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Health & Demographic Surveillance System Profile

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Health & Demographic Surveillance System Profile: Bandafassi Health and Demographic Surveillance System (Bandafassi HDSS), Senegal

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Abstract

The Bandafassi Health and Demographic Surveillance System (Bandafassi HDSS) is located in south-eastern Senegal, near the borders with Mali and Guinea. The area is 700 km from the national capital, Dakar. The population under surveillance is rural and in 2012 comprised 13 378 inhabitants living in 42 villages. Established in 1970, originally for genetic studies, and initially covering only villages inhabited by one subgroup of the population of the area (the Mandinka), the project was transformed a few years later into a HDSS and then extended to the two other subgroups living in the area: Fula villages in 1975, and Bedik villages in 1980. Data have been collected through annual rounds since the project first began. On each visit, investigators review the composition of all the households, checking the lists of people who were present in each household the previous year and gathering information about births, marriages, migrations and deaths (including their causes) since then. One specific feature of the Bandafassi HDSS is the availability of genealogies.

Key Messages

- Bandafassi HDSS, established in 1970 in south-eastern Senegal, and covering a population of 13 000 individuals in 2012, is among the world's oldest demographic surveillance systems.
- Bandafassi age, sex and cause-specific mortality rates for earlier periods when mortality was very high are used by the UN and other institutions to refine and adapt current model life-tables.
- Bandafassi HDSS data include genealogies and each individual, each child especially, is linked to both parents. Changes of family and kin group composition over time can be examined as a consequence.
- In collaboration with Agence Nationale de la Statistique et de la Démographie (national statistical office of Senegal), Bandafassi HDSS is used to validate national censuses and to test new techniques for improving data collection.

Origins of the Bandafassi Health and Demographic Surveillance System

The Bandafassi project, in Senegal, was established in 1970 originally for genetic studies. The objective was to measure survival rates in various genotype subgroups of the population, comparing, for example, persons with the gene responsible for drepanocytosis (gene S) and those without it. Genotypes were determined from blood samples; survival rates were estimated by following up individuals with a known genotype over several years. This follow-up involved regular updates of demographic information on births, deaths, marriages and migrations covering the entire population. The project was initiated and conducted during this early period by the Musée de l'Homme of Paris and the French National Institute for Demographic Studies (Institut National d'Etudes Démographiques). The genetic objective later became secondary, however, and the project was transformed in the mid-1970s into a health and demographic surveillance system (HDSS) whose main objective was to study the demographic and health situation of a West African population with high mortality levels, to observe changes over time and to examine the factors involved.[1] The rationale for this transformation was the need for reliable demographic information concerning sub-Saharan Africa in the 1970s, in particular in rural areas for which very few data were available.

What does the Bandafassi HDSS cover now?

The core Bandafassi HDSS collects information on events—births, deaths, marriages and migrations. The objective is to obtain accurate estimates of demographic levels and trends in the community. Mortality is measured by sex, age and cause of death, and differences by social factors such as ethnic group are examined. Another basic objective is to study changes in marriage and fertility patterns, household, family and kinship.

Research on more specific topics is also conducted. It makes use of the data collected routinely by the Bandafassi HDSS in combination with specific supplementary information on the study topic collected during one particular round. Examples of such research include studies of malaria, sexually transmitted diseases, contraceptive prevalence, breastfeeding, nutrition, etc., and the genetic studies mentioned above using genetic material collected at the beginning of the project.

The Bandafassi HDSS is now a joint project of the Institut National d'Etudes Démographiques (INED) and Institut de Recherche pour le Développement (IRD), and a member of the INDEPTH network (http://www.indepth network.org).

Where is the Bandafassi HDSS area?

The Bandafassi area is in the Kedougou Region of south-eastern Senegal, near the borders of Mali and Guinea (Figure 1a). The site covers about half the 'arrondissement' (district) of Bandafassi. The Niokholo-Koba National Park forms the boundary to the north, with the Gambia River in between. The boundaries to the east, south and west are delineated by roads and village boundaries (Figure 1b).

The ecological zone is Sudan savannah. The climate is characterized by two seasons, a rainy season, from June to October, and a dry season, from November to May, with average rainfall of 1150 mm per year during 1980–2010.

The Bandafassi HDSS population is rural, and the main economic activities are cultivation of cereals (sorghum, millet, maize and rice), peanuts and cotton, and cattle-breeding. Part of the young male population migrates seasonally to cities or other rural areas of the country. The population lives in 42 small villages (each with slightly more than 300 inhabitants on average in 2012). The population density is low (22 inhabitants per km^2 in 2012). The population is divided into three ethnic groups who live in distinct villages:

- Bedik (25% of the population in 2012), who have their own language, which is related to the Mande linguistic group

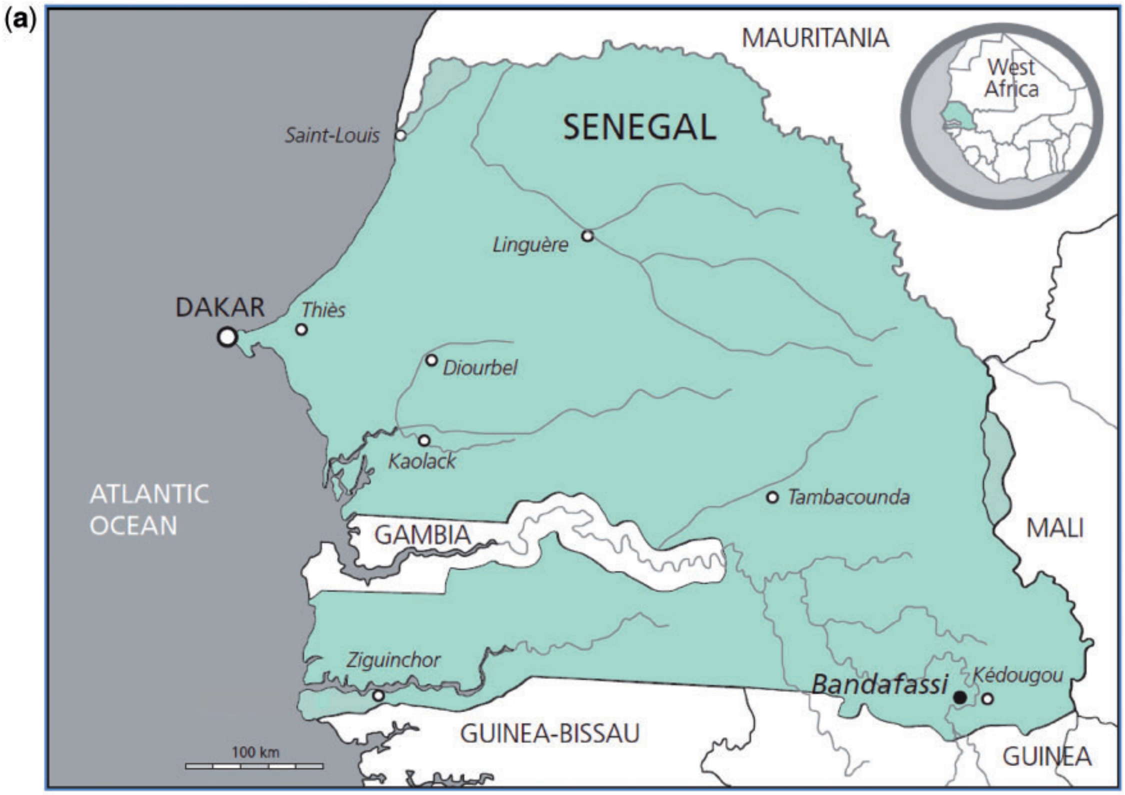

Figure 1a. Location of Bandafassi HDSS in Senegal.

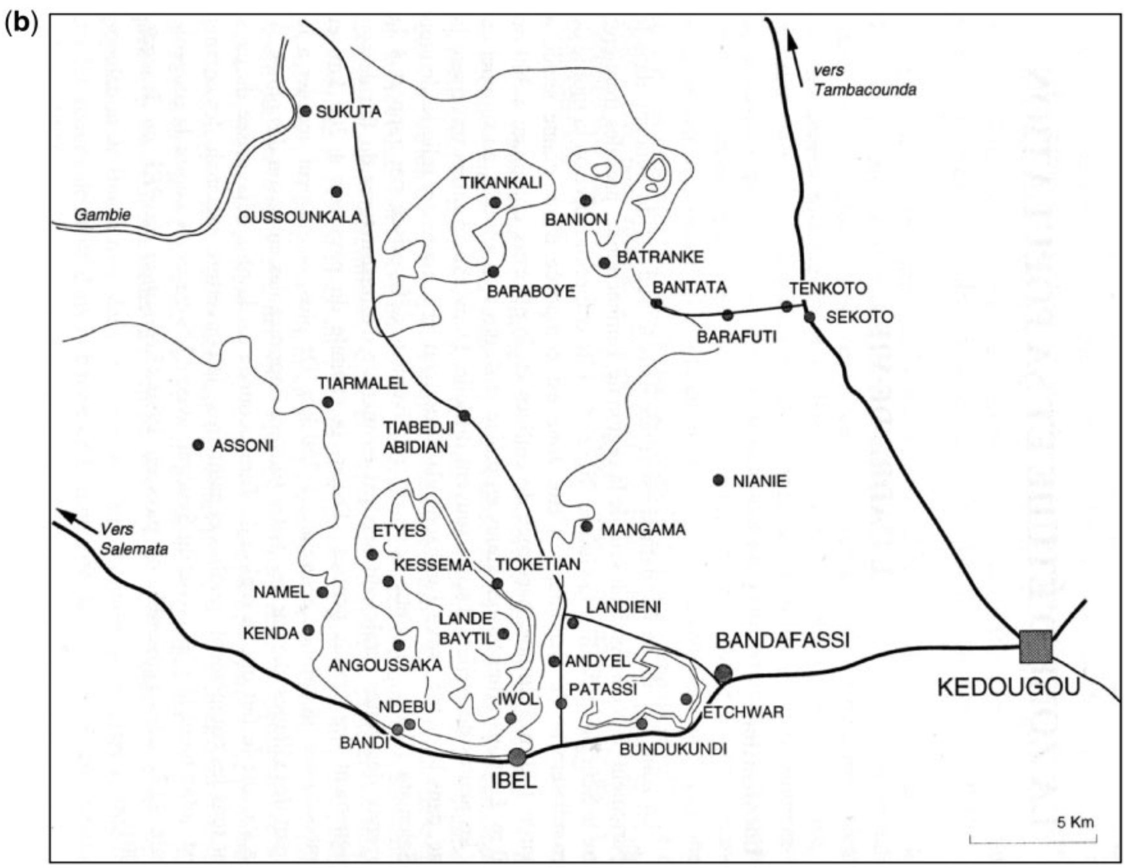

Figure 1b. Map of Bandafassi HDSS showing the location of villages.

- Mandinka (16% of the population)
- Fula Bande (59% of the population), culturally very close to the Fula subgroups of Guinea.

The Fula and two-thirds of the Mandinka describe themselves as Muslims, whereas a minority of the Mandinka (23% in 1998) and most of the Bedik (88%), describe themselves as Christians, and the rest as Animists.

The residential unit is a compound housing the members of an extended patrilineal family (15 persons on average). A compound usually contains one hut for each ever-married woman and sometimes additional huts for unmarried adult sons and for the head of the compound. Polygyny is frequent: there are 170 married women per 100 married men (in 2012).

As in 2012, the vast majority of dwellings are huts with thatched roofs. Water is taken from rivers, backwater, wells or boreholes. Most compounds have no toilet facilities, and no one has electricity with a few exceptions (20 compounds) in the Bandafassi village, which has power for one-third of the day. The area is one of the most remote in Senegal, 700 km from the national capital, Dakar, and 250 km from the closest large city, Tambacounda, with poor local roads, often impassable during the rainy season.

In 2003, the region's healthcare provision was enhanced by the opening of a modern new hospital which was in operation until its closure in July 2013.[2] During that period, the preexisting local dispensaries have continued to offer health care in exactly the same way as before. This facility offered general medical care, along with obstetric-gynaecological and surgical services that are usually only available in the largest city hospitals. Before it was opened, the closest hospital equipped to perform a caesarian section was in the city of Tambacounda. The new hospital was built on the initiative of 'Education and Health', a foundation set up by Mrs Viviane Wade, former First Lady of Senegal. Its construction was paid for by the council of the Hauts-de-Seine département in France. It could cope with all types of health emergencies, but was built with the main objective of reducing maternal mortality in the region. The hospital was located in a hilly rural area 35 km from Kedougou, next to the Bedik hamlet of Ninéfescha. The hospital closed in 2013, not because of lack of use, but because it was very costly and not adapted to the needs of the local population.

Before 1987, when the national immunization programme (Expanded Programme on Immunization) reached the area for the first time, vaccination coverage was almost zero. Full vaccination was given to 39% of children aged 12–35 months in 1992, and to 32% in 2001.

In 2012, half of the villages had primary schools and four of them secondary schools; 26% of women aged 15–29 and 10% of those aged 30–44 had been to school for at least 1 year (as in 2000).

Who is covered by the Bandafassi HDSS and how often have they been followed up?

The initial census

Established in 1970 and initially covering only eight villages inhabited by one subgroup of the local population (the Mandinka), the demographic surveillance was extended to the two other subgroups living in the area: 26 Fula villages in 1975, and eight Bedik villages in 1980. In 1975 and 1980, the newly enumerated subpopulation was added to the population already being followed up;[3,4] so the entire population of the area has been under surveillance since 1980 only. It numbered 7104 inhabitants at the beginning of 1981 and has nearly doubled since, attaining 13 378 inhabitants at the beginning of 2012.

Several surveys were organized just after the initial census, to complement the census information and collect other data needed for subsequent studies. These included: a union and fertility survey in which all living women were asked about their union and maternity histories, so that all the children ever born to them could be recorded; a specific age survey to improve age determination;[5] and the systematic collection of genealogies.

An age survey was organized just after the initial census, to estimate ages of adults and children or to improve reliability of age data collected during the census. Ages of individuals were estimated using an indirect method based on two sorts of data: the classification of the population of a village by birth order and the calendar of the circumcision groups. The ordering of the population of a village by birth order provides relative ages; to obtain absolute ages, we turned to a second type of chronological classification, concerning male circumcision groups. Male circumcision, which was traditionally performed at around 15 years of age, with variations by ethnic group and period, is a very important festival. It usually takes place in February or March, every 3 or 4 years. Circumcision groups, identified by members' names, were listed in chronological order for each village. The dates of the circumcision festivals were estimated from both the chronological order of the festivals of all the villages of the area, and a historical calendar. These data, together with various assumptions concerning mean age at circumcision, formed the basis of our age computations for individuals who were resident in the Bandafassi area at the initial census. Our estimation centred on the age at which each circumcised male was circumcised. We thus computed the age of these males and then, by interpolation, the ages of the non-circumcised population.

The collection of genealogies

Genealogies were collected just after the initial census, starting with any compound head and any of the resident adult females, going up to known ascendants and then down to living collateral relatives.[3] The genealogies collected in related compounds were matched afterwards. These genealogies were collected first for genetic and anthropological studies, but they were also useful in providing detailed information on the relationships between members of a compound, in particular the relationship of each individual to the compound head. Errors in the census concerning a person's parents (fathers mostly, but also sometimes mothers), and omissions of individuals, which were more frequent for sub-categories like orphans or old widowed women, could be detected and corrected.

Criteria used for in-migration and out-migration

At the census, a person was considered a member of the compound if the head of the compound declared this to be the case. This definition was broad and resulted in a *de jure* study population. Thereafter, a criterion was used to decide whether and when a person was to be excluded or included in the population.

A person is considered to exit the study population by either death or out-migration. Part of the population of Bandafassi engages in seasonal migrations, sometimes remaining 2 or 3 years outside the area before returning. A person who was absent from three successive yearly rounds, without returning in between, is regarded as having emigrated and as no longer resident in the study population at the date of the third round.

A new person is considered to have entered the study population either through birth to a woman of the study population or through in-migration. Information on in-migrants is collected when the list of compounds of a village is checked ('Are there any new compounds or new families who have settled since the last visit?') or when the list of members of a compound is checked ('Are there any new persons in the compound since the last visit?'). Some in-migrants are villagers who left the area several years before and were excluded from the study population. Information is collected to determine in which compound they were previously registered, to match new and old information. Information is routinely collected on movements from one compound to another within the study area. Some population categories, such as older widows or orphans, frequently move for short periods of time and live between several compounds. These people may be considered as members of all the compounds or of none of them. As a consequence, their movements are not always declared.

Update rounds

Once each year, usually in February or March, all villages and hamlets are visited by investigators who meet specific informants in each hamlet. Together, they review the composition of all the households, check the lists of people who were present in each one the previous year and gather information about births, marriages, migrations and deaths (including their causes) since the preceding visit.

What has been measured and how have the Bandafassi HDSS databases been constructed?

The core data collected throughout the Bandafassi HDSS include individual and household identifying information, parent identification and spousal relationships at each time point. Sufficient data are collected to link individuals of all ages to both parents, facilitating genetic and orphanhood studies. Verbal autopsies collect detailed data on symptoms and signs during the terminal illness, so that the cause of death can be determined by a physician or a computer algorithm. The verbal autopsy questionnaire was introduced in 1984, first for the deaths of children below 15 years of age and of women aged 15–49 only, and since 2003 for all deaths. Before then, simple questions were asked, such as 'Why did the person die?', or 'Of what disease?'. Core data items are summarized in Table 1. Other data are collected in the context of specific surveys, often on population samples, such as surveys mentioned below on sexually transmitted disease (STD) infections and on contraception.

Information collected during the baseline and follow-up surveys is coded and stored in databases designed in the 1970s and subsequently modernized. The data are held in multiple event tables in the database with a single-view table describing all Bandafassi HDSS events. Each person who has been member of the resident population at one time or has been mentioned as spouse or relative of a resident member is described with an identity number enabling linkage between the different tables (a total of about 50 000 identity numbers have been attributed). The information collected during each annual survey is coded and entered with Access software and, after verification, added to the database using PostgreSQL software.

Key findings and publications

Basic demographic indices for the period 1971–2011 are summarized in Table 2, and the population pyramid at 1 January 2012 is shown in Figure 2. This pyramid reflects the high fertility and high mortality levels, and the

Table 1. Information collected or checked at each annual round of the Bandafassi HDSS

Household information	
Household	Name and identification number (ID) of head of household
Individual information	
Resident	Update of residency status (for all) (still resident, died, out-migrated ?) Update of marital status (for adults aged 13 years or more) (formed a new union ? still in union with X ?) Update of maternities (for women aged 13–55 years) (delivered a live born baby since the last visit ? a still birth ?) Update of pregnancy status (for women aged 13–55 years) (currently pregnant ?)
Birth	Date and place of birth Names and sex of child Mother's and father's names and identification numbers (ID) (links)
Death	Date and place of death Cause of death (verbal autopsy)
Out-migration	Date of out-migration New residence (village and household if within the Bandafassi HDSS) Reason for out-migration
In-migration	Date of in-migration Previous residence (village and household if within the Bandafassi HDSS) Names, sex, date of birth and ID (if yet registered in the Bandafassi HDSS) Reason for out-migration Names, survival status, residence and ID of father and mother Union and birth histories with ID of spouses and children (for adults)
Union formation	Date of cohabitation Names, mother's and father's names, previous residence and ID of new spouse
Union disruption	Date of decohabitation Cause of disruption

Table 2. Demographic characteristics of the Bandafassi HDSS

	Period				
	1971–75	1976–80	1981–90	1991–2000	2001–2011
Number of villages under surveillance	8[a]	34 (8 + 26)[b]	42 (8 + 26 + 8)[c]		
Total population under surveillance[d]	1086	5140	8343	10 899	13 378
Crude birth rate / 1000	47.5	51.3	50.3	47.6	44.6
Crude death rate / 1000	39.4	29.8	23.4	19.0	12.9
Population growth rate /1000[e]	17.9	8.5	17.6	25.7	18.8
Infant mortality /1000 live births	263	214	173	136	79
Under five mortality /per 1000 live births	490	393	322	254	155
Life expectancy at birth (males) (years)	26.3	32.9	39.5	45.6	55.6
Life expectancy at birth (females) (years)	24.2	32.7	41.1	46.9	56.9
Total fertility rate (children per woman)	6.4	6.6	6.4	6.7	6.5

[a] One part of the villages of the area (8 Mandenka villages).
[b] One part of the villages of the area (8 Mandenka villages + 26 Fula villages).
[c] All villages of the area (8 Mandenka villages + 26 Fula villages + 8 Bedik villages).
[d] At the end of each period.
[e] Including migrations.

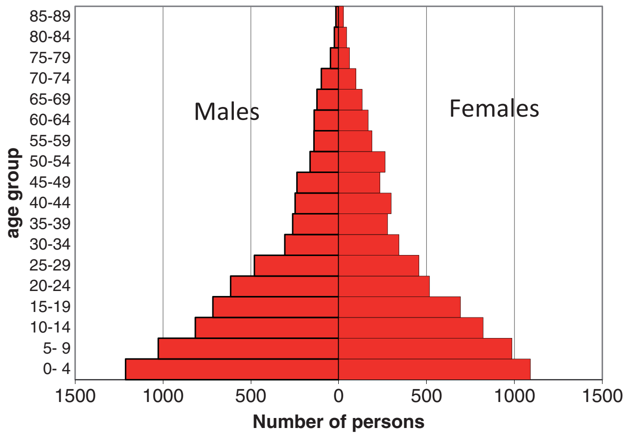

Figure 2. Population pyramid of Bandafassi HDSS in Senegal on 1 January 2012.

out-migration of young adults of both sexes from this rural area to seek education and employment. The population has increased at a rate of 2.1% per annum on average, the natural increase (2.6% per annum) being partly counterbalanced by a net migration rate of −0.5%.

The Bandafassi HDSS has produced estimates of mortality by sex, age and period for more than 40 years. Life-tables of this kind, based on observations and covering such a long period, are rare for West African rural populations. One of their advantages is that the tables cover periods when the Bandafassi population was poorly served by health services and did not benefit, for example, from basic health programmes like the Expanded Programme on Immunization (EPI).

The age pattern of under-5 mortality diverges from the model life-tables

One important finding of Bandafassi HDSS concerns the age pattern of mortality from birth to age 5 years. During the first surveillance period, from 1970 to the mid 1980s, the probability of death from ages 1 to 5 years (the probability for a child still alive at his/her first birthday of dying before his/her fifth birthday) was higher than the probability of death from birth to age 1 year,[6,7] This pattern does not correspond to any model life-tables as explained in section 1 of the online appendix (available as Supplementary data at *IJE* online).

An irregular decline in child mortality

The data collected in the Bandafassi HDSS show that under-five mortality decreased 3-fold in the area from the 1970s to the 2000s, but the fall has not been regular. The first period of rapid child mortality decline coincides with the acceleration of the Expanded Programme on Immunization in 1987.[8] The proportion of vaccinated children was very low until that year, but then increased sharply in the area as a result of the vaccination campaign of 1987, with nearly half of all children fully vaccinated just afterwards. Child mortality (5q0) then decreased rapidly: it was 40% lower during the 6 years after the acceleration of the EPI than during the 6 years before.[8,9] The decline of mortality was linked to the reduction in deaths from infectious diseases, thanks largely to vaccinations, which produced, for example, a spectacular decline in deaths from measles, previously one of the primary causes of child mortality as explained in section 2 of the online appendix (available as Supplementary data at *IJE* online). The decline was interrupted at the beginning of the 1990s and child mortality then stagnated for a decade. Vaccination coverage levelled off and deaths from measles, although not returning to the previously very high levels, stopped their downward trend. Deaths from malaria, on the other hand, increased sharply following the spread of chloroquine resistance.[10,11]

Child mortality resumed its rapid decline in the 2000s, thanks to a combination of factors, including renewed vaccination efforts and investment in anti-malaria programmes. The decrease in mortality is the consequence of progress in all the main causes of childhood death, including diarrhoeal diseases and acute respiratory infections. Both programmes probably had a much larger impact than would be expected from a mere reduction or eradication of deaths from malaria or vaccine-preventable infections, and they may have had synergic effects.[10]

Malaria mortality: a temporary increase in the 1990s

Malaria has been studied in the Bandafassi HDSS since the late 1980s via entomological and parasitological surveys. Parasitaemia among children has been measured at different seasons and the proportion of malaria strains resistant to different chemicals has been repeatedly measured.[12] Deaths from malaria are difficult to diagnose with certainty since no laboratory tests are available. An ongoing detailed analysis of mortality data considering the broad category of 'death probably attributable to malaria' indicates that it increased 2- to 3-fold during the 1990s, a rise attributable to the appearance and spread in the early 1990s of malaria strains that were resistant to chloroquine, the antimalarial drug widely used in Senegal both preventively and curatively up to 2003.[10,11] This unfavourable trend in malaria deaths is one of the reasons why overall child mortality stagnated in Bandafassi. It was followed by an opposite trend, a dramatic decline in mortality attributable to malaria from 2000 onwards. The investment in antimalaria programmes at the national level probably had an important effect thanks to the introduction of new treatments [amodiaquine + sulfadoxine/pyrimetamine (AQ + SP) replaced chloroquine for the first-line treatment of malaria in 2003, artesunate + amodiaquine (ACT) in 2006], the introduction of rapid diagnostic tests in 2007 in health facilities and the mass distribution of insecticide-treated nets (ITN) from 2008 onwards.

No decrease in maternal mortality despite the new hospital

The Bandafassi HDSS data show that adult mortality has decreased over the period of surveillance, but less than child mortality. The risk for a woman aged 15 of dying before reaching age 60 (45q15) decreased from 358 per thousand in 1985–89 to 255 in 2005–09, and for a man, from 340 to 306. These estimates are probably more reliable than is usually the case for this kind of population thanks to intensive efforts to improve age determination.

Maternal mortality is relatively high in Bandafassi (around 900 maternal deaths per 100 000 live births over the entire surveillance period).[2,13–15] It did not show noticeable signs of decline immediately following the opening of a new modern hospital within the area in 2003, as explained in section 3 of the online appendix (available as Supplementary data at *IJE* online).

Mortality due to violence and accidents still reflects rural living conditions. For example, snake bites cause many deaths (the standardized annual rate of deaths is 13.4 per 100 000 inhabitants over the period 1985–2004), representing one-fourth of overall mortality from external causes (56 deaths per year per 100 000 inhabitants)[16] (more information is provided in section 4 of the online appendix, available as Supplementary data at *IJE* online).

STD infections: very low HIV prevalence

A sero-prevalence survey found no cases of HIV infection in 1998 among a representative sample of 854 adults aged 15–59 years.[17] During the same survey, 11% of the sample had evidence of past syphilis and 5% of active syphilis.[18] Interviews of respondents on sexuality, risk factors for HIV and other STD infections, as well as perceptions of AIDS and its prevention, showed that short-term mobility was associated with risk behaviours. Nonetheless, the level of HIV infection in Bandafassi has probably remained very low, mirroring the relatively low level in Senegal as a whole (Demographic and Health Surveys conducted in 2005 and 2010–11 found that 0.7% of persons aged 15–49 were infected by HIV at each date in the whole of the country).[19]

Modern contraception can disseminate very rapidly in rural Africa

The demography of polygyny and its influence on fertility have also been studied in detail using Bandafassi HDSS data[20] (see section 5 and 6 of the online appendix, available as Supplementary data at *IJE* online). The diffusion of contraception has been monitored at individual level since its introduction, by matching three sources of information: a survey on contraception in 2000, the family planning registers held by the local dispensary and the HDSS data. Surprisingly, contraception spread very rapidly in the region of Bandafassi in the 1990s, but only in a few villages located near the dispensary or having an effective health agent. Even more remarkable is the finding that contraceptive use dropped sharply in the early 2000s following a change of nurse. In this population, difficulties and failures do not stem from an ignorance of contraception among the population or a refusal to use it, but rather from the quality of the relationships with the health staff and the degree of accessibility of contraception.[21]

The genetic diversity of Africa and the history of human peopling of the Earth

Analysis of genetic data collected in the first years of the project have shed new light on the genome diversity of humans and on the genetic variations within African populations. Combined with analysis of other data, in particular linguistic ones, they have been used to construct a history of sub-Saharan Africa and of scenarios for ancient migrations and peopling of the Earth from the first population of *Homo sapiens* living around 200 000 years ago.[22–26]

Bandafassi HDSS: an ideal site for methodological studies

The Bandafassi HDSS is periodically used for methodological studies to evaluate the quality of data collected by censuses and demographic surveys in countries with limited vital registration, and to test new ‘unconventional’ techniques to improve data collection. We mentioned above the age survey organized just after the first census, which was used to estimate indirectly the age of each resident adult independently of the ages declared in the census, which were affected by substantial error and bias.[5] We have also mentioned the systematic collection of genealogies which made it possible to detect errors of filiation and omissions of whole households or individuals and to correct them. We measured the probability of different kinds of errors in the census and particularly omissions of subcategories like orphans or old widowed women, which were much more frequent than for other groups.[3] In the study of contraception, the declarations of women when they were interviewed in 2000 could be matched at the individual level with information kept by family planning registers at the local facilities. Surprisingly, current and ever practice of contraception was considerably under-reported by women: 12% of those aged 15–49 years had ever used modern contraception (this was ascertained by the registers), vs a proportion of just 5% recorded in the survey.[21]

Estimates of adult mortality in countries with limited vital registration are often derived from information collected by surveys about the survival of a respondent's siblings. The completeness and accuracy of such data were evaluated in Bandafassi by linking—at the individual level—siblings' survival histories reported by a sample of female respondents to HDSS data. Respondents often reported inaccurate lists of siblings, omitting 4% of their live sisters, 9% of their deceased sisters and 17% of their sisters who had migrated out of the HDSS area. Based on siblings' survival histories, 45q15 was underestimated by 20% relative to HDSS data.[27,28] A new questionnaire designed to reduce reporting errors is currently being tested.

Future analysis projects

We plan to continue providing data on demographic trends: mortality (child, adult); fertility (intensity, timing, non-marital, fostered children); and marriage (marital patterns, divorce and polygyny). We are further exploring changes in household, family and kinship size and composition in relation to the increase in life expectancy and population ageing. In collaboration with the Senegalese statistical office in charge of the census ('Agence Nationale de la Statistique et de la Démographie'), we plan to evaluate the data collected by the national censuses (especially those of 2002 and 2013) by matching at the individual level the census data collected for the Bandafassi villages with those of the Bandafassi HDSS (the same study will be run in Niakhar and Mlomp HDSS). We will study the exhaustiveness of the census, and errors and bias in reporting of age, survival of parents and household deaths in the past 12 months (and declaration of causes of death, especially maternal deaths and deaths from external causes). Microsimulations will be performed to estimate the effect of misreporting on estimates of mortality rates and to identify adjustment factors.

Strengths and weaknesses

A major strength of the Bandafassi HDSS is the long duration of the follow-up which provides continuous time series over 43 years (33 years for the last villages included) as the data collection method has remained practically unchanged, and a unique historical perspective of demographic changes in the study area. As it started before the introduction of major innovations like routine vaccinations and contraception, it allows the description of their diffusion and their consequences since they were first introduced. Another strength is the genealogies collected at the beginning and updated since then with the addition of more recent generations. Although initially collected for genetic studies, they are useful in facilitating the follow-up and improving its quality (for example by reducing errors of identification), and also for analysis of changes in household and family composition and social relations.

The main weakness of Bandafassi HDSS is its size, which is often too small for trials. However, when combined with the information collected in the two other HDSS in rural Senegal—Niakhar[29] and Mlomp[30]—its data can be used to perform multi-site studies. The three sites are well suited for comparative analysis: they are located in very different regions and environments within a country with contrasting population densities and health services, and the data collection methods are very similar.

Data sharing and collaboration

Data are not open access but may be shared within the framework of a collaboration agreement. Collaborative research projects are encouraged. Enquiries and queries can be submitted to the first or the last author (Gilles.Pison@ined.fr; Valerie.Delaunay@ird.fr).

Supplementary Data

Supplementary data are available at *IJE* online.

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Conflict of interest: None declared.

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