The Excess Mortality of Twins Compared to Singletons from Birth to Age 5 in Sub-Saharan Africa: Analysis of Health and Demographic Surveillance Systems (HDSS)' Data

Adama Ouedraogo , *Institut national d'études démographiques et Université Paris 1 Panthéon Sorbonne*
Gilles Pison, *French National Museum of Natural History and Institut National d'Études Démographiques (INED)*
Abdramane Soura, *Université de Ouagadougou*
Sophie Le Coeur, *Institut National d'Études Démographiques (INED)*
Valérie Delaunay, *Institut de Recherche pour le Développement (IRD)*
Ane Fisker, *Statens Serum Institut*
Kassoum Dianou, *Observatoire de population de Ouagadougou*

Full Article [1]

1. Introduction

Twin children generally have higher mortality than singletons. This situation is all the more worrying in Sub-Saharan African countries as mortality is already at higher levels than elsewhere in the world. What makes the health of twins an additional public health challenge on the continent.

Many studies have already analysed the excess twin mortality in Sub-Saharan Africa (Gilles Pison, 1987 ; Guo & Grummer-Strawn, 1993 ; Monden & Smits, 2017 ; Christensen & Bjerregaard-Andersen, 2017 ; Bellizzi, & al., 2018). These studies have shown that twins under 5 mortality rates are 3 to 5 times higher than that of singletons. They also showed that this excess mortality is very higher at the early life age. These different studies have also shown that biomedical factors such as low birth weight (Daguet, 2002 ; INSERM, 2011 ; Hu et al., 2015) and prematurity (Chauhan et al., 2010 ; Couvert, 2011 ; Makrydimas & Sotiriadis, 2014) are the main associated factors of excess twin mortality. These results were confirmed by our analysis conducted as part of a doctoral research project ("Demography and health of twins in Sub-Saharan Africa" by Adama OUEDRAOGO).

In the studies just mentioned above, the data used to analyse twin excess mortality were cross-sectional data. Does the analysis of longitudinal data such as Health and Demographic Surveillance Systems (HDSS) yield the same results? What is the additional contribution compared to the analysis based on national surveys data?

[1] This is a first version. The full article is currently being finalized.

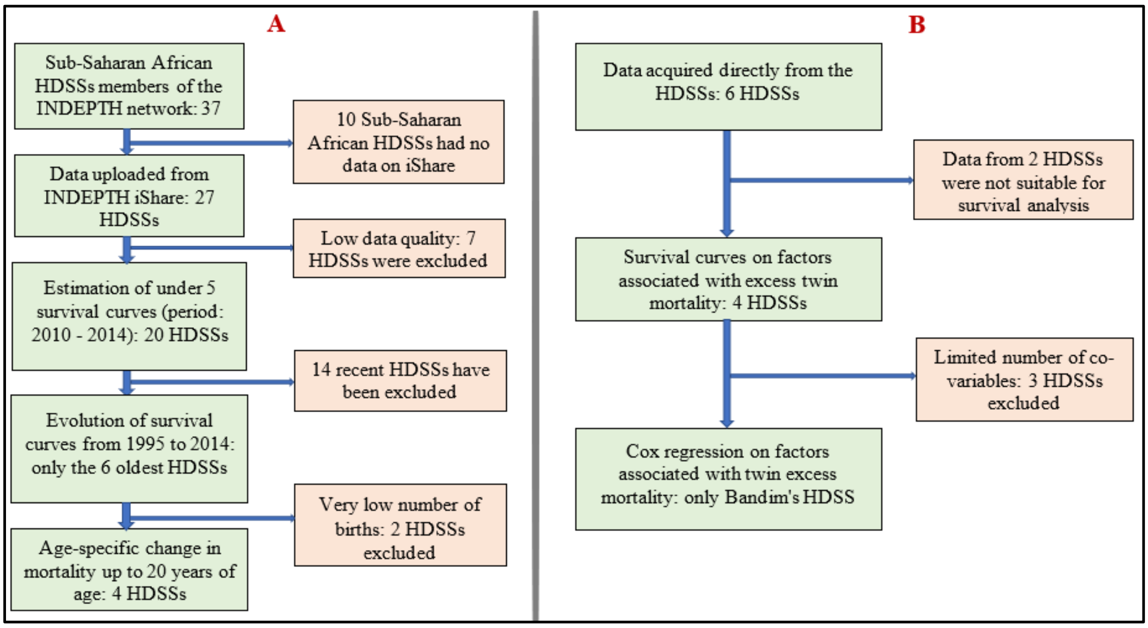
This work mainly studies the excess mortality of twins between 0 and 5 years of age, its variations according to HDSS sites and periods as well as its associated factors. More specifically, it includes the following points:

- Estimation of comparative survival curves of twins and singletons between 0 and 5 years old over the period 2010 – 2014 [2] in 20 HDSSs of the INDEPTH network [3];
- The evolution over time (from 1995 to 2014) of these survival curves (using data from the 6 oldest HDSSs);
- Determine up to what year of age the excess twin mortality is observed;
- The analysis of the associated factors of the excess twin mortality between 0 and 5 years of age.

2. Data and Methods

The data we use are those of the HDSS members of the INDEPTH network. They come from two sources: INDEPTH iShare data (https://www.indepth-ishare.org/) and data obtained directly from HDSSs. The following **Figure 1** schematizes (Diagram A and Diagram B) the steps in the use of the data. Diagram A describes the use of INDEPTH iShare data while Diagram B describes the use of data obtained directly from HDSSs.

Figure 1: Data exploitation schematics



Source: Authors' construction.

[2] Period chosen with the objective of being able to take into account as many HDSSs as possible
[3] INDEPTH = International Network for the Demographic Evaluation of Population and Their Health

The methods used are survival analysis: the actuarial method was used to construct the survival curves and the Cox model was used to analyse the associated factors of the twin excess mortality.

3. Summary Results

a. *Comparative survival curves of twins and singletons between 0 and 5 years old in 20 HDSSs (Period: 2010-2014).*

Using the data from the 20 HDSSs, we show that over the period 2010-2014, the survival probabilities of twins are very much lower than those of singletons (see **Figure 2** below). Let us describe in the following lines some disparities between HDSSs. It should be noted that in **Figure 2**, the HDSSs are arranged by region, country and alphabetically within each country.

Figure 2 below allows us to classify the HDSSs into four groups based on the survival gap between twins and singletons. A first group is made up of HDSSs for which the survival gaps are the greatest. This group is composed of the following three HDSSs: Bandafassi (Senegal), Gilgel Gibe (Ethiopia) and Kersa (Ethiopia). In these HDSSs, the survival curves of twins are much lower compared to those of singletons. The amplitude of the difference between the two survival curves is close to 0.3 points of survival probability.

The second group is composed of the following 10 HDSSs: Farafenni (Gambia), Karonga (Malawi), Kilite Awlaelo (Ethiopia), Kintampo (Ghana), Nairobi (Kenya), Nanoro (Burkina Faso), Niakhar (Senegal), Nouna (Burkina Faso), Ouaga (Burkina Faso) and Taabo (Cote d'Ivoire). For these HDSSs, we observe differences in survival curves between twins and singletons that are significant but remain lower than those of the previous group. Indeed, in these HDSSs, the differences between the two survival curves are between 0.15 and 0.2 survival probability points.

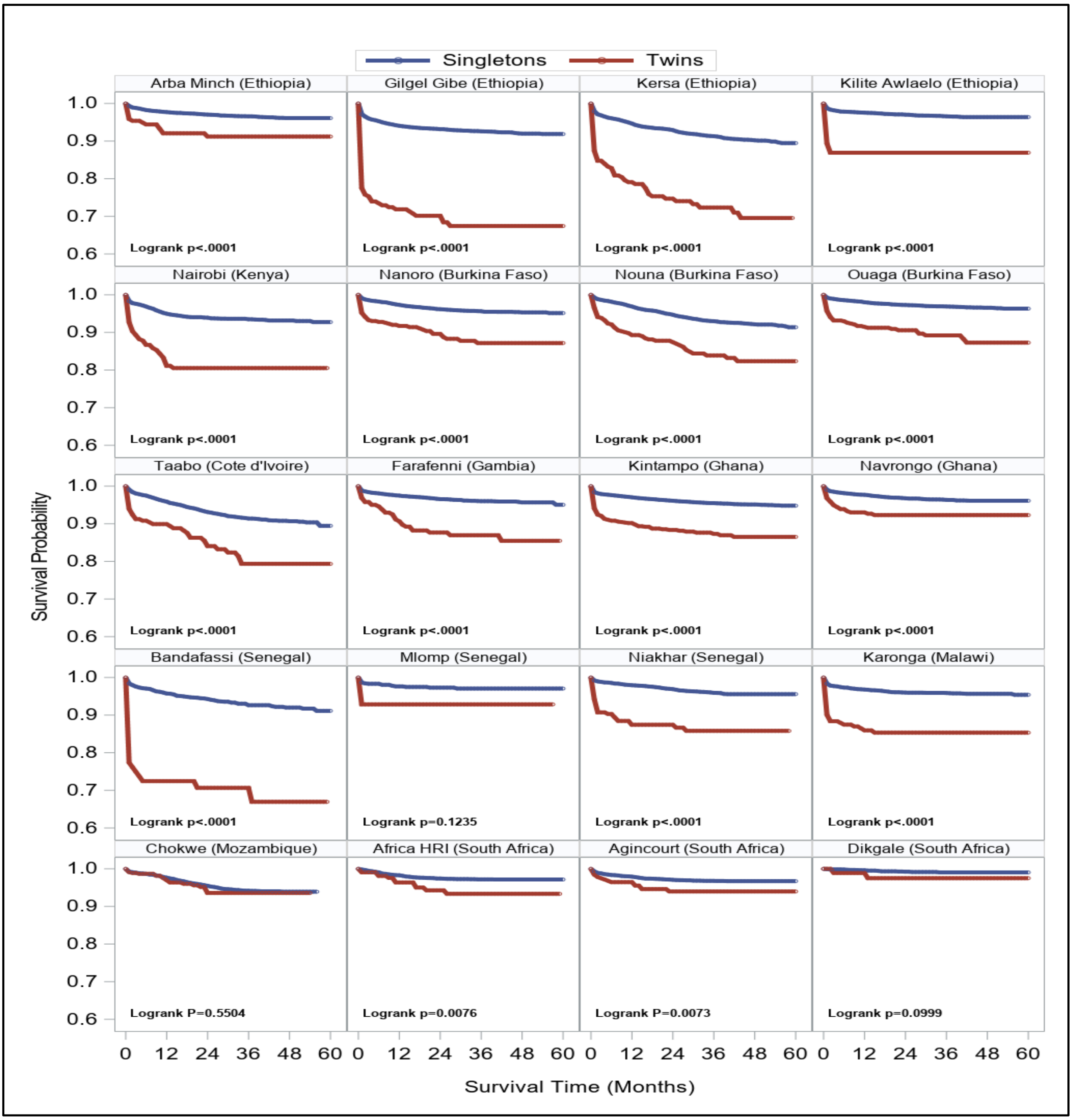
Group 3 consists of the HDSSs of Africa HRI [4] (South Africa), Agincourt (South Africa), Arba Minch (Ethiopia) and Navrongo (Ghana). These are sites for which our results indicate very small differences in survival between twins and singletons. In fact, the differences in survival curves being less than 0.1 points of survival probability.

The last group consists of sites for which no statistical differences was observed between the survival curves of twins and those of singletons. This group includes the HDSSs of Chokwe

[4] HRI=Health Research Institute

(Mozambique), Dikgale (South Africa) and Mlomp (Senegal). For these HDSSs, the Log-Rank test obtains p-values greater than 5%. For the HDSSs of Chokwe and Dikgale we confirm the real absence of twin excess mortality over the period 2010-2014. But for Mlomp's, it is difficult to conclude that there is no obvious difference due to the small number of children in this HDSS. This leads to a lack of statistical robustness in our comparison tests.

Figure 2: Survival curve from 0 to 5 years according to the type of child - twin or singleton - in 20 Sub-Saharan Africa's HDSSs taken separately (period: 2010- 2014)

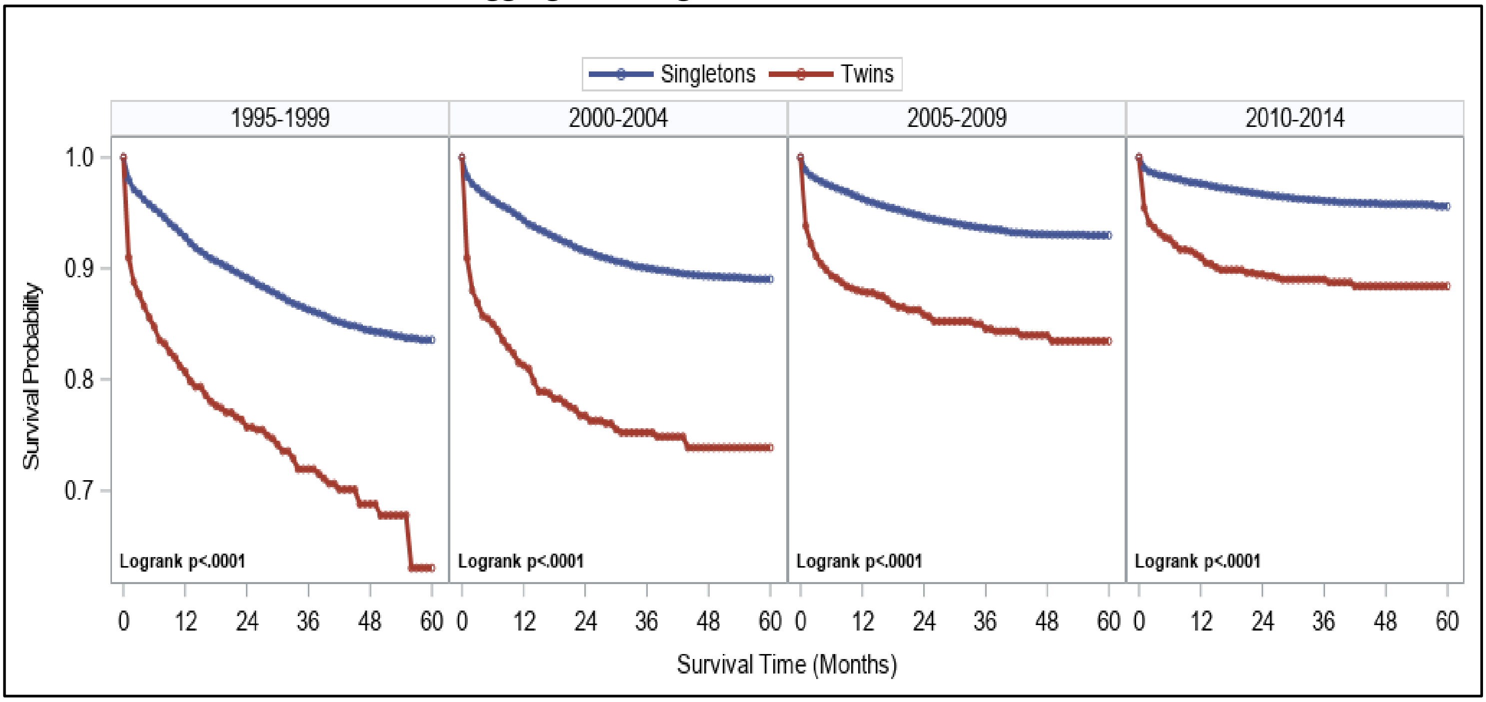


Source: Indepth's iShare Repository, authors' construction.

b. Evolution from 1995 to 2014 of the comparative survival curves of twins and singletons between 0 and 5 years

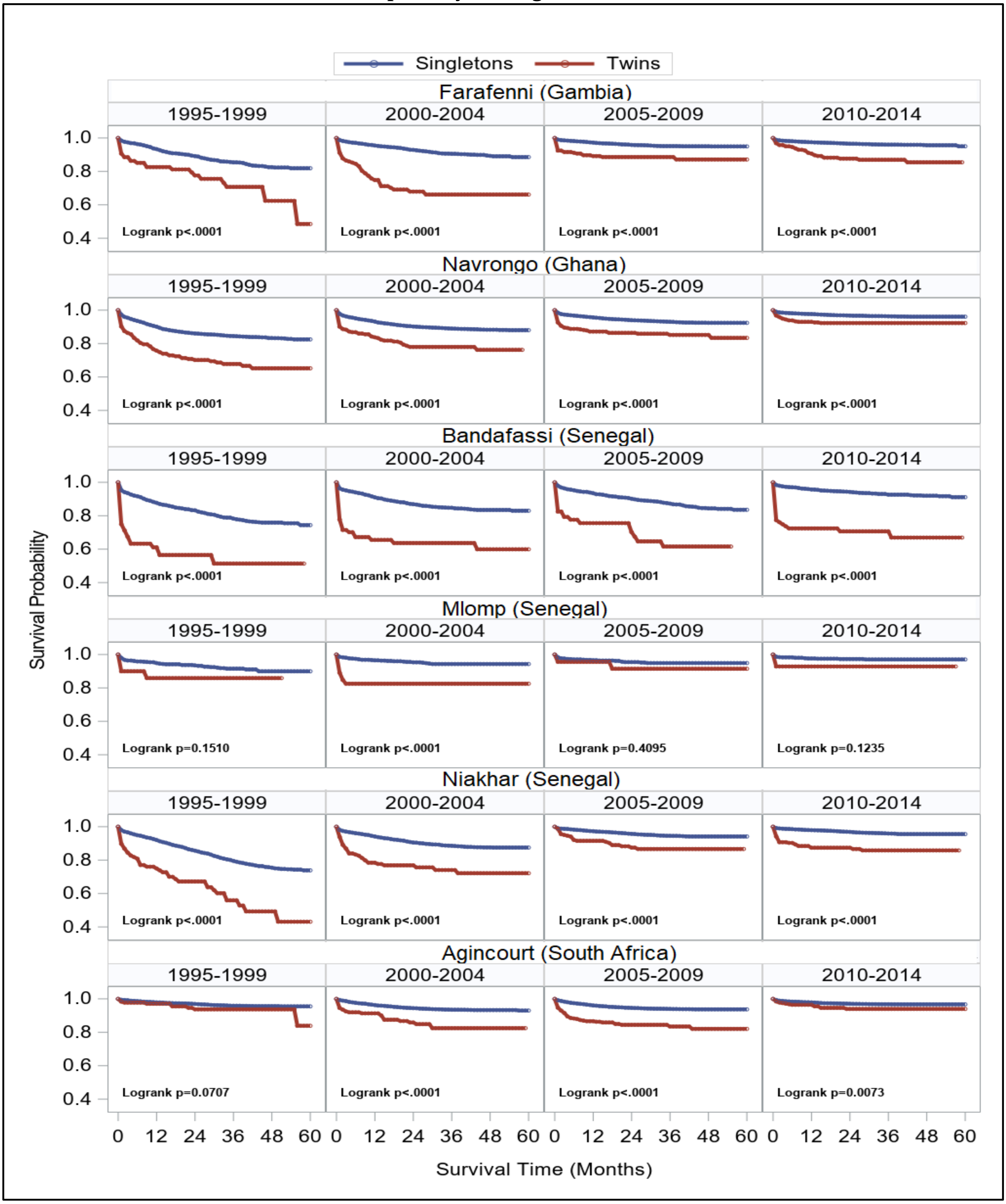
The two graphs below (**Figure 3** and **Figure 4**) represent the survival curves compared between twins and singletons over 4 distinct periods: 1995-1999, 2000-2004, 2005-2009 and 2010-2014. We can thus observe the evolution over time of the excess mortality of twins compared to singletons. The **Figure 3** presents this evolution using aggregated data from the 6 oldest HDSSs (Agincourt, Bandafassi, Farafenni, Mlomp, Navrongo and Niakhar), and the **Figure 4** presents it by considering the 6 HDSSs separately. Our results show a very significant increase in survival probabilities for both twins and singletons over time. They also show an important reduction in twin excess mortality over time. This result suggests a greater increase in the probability of survival over time in twins than in singletons. It should be noted that **Figure 4** is arranged by country and in alphabetical order of the HDSSs name of each country.

Figure 3: Comparative survival of twins and singletons aged 0-5 years from 6 Sub-Saharan Africa HDSSs - aggregate change between 1995 and 2014



Source: Indepth's iShare Repository, authors' construction.

Figure 4: Comparative survival of twins and singletons aged 0-5 years from 6 Sub-Saharan Africa HDSSs taken separately - change between 1995 and 2014

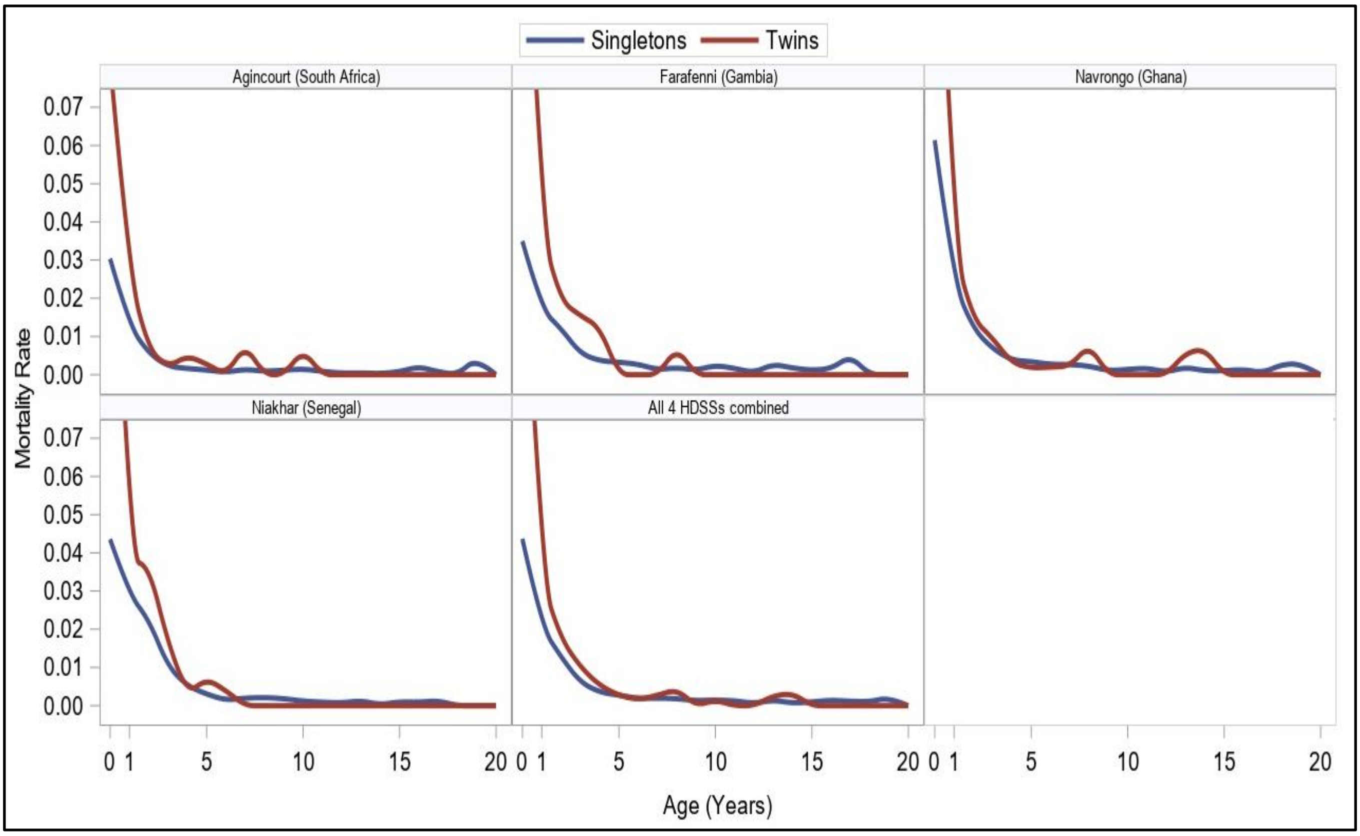


Source: Indepth's iShare Repository, authors' construction.

c. Does the excess twin mortality compared to singletons persist beyond 5 years of age?

Our results confirm the existence of twin excess mortality by age. However, this age-specific excess mortality would be practically non-existent beyond the 5th year of age. These results are confirmed that the data from the 4 HDSSs are considered separately or aggregated (see **Figure 5** above). Among the four HDSSs studied, the under 5 twin over-mortality by age appears to be higher in Farafenni (Gambia). On the other hand, it seems to be lowest in Navrongo (Ghana).

Figure 5: Age-specific change in mortality up to 20 years of age - comparisons between twins and singletons



Source: Indepth's iShare Repository, authors' construction.

d. Associated factors to twin' excess mortality: case of the Bandim urban HDSS (Guinea-Bissau)

Here we present the results about the associated factors of twin excess mortality. These results were obtained by a Cox regression model. It measures the instantaneous risk of death (In our case it is the death before the 5th birthday) of children. This is done by highlighting the gap between twins and singletons and observing the impact of some risk factors on this gap. As a reminder, this regression only concerns the Bandim HDSS, which is the only one that has a sufficient number of empirically co-variables influencing child mortality in Africa. The results are recorded in **Table 1**.

In the Bandim HDSS, twins have instant crude risks of death that are 2.5 times higher than those of singletons. The inclusion in the model of factors potentially associated with mortality has made it possible to adjust downward the risk gap of death between twins and Singletons. Thus, by introducing biomedical factors such as birth weight, place of delivery and duration of pregnancy, the risk of death of twins decreases to 1.35 times that of singletons. This result clearly confirms the predominant role of biomedical factors in explaining the differences in mortality between twins and singletons.

By subsequently adding demographic factors (gender, maternal age and year of birth), then socio-cultural factors (mother's education and mother's ethnicity), the risk of child mortality between twins and singletons in Bandim is 1.42. But this slight increase in risk after adjusting for demographic and socio-cultural factors is not statistically significant. Adding demographic and socio-cultural factors does not therefore modify the twins-singletons mortality Odds ratios (OR), suggesting that they do not have an impact independently of other factors. Moreover, the high odds ratios found with biomedical factors, mainly prematurity (Adjusted OR=3.5) and birth weight (Adjusted OR =2.01), confirm the predominance of these two factors in explaining twin excess mortality (see **Table 1**). Other factors significantly associated with child mortality were: male sex (Adjusted OR=1.13), young age of mothers (Adjusted OR=1.12), older year of birth (Adjusted OR=0.955), and lack of maternal education (Adjusted OR=1.74).

Table 1: **Instant risk of death in the Bandim's HDSS (Guinea-Bissau)**

Variables	Unadjusted Odds Ratio		Adjusted Odds Ratio					
			By biomedical co-variables		By biomedical and demographic co-variables		By biomedical, demographic and socio-cultural co-variables	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Twinship								
Twin	***2.46****	2.25–2.70	***1.35* ****	1.15–1.57	***1.43* ****	1,22–1,66	***1,42* ****	1,22–1,66
Singleton	Ref		Ref		Ref		Ref	
Preterm birth								
No			Ref		Ref		Ref	
Yes			3.33 ***	2.70–4.10	3.40 ***	2.72–4.21	3,50 ***	2,80–4,35
Birthweight								
« Normal » birthweight			Ref		Ref		Ref	
Low birthweight			2.04 ***	1.84–2.25	2.00 ***	1.82–2.22	2,01 ***	1,82–2,23
Place of delivery								
Home			1.24 **	1.05–1.50	1.10	0.92–1.30	1,08	0,91–1,30
Health Service			Ref		Ref		Ref	
Sex of child								
Male					1.14 ***	1.06–1.23	1.13 **	1,05–1,22
Female					Ref		Ref	
Maternal age								
<20 years old					1.14 **	1.04–1.24	1.12 *	1,02–1,22
20-39 years old					Ref		Ref	
>=40 years old					1.20	0.95–1.55	1.21	0,94–1,55
Year of birth								
Year of birth					0.956 ***	0.95–0.961	0.955 ***	0,95–0,96
Mother's education								
Formal education							Ref	
None							1.74 ***	1.42–2.13
Mother's ethnicity								
Balanta							0.98	0.80–1.21
Mancanha							0.92	0.75–1.13
Mandinga							Ref	
Mandjaco							1.20 *	1.00–1.44
Papel							1.21 *	1.02–1.43
Fulani							0.88	0.73–1.06
Other							1.01	0.85–1.20

OR=Odds Ratio measuring the instant risk of death; CI= confidence interval; ***=1‰, **=1% and *=5 %; ref =reference parameter;
Source: Bandim's HDSS; authors' calculation.

4. Conclusion

Our results from the HDSSs in Sub-Saharan Africa confirm that twin children face significantly lower probabilities of survival than non-twins. They also show a significant decrease in child mortality over time in these HDSSs. Our findings further show an important role of low birth weight and prematurity to explain twin excess mortality. But the impact of socio-demographic factors such as the child gender, maternal age, and mother's ethnicity and education is also not negligible. This paper also shows that there is almost no excess death of twins compared to singletons after 5 years of age.

We note that this work has some limitations. Indeed, by embarking on this rather colossal analysis of the data of some twenty HDSSs in Sub-Saharan Africa, we were sure to encounter many difficulties related to data quality and internal consistency. Because the management of these data is far from uniform in the HDSSs despite the existence of the INDEPTH network which tries to harmonize them. For example, the disparity in the types of variables collected, differences in experience in the management of HDSSs, difficulties in accessing data, the summary type of the data available on the INDEPTH iShare platform, etc. are all elements that obviously constituted obstacles to our approach. However, we believe that the methodological solutions we have mobilized as well as the rigour in the selection and analysis of the data have helped to minimize possible limitations.

In terms of recommendations, we insist on the fact that the health of twins remains a major challenge for the countries of Sub-Saharan Africa which is the Continent with the highest rates of twinning in the world. We know that it is utopian to think that we can eliminate the entire survival gap between twins and singletons. However, it is still possible not only to further reduce child mortality on the Continent but also to further reduce disparities between twins and singletons. This reduction should be based on the development of accessible and essential obstetrical and paediatric services for the management of complications related to twin births. It must also be carried out by including actions in health and social policies that take into account the fragile nature of twins and that also allow parents to provide "domestic" care that is commensurate with the burden of multiple births. In a nutshell, the aim is to continue and intensify the efforts that have contributed to the reduction of mortality on the Continent in recent years, through early detection of twin pregnancies, improved follow-up of high-risk pregnancies, improved obstetric care, and improved postnatal surveillance and new-borns care.

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