2015 | 2009– 2015* | MIS | 8,942 | 145 | ***16.2*** | ***16.6*** | |
| | 2012–13 | 2003–2012 | Standard DHS | 19,540 | 315 | ***16.1*** | ***16.9*** | |
| | 2006 | 1997–2006 | Standard DHS | 27,486 | 481 | ***17.5*** | ***18.2*** | |
| | 2001 | 1992–2001 | Standard DHS | 25,523 | 456 | ***17.9*** | ***18.4*** | |
| | 1995–96 | 1986–1995 | Standard DHS | 19,958 | 315 | ***15.8*** | ***16.1*** | |
| | 1987 | 1978–1987 | Standard DHS | 6,684 | 78 | ***11.7*** | ***12.6*** | |
| Mauritania | 2011 | 2002–2011 | MICS UNICEF | 18,049 | 287 | ***15.9*** | ***15.3*** | ***15.3*** |
| Mozambique | 2011 | 2002–2011 | Standard DHS | 20,187 | 385 | ***19.1*** | ***20.0*** | ***19.6*** |
| | 2003 | 1994–2003 | Standard DHS | 19,292 | 373 | ***19.3*** | ***20.6*** | |
| | 1997 | 1988–1997 | Standard DHS | 13,207 | 229 | ***17.3*** | ***18.2*** | |
| Namibia | 2013 | 2004–2013 | Standard DHS | 9,253 | 127 | ***13.7*** | ***13.5*** | ***14.2*** |
| | 2006–07 | 1997–2006 | Standard DHS | 9,715 | 134 | ***13.8*** | ***14.2*** | |
| | 2000 | 1991–2000 | Standard DHS | 7,637 | 104 | ***13.6*** | ***13.8*** | |
| | 1992 | 1983–1992 | Standard DHS | 7,093 | 110 | ***15.5*** | ***15.3*** | |
| Niger | 2012 | 2003–2012 | Standard DHS | 24,602 | 417 | ***16.9*** | ***17.2*** | ***18.0*** |
| | 2006 | 1997–2006 | Standard DHS | 18,200 | 329 | ***18.1*** | ***18.6*** | |
| | 1998 | 1989–1998 | Standard DHS | 15,067 | 262 | ***17.4*** | ***18.0*** | |
| | 1992 | 1983–1992 | Standard DHS | 13,187 | 222 | ***16.8*** | ***18.2*** | |
| Nigeria | 2016–17 | 2007–2016 | MICS UNICEF | 54,030 | 1,072 | ***19.8*** | ***19.5*** | ***19.8*** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2015 | 2010– 2015* | MIS | 7,507 | 125 | ***16.7*** | ***16.9*** | |
| | 2013 | 2004–2013 | Standard DHS | 60,142 | 1,119 | ***18.6*** | ***18.4*** | |
| | 2010 | 2001–2010 | MIS | 10,608 | 215 | ***20.3*** | ***20.4*** | |
| | 2008 | 1999–2008 | Standard DHS | 54,141 | 1,007 | ***18.6*** | ***18.8*** | |
| | 2003 | 1994–2003 | Standard DHS | 11,250 | 236 | ***21.0*** | ***21.8*** | |
| | 1990 | 1981–1990 | Standard DHS | 15,491 | 251 | ***16.2*** | ***16.7*** | |
| | 1986 | 1977 - 1986 | Special–Ondo | 5,619 | 111 | ***19.8*** | ***18.5*** | |
| Rwanda | 2014–15 | 2005–2014 | Standard DHS | 15,579 | 226 | ***14.5*** | ***14.1*** | ***12.3*** |
| | 2013 | 2007–2013* | MIS | 3,797 | 48 | ***12.6*** | ***11.2*** | |
| | 2010 | 2001–2010 | Standard DHS | 17,220 | 250 | ***14.5*** | ***13.8*** | |
| | 2007–08 | 1998–2007 | Interim DHS | 10,095 | 146 | ***14.5*** | ***13.0*** | |
| | 2005 | 1996–2005 | Standard DHS | 16,295 | 229 | ***14.1*** | ***13.1*** | |
| | 2000 | 1991–2000 | Standard DHS | 14,567 | 186 | ***12.8*** | ***11.5*** | |
| | 1992 | 1983–1992 | Standard DHS | 10,877 | 109 | ***10.0*** | ***9.6*** | |
| Sao Tome | 2014 | 2005–2014 | MICS UNICEF | 3,773 | 60 | ***15.9*** | ***16.7*** | ***18.3*** |
| | 2008–09 | 1999–2008 | Standard DHS | 3,608 | 70 | ***19.4*** | ***20.0*** | |
| Senegal | 2016 | 1997–2016 | Continuous | 12,686 | 235 | ***18.5*** | ***18.4*** | ***17.0*** |
| | 2015 | 2006–2015 | Continuous | 13,065 | 256 | ***19.6*** | ***19.3*** | |
| | 2014 | 2005–2014 | Continuous | 12,490 | 271 | ***21.7*** | ***21.7*** | |
| | 2012–13 | 2003–2012 | Continuous | 12,515 | 225 | ***18.0*** | ***18.0*** | |
| | 2010–11 | 2001–2010 | Standard DHS | 22,823 | 428 | ***18.8*** | ***18.7*** | |
| | 2008–09 | 1999–2008 | MIS | 28,686 | 504 | ***17.6*** | ***17.9*** | |
| | 2006 | 2001–2006* | MIS | 4,727 | 81 | ***17.1*** | ***16.9*** | |
| | 2005 | 1996–2005 | Standard DHS | 20,524 | 348 | ***17.0*** | ***16.7*** | |
| | 1997 | 1988–1997 | Standard DHS | 14,354 | 212 | ***14.8*** | ***14.5*** | |
| | 1992–93 | 1983–1992 | Standard DHS | 10,906 | 138 | ***12.7*** | ***12.4*** | |
| | 1986 | 1977–1986 | Standard DHS | 8,148 | 93 | ***11.4*** | ***11.9*** | |
| Sierra Leone | 2016 | 2011–2016* | MIS | 6,742 | 145 | ***21.5*** | ***21.6*** | ***20.9*** |
| | 2013 | 2004–2013 | Standard DHS | 23,750 | 499 | ***21.0*** | ***21.4*** | |
| | 2008 | 1999–2008 | Standard DHS | 11,241 | 211 | ***18.8*** | ***19.6*** | |
| Somalia | 2006 | 1997–2006 | MICS UNICEF | 12,581 | 69 | ***5.5*** | ***5.5*** | ***5.5*** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| South Africa | 1998 | 1989–1998 | Standard DHS | 10,287 | 131 | ***12.7*** | ***12.7*** | ***12.7*** |
| Sudan | 1989–90 | 1980–1989 | Standard DHS | 12,959 | 195 | ***15.0*** | ***15.0*** | ***15.0*** |
| South Sudan | 2010 | 2001– 2010 | MICS UNICEF | 17,401 | 342 | ***19.7*** | ***19.9*** | ***19.9*** |
| Swaziland | 2014 | 2005–2014 | MICS UNICEF | 4,571 | 60 | ***13.1*** | ***13.9*** | ***14.7*** |
| | 2010 | 2001–2010 | MICS UNICEF | 4,603 | 63 | ***13.7*** | ***14.8*** | |
| | 2006–07 | 1997–2006 | Standard DHS | 5,269 | 75 | ***14.2*** | ***15.2*** | |
| Tanzania | 2015–16 | 2006–2015 | Standard DHS | 18,852 | 315 | ***16.7*** | ***16.6*** | ***18.7*** |
| | 2011–12 | 2004–2012 | AIS | 10,825 | 186 | ***17.2*** | ***16.9*** | |
| | 2010 | 2001–2010 | Standard DHS | 14,841 | 249 | ***16.8*** | ***16.7*** | |
| | 2007–08 | 1998–2007 | AIS | 13,728 | 293 | ***21.3*** | ***21.3*** | |
| | 2004–05 | 1995–2004 | Standard DHS | 15,619 | 322 | ***20.6*** | ***20.9*** | |
| | 1999 | 1990–1999 | Standard DHS | 6,022 | 127 | ***21.1*** | ***21.8*** | |
| | 1996 | 1987–1996 | Standard DHS | 12,687 | 231 | ***18.2*** | ***18.5*** | |
| | 1991–92 | 1982–1991 | Standard DHS | 14,849 | 246 | ***16.6*** | ***17.2*** | |
| Togo | 2013–14 | 2004–2013 | Standard DHS | 13,594 | 311 | ***22.9*** | ***22.3*** | ***23.7*** |
| | 1998 | 1989–1998 | Standard DHS | 13,755 | 306 | ***22.2*** | ***21.5*** | |
| | 1988 | 1979–1988 | Standard DHS | 5,853 | 158 | ***27.0*** | ***27.3*** | |
| Uganda | 2014–15 | 2008–2015* | MIS | 5,930 | 91 | ***15.3*** | ***16.4*** | ***16.3*** |
| | 2011 | 2002–2011 | Standard DHS | 14,829 | 242 | ***16.3*** | ***16.6*** | |
| | 2009 | 2000–2009 | MIS | 7,398 | 129 | ***17.4*** | ***18.1*** | |
| | 2006 | 1997–2006 | Standard DHS | 15,725 | 241 | ***15.3*** | ***15.8*** | |
| | 2000–01 | 1991– 2000 | Standard DHS | 13,021 | 176 | ***13.5*** | ***14.3*** | |
| | 1995 | 1986–1995 | Standard DHS | 12,858 | 195 | ***15.2*** | ***16.3*** | |
| | 1988–89 | 1980–1989 | Standard DHS | 8,858 | 143 | ***16.1*** | ***17.0*** | |
| Zambia | 2013–14 | 2004–2013 | Standard DHS | 25,653 | 444 | ***17.3*** | ***17.9*** | ***19.4*** |
| | 2007 | 1998–2007 | Standard DHS | 11,543 | 223 | ***19.3*** | ***20.2*** | |
| | 2001–02 | 1992–2001 | Standard DHS | 12,623 | 217 | ***17.2*** | ***18.3*** | |
| | 1996 | 1987–1996 | Standard DHS | 12,906 | 255 | ***19.8*** | ***21.0*** | |
| | 1992 | 1983–1992 | Standard DHS | 11,572 | 213 | ***18.4*** | ***19.6*** | |
| Zimbabwe | 2015 | 2006–2015 | Standard DHS | 11,060 | 185 | ***16.7*** | ***17.0*** | ***16.9*** |
| | 2014 | 2005–2014 | MICS UNICEF | 16,840 | 276 | ***16.4*** | ***16.7*** | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2010–11 | 2001–2010 | Standard DHS | 9,839 | 142 | ***14.4*** | ***15.4*** |
| | 2009 | 2000–2009 | MICS UNICEF | 12,259 | 212 | ***17.3*** | ***18.2*** |
| | 2005–06 | 1996–2005 | Standard DHS | 9,664 | 143 | ***14.8*** | ***15.8*** |
| | 1999 | 1990–1999 | Standard DHS | 6,811 | 110 | ***16.2*** | ***16.9*** |
| | 1994 | 1985–1994 | Standard DHS | 8,044 | 129 | ***16.0*** | ***16.4*** |
| | 1988 | 1979–1988 | Standard DHS | 6,464 | 118 | ***18.3*** | ***18.7*** |

***Sub-Saharan Africa (SSA) level***

| | ***Year*** | ***Period*** | ***Data source*** | ***All births*** | ***Twin births*** | ***Crude rate of twinning (‰)*** | ***Standardized twinning rate (‰)*** | ***Average standardized rate (‰)*** |
|---|---|---|---|---|---|---|---|---|
| SSA | 2015 | 2006–2015 | DHS and MICS | 449,030 | 8,201 | ***18.3*** | ***18.4*** | ***17.7*** |
| | 2010 | 2001–2010 | | 624,271 | 11,215 | ***18.0*** | ***18.4*** | |
| | 2000 | 1991–2000 | | 379,439 | 6,725 | ***17.6*** | ***18.4*** | |
| | 1990 | 1981–1990 | | 304,442 | 4,795 | ***15.8*** | ***16.5*** | |
| | 1980 | 1971–1980 | | 177,014 | 2,519 | ***14.2*** | ***17.6*** | |

**Source**: DHS and MICS; authors' calculations

## Appendix 2: Extract from the birth section of the women's questionnaire 15–49 years old (DHS Ghana 2014)

211 Now I would like to record the names of all your births, whether still alive or not, starting with the first one you had.
RECORD NAMES OF ALL THE BIRTHS IN 212. RECORD TWINS AND TRIPLETS ON SEPARATE ROWS.
(IF THERE ARE MORE THAN 12 BIRTHS, USE AN ADDITIONAL QUESTIONNAIRE, STARTING WITH THE SECOND ROW).

| 212<br>What name was given to your (first/next) baby?<br>RECORD NAME.<br>BIRTH HISTORY NUMBER | 213<br>Is (NAME) a boy or a girl? | 214<br>Were any of these births twins? | 215<br>In what month and year was (NAME) born?<br>PROBE: What is his/her birthday? | 216<br>Is (NAME) still alive? | 217<br>IF ALIVE:<br>How old was (NAME) at his/her last birthday?<br>RECORD AGE IN COM-PLETED YEARS. | 218<br>IF ALIVE:<br>Is (NAME) living with you? | 219<br>IF ALIVE:<br>RECORD HOUSE-HOLD LINE NUMBER OF CHILD (RECORD '00' IF CHILD NOT LISTED IN HOUSE-HOLD). | 220<br>IF DEAD:<br>How old was (NAME) when he/she died?<br>IF '1 YR', PROBE: How many months old was (NAME)?<br>RECORD DAYS IF LESS THAN 1 MONTH; MONTHS IF LESS THAN TWO YEARS; OR YEARS. | 221<br>Were there any other live births between (NAME OF PREVIOUS BIRTH) and (NAME), including any children who died after birth? |
|---|---|---|---|---|---|---|---|---|---|
| 01 | BOY 1<br>GIRL 2 | SING 1<br>MULT 2 | MONTH<br>YEAR | YES . . 1<br>NO . . . 2 → 220 | AGE IN YEARS | YES . . . 1<br>NO . . . . 2 | HOUSEHOLD LINE NUMBER<br>(NEXT BIRTH) | DAYS . . . 1<br>MONTHS 2<br>YEARS . . 3 | |
| 02 | BOY 1<br>GIRL 2 | SING 1<br>MULT 2 | MONTH<br>YEAR | YES . . 1<br>NO . . . 2 → 220 | AGE IN YEARS | YES . . . 1<br>NO . . . . 2 | HOUSEHOLD LINE NUMBER<br>(GO TO 221) | DAYS . . . 1<br>MONTHS 2<br>YEARS . . 3 | YES . . . . 1 ADD BIRTH<br>NO . . . . . 2 NEXT BIRTH |

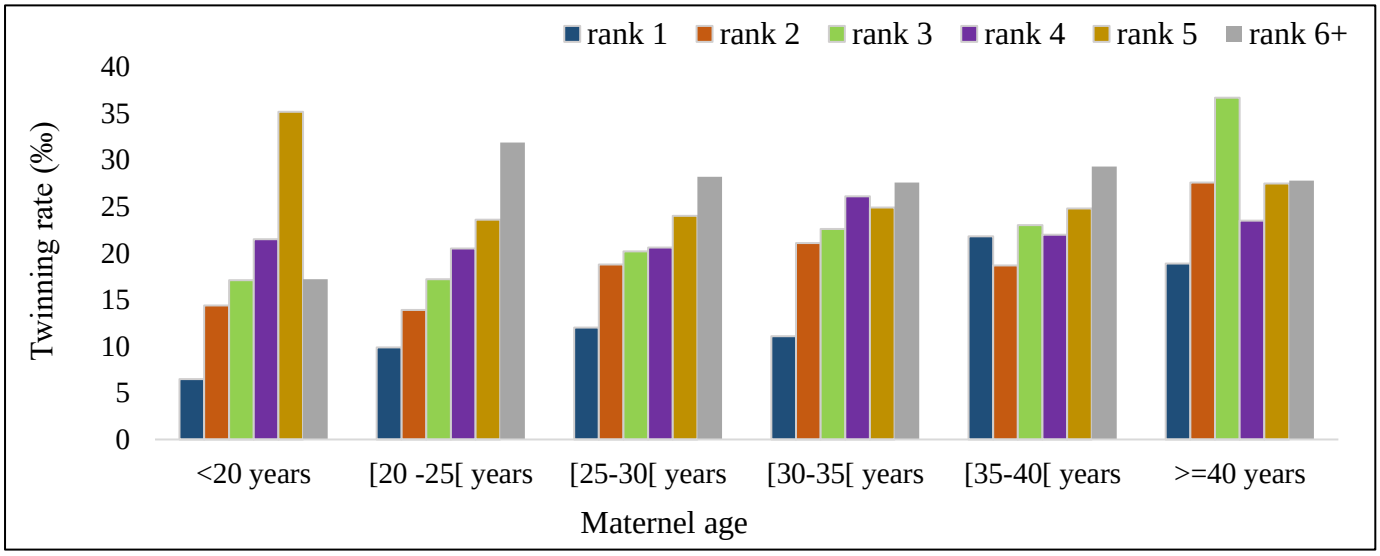
## Appendix 3: Which of the maternal age or birth rank is the most important factor?

### a) Decomposition of effects of birth rank and maternal age.

| Models | AIC value | Difference |
|---|---|---|
| a. Final model | 85,393.279 | |
| b. Final model without maternal age variable | 85,422.355 | (b-a) = 29.076 |
| c. Final model without birth rank variable | 85,851.031 | (c-a) = 428.676 |

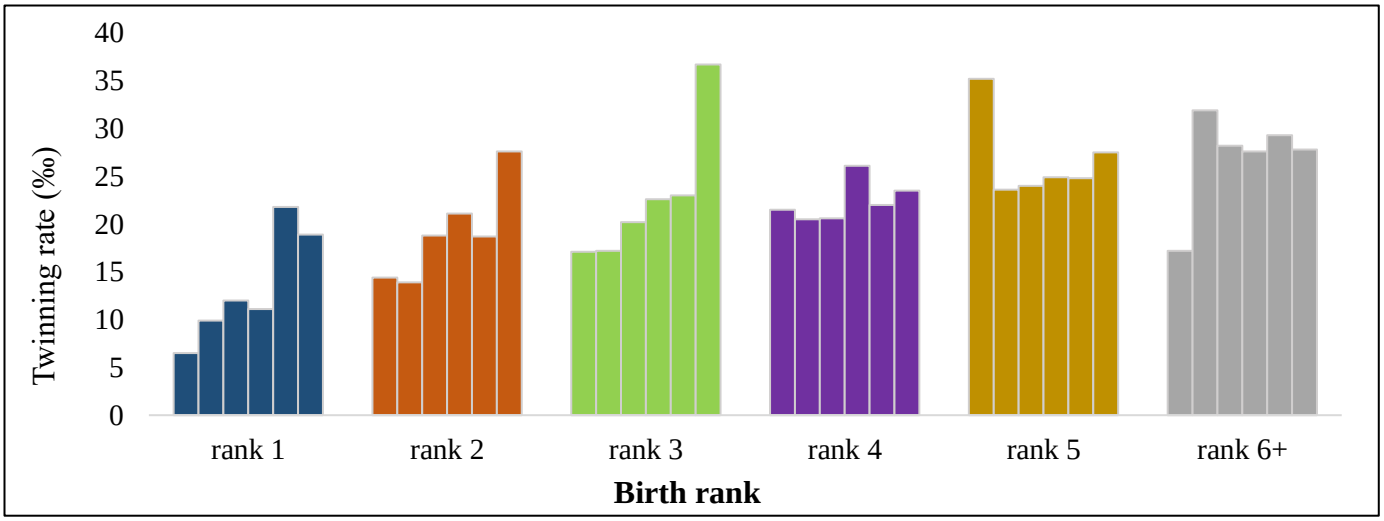
**Source:** DHS and MICS; authors' calculations

### b) Twinning rate by birth rank for equal maternal age




**Source:** DHS and MICS; authors' construction

### c) Twinning rate by maternal age for equal birth rank




**NB:** For each rank, the age classes are successively: <20 years, [20–25 years], [25–30 years], [30–35 years], [35–40 years] and >=40 years.
**Source:** DHS and MICS; authors' construction