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Fertility trends and net reproduction in Agincourt, rural South Africa, 1992-20041

MICHEL L. GARENNE[1,2], **STEPHEN M. TOLLMAN**[2], **MARK A. COLLINSON**[2], and **KATHLEEN KAHN**[2]

[1]IRD and Institut Pasteur, Paris, France

[2]MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt), School of Public Health, University of the Witwatersrand, South Africa

Abstract

Aims: To analyse trends in fertility rates and net reproduction rates in Agincourt, a rural area of South Africa located in the former homeland of Gazankulu near the Mozambican border. Trends are analysed in the context of widely available modern contraceptive methods and increasing HIV/AIDS.

Methods: A health and demographic surveillance system has been in place since 1992, covering a population of approximately 70,000 persons, with an annual census update and comprehensive recording of births and deaths. It was complemented by a retrospective study of fertility at baseline. Retrospective and prospective data were used to calculate trends in fertility, survival, and net reproduction. When possible, they were compared with data from other censuses and surveys in the same ethnic group.

Results: The fertility transition has almost ended over a course of 25 years in Agincourt. The total fertility rate (TFR) averaged 6.0 in 1979 and 2.3 in 2004. Fertility declined in proportionate fashion in all age groups including adolescents in the recent period. The net reproduction rate (NRR) declined from 1.8 to 1.0 during the prospective period (1992–2004). At current rates of change in fertility and mortality, the NRR can be expected to reach 0.63 by the year 2010.

Conclusions: The situation of a below-replacement fertility level is new for rural Africa, and is likely to have many demographic, economic and social implications. The population could decline in the country as a whole, and is nearly static in Agincourt because of negative migration flows balancing the small excess from natural increase.

Keywords

Agincourt; demographic transition; fertility rate; fertility trends; HIV/AIDS; net reproduction rate; replacement fertility; South Africa

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Correspondence: M. L. Garenne, Institut Pasteur, Paris, France. mgarenne@pasteur.fr.

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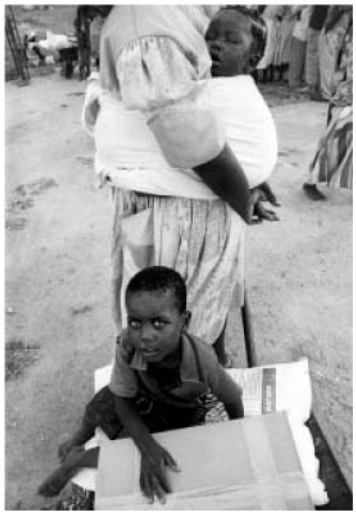
Background



Sub-Saharan Africa remains the continent with the highest levels of fertility. For decades the fertility transition was seen as remote, with some exceptions in eastern and southern Africa. However, the Demographic and Health Surveys programme (DHS), which followed the World Fertility Surveys programme (WFS), showed repeatedly that fertility was declining almost everywhere in Africa, especially in urban areas [1]. In their overview of fertility decline using the WFS and DHS surveys, Garenne & Joseph argued that the transition had started almost everywhere in urban areas, in the 1960s for the pioneers and in the 1980s for the latecomers, and that it began some 10 to 20 years later in the rural areas [2]. The speed of fertility decline was found to be variable across countries, from rapid declines in urban Kenya, to slow changes in remote places such as rural West Africa, where fertility remains at very high levels and close to natural fertility.

With the emergence of the HIV epidemic in the early 1980s, fears of negative population growth due to increasing mortality were expressed. However prevailing birth rates were sufficiently high such that demographic projections made in the late 1980s indicated that population growth would continue for a long time [3,4].

Twenty years later the situation is quite different: fertility has declined dramatically in many areas and much faster than expected; HIV seroprevalence has risen to much higher levels than anticipated; AIDS became the leading cause of death in many places; and concerns over replacement-level fertility could justifiably be expressed.

The situation of South Africa is outstanding in many respects when compared with other African countries. South Africa is far more developed economically, with a strong industrial base, higher income, and higher levels of education. However the average situation hides considerable disparity – between middle- and upper-class whites living at socioeconomic parity with Europeans, and poor black Africans in remote rural areas living in conditions similar to other parts of the continent. Certain areas that formed part of the Bantustan system during the *apartheid* years (the “homelands”) were particularly disadvantaged and benefited from less, and often ineffective, investment in health and education than cities and towns, and other rural areas.

Earlier work has documented the onset of fertility decline in South Africa. Mostert showed that fertility has been declining since the late 1960s, from levels just below 6 children per woman in 1965–69 to 3.4 children per woman in 1990–94 [5]. Similar findings have been documented by other authors [6-9]. Reconstruction of fertility trends from the 1998 South African DHS survey also showed a similar trend [2]. Moultrie & Timaeus, using census and survey data, came to similar conclusions [10]. The onset of fertility decline appeared to occur in parallel with the launching of a large national family planning programme in 1974, although fertility seemed to have declined somewhat earlier in urban areas including among the black African population [11-13]. The national family planning programme rapidly reached rural areas where modern contraceptives were provided in public health clinics at no cost.

Fertility decline in rural areas, especially in the former homelands, is less documented. In their study from the Hlabisa district in KwaZulu-Natal, Camlin & colleagues showed that fertility declined rapidly at least since the early 1980s, and reached levels close to replacement in 2003 [14]. In this study, fertility decline affected all age groups similarly, with the exception of adolescent fertility which tended to remain high between 1980 and 2001.

Proper documentation of the fertility decline takes on increasing value in face of the fast-increasing HIV/AIDS epidemic in South Africa. Current levels of HIV seroprevalence among pregnant women exceed 20% in most provinces, and reach 40% or more in areas of KwaZulu-Natal. The combination of high mortality and low fertility could lead to below-replacement fertility levels, and therefore to negative population growth in the long run. These questions are pertinent for several Southern African countries, not only for urban areas but increasingly in rural settings.

Aims

This paper aims to document the course of the fertility transition, and its consequences for net reproduction, in a rural area of South Africa, in the context of modern contraception and an expanding HIV/AIDS epidemic. The study is part of a comprehensive effort to document health and population change in post-apartheid rural South Africa, to research its driving factors and to understand the consequences.

Material and methods

Study area

The Agincourt study area and health and demographic surveillance system (HDSS) are well described elsewhere [15-17], and in other papers in this collection. In brief, the study area is located in the north-eastern part of South Africa, near the Kruger National Park and Mozambican border, and at the boundary between the Limpopo and Mpumalanga provinces. The study population accounted for about 70,000 persons in 2004 and lives in a sub-district comprising 21 villages of the Bushbuckridge district.

The population is of the Shangaan (part of the Tsonga) ethnic group, a group that has lived for centuries on both sides of the border between South Africa and Mozambique. Starting in the early twentieth century, the population was repeatedly relocated from more fertile surrounding areas into atypical homeland villages as part of *apartheid* policy, and until 1994 the area was part of the Gazankulu “homeland”. Freedom of movement was restricted throughout the apartheid years, with legislation being progressively repealed from the late 1980s.

During and in the aftermath of the Mozambican civil war (1975–82), many farmers and their families crossed the border to take refuge in South Africa, with many settling in border areas of Gazankulu. Of the current population of the Agincourt study area, close to a third are of Mozambican origin. Mozambicans tended to be poorer and less educated than native South Africans, but have dramatically improved their situation over recent years.

Modern contraception is relatively new in the study area. The 1974 national family planning programme reached the area within a few years of its launch. Since then, a range of modern contraceptive methods has been available and free in public health clinics, in particular the oral contraceptive, the IUD, and the preferred injectable (Depo-Provera). According to the 1998 DHS survey, restricted to Shangaan living in rural Limpopo province, 45% of ever-married women and 59% of never-married women who already had intercourse were using modern contraception.

As in most parts of South Africa, HIV/AIDS is raging in Agincourt. The virus arrived around 1990, and the first documented AIDS death in the study area occurred in 1993 [24]. Since then, HIV seroprevalence has increased dramatically and was estimated at around 25% among pregnant women in 2004 [18]. AIDS is now the leading cause of death among adults in Agincourt, accounting for 36% of the deaths in women aged 15–49 years.

Studies conducted in the 1980s and 1990s showed that HIV infection lowered period fertility by some 20% to 40% depending on the survey and the stage of the epidemic [19]. The average of six local studies conducted in eastern Africa indicated a 24% reduction in general fertility rate (GFR) and a 32% reduction in TFR [19]. The 2004 Cameroon DHS survey provides recent estimates based on a national population: HIV-seropositive women had 24% lower GFR and 37% lower TFR than sero-negative women in the three years prior to the survey (authors' calculations). Furthermore, age-specific fertility rates were somewhat higher among HIV sero-positive women below age 20, but much lower at age 30–34, indicating complex interactions between age, fertility and HIV infection. HIV infection has both biological effects on fertility (reducing fecundity, increasing pregnancy loss) and behavioural effects (on marriage, contraceptive use, frequency of intercourse, breastfeeding, abstinence) [19].

Data collection

Routine collection of health and demographic data has been in place in Agincourt since 1992, with an annual census and systematic recording of all births, deaths, in- and out-migrations, plus other events [15-16]. For the analysis of fertility trends, two sources of data were utilized: prospective and retrospective. The retrospective arm of the study is built on full maternity histories of all women of reproductive age collected at baseline, as carried out in retrospective surveys such as the Demographic and Health Surveys (DHS). The prospective arm is the routine collection of new births at each annual census, done by updating maternity histories of women present at the previous round, and completing full maternity histories of immigrant women. Chances of missing events are small, although some live births followed by early deaths were probably miscounted in the first few years of the HDSS, and some live births that occurred after in-migration (and therefore count as eligible) might have been improperly entered in the maternity history file.

In addition to fertility data, mortality data were used for computing net reproduction rates and were also drawn from the routine HDSS. Life tables were computed from census data and death registration data, by calendar year and single year of age, for the prospective period. This allowed computation of the age-specific survival rates necessary for the calculation of net reproduction.

All rates were calculated per person-years at risk, and standard formulae were used to calculate age-specific fertility rates, age-specific death rates, general fertility rates, total fertility rates, and net reproduction rates. The age-specific fertility rate (ASFR) is the incidence of live births per female population of a given age group per year; general fertility rate (GFR) is the incidence of live births per female population of reproductive age (15–49 years); total fertility rate (TFR) is the mean number of live births for women who survive the reproductive period (in this study aged 12–49 years); the net reproduction rate (NRR) is the mean number of female births in the next generation produced by females born in the generation before: it includes a fertility component (children born during the reproductive period), a mortality component (survival from birth to reproductive age), and a sex ratio at birth. For all calculations, the sex ratio at birth was taken as 1.00, the average for South Africa over the 1991–2002 period. In Agincourt, the sex ratio at birth averaged 0.985 (95% CI=0.959–1.013) over the 1992–2004 period, a value not significantly different from 1. The sex ratio at birth is commonly low and close to 1 in southern Africa [20]. Tables are presented in 5-year age groups, starting at age 12, to better capture adolescent fertility and as recommended by other authors [21].

Comparisons were made with other sources of data: censuses and surveys. Each time the same ethnic group was selected: speaking the same language (XiTsonga), living in the same province (Limpopo) and in rural areas. There is strong geographic concentration with a majority of the rural Shangaan of Limpopo living in the Bushbuckridge district. Data from the 1996 and 2001 Census (10% samples provided by the Integrated Public Use Microdata Series (IPUMS) project), allowed for computation of completed family size by birth cohort, and general fertility rate by applying the reverse survival method to the births of the past three years. Data from the 1998 DHS survey allowed for computation of fertility rates directly, but were based on a small sample of 225 women resulting in wide confidence intervals. Comparison with these data sources, and the Africa Center demographic information system in Hlabisa district in KwaZulu-Natal, showed that Agincourt data are comparable to others (see “Results“ below).

Results

Population dynamics

The study area had positive population growth at baseline (1992–93): birth rates exceeded death rates by far (30.9 per 1000 versus 5.0 per 1000), and in-migration more than compensated out-migration flows (82.5 per 1,000 versus 62.5 per 1,000). As a result the population was growing quite rapidly (Table I). The situation changed dramatically over time: birth rates declined to 21.0 per 1,000 in the last two years (2003–04); death rates increased to 10.9 per 1,000 primarily as a result of the HIV/AIDS epidemic; out-migration always exceeded in-migration after 1994 when people had the freedom to move away from the former homeland areas and to settle elsewhere. As a result, population growth essentially halted, and indeed was negative in 2002 and close to zero thereafter. The total population of the study area stabilized at around 70,000 persons, some 10,000 more than at baseline.

Fertility decline

The history of fertility decline in the study area was reconstructed by comparing retrospective and prospective data (Figure 1). The completed family size (CFS) for cohorts born before 1950 was estimated at 5.12 children per women, a value almost identical to that of the 1996 census (CFS=5.17) for the cohorts born between 1910 and 1949 in the same population. The total fertility rate was estimated at 6.0 children per woman in the late 1970s and seems to have started to decline around 1980. However, the fertility decline was halted by the influx of Mozambican refugees who came in large numbers in the early to mid-1980s

into the study area, fleeing the civil war across the border. They had a higher fertility than the native South Africans, even though both belong to the same *shangaan* ethnic group.

The fertility decline resumed soon afterwards, for both South Africans and Mozambicans, and the TFR was about 4.0 children per woman at baseline (1992–93). Note that prospective and retrospective data are fully compatible just before and just after the first census (1992). Fertility continued to decline during the prospective period, and the TFR equalled 2.3 children per woman in 2004. The fertility level appeared somewhat lower than the trend line in the mid-1990s for unknown reasons, and then stalled for a few years though differences were small. Census data also showed a stagnation in fertility between 1996 and 1999, with a general fertility rate (GFR) of 97 per 1,000 in 1996 and 101 per 1,000 in 1999, values almost identical to corresponding values in the Agincourt HDSS (99 and 102 per 1,000 respectively).

The decline from 6.0 to 2.3 children per woman describes an almost complete course of the fertility transition over a 25-year period (1979–2004), which is remarkable for a rural area of Africa.

Age pattern of fertility decline

Both prospective and retrospective data provide the age pattern of fertility (Figure 2). Since the onset of the fertility transition, fertility rates have declined in a proportionate way at all ages, although adolescent fertility remained high for a long time and started to decline as in other age groups only in the mid-1990s. Note that the pattern of decline for adolescents is not as smooth as for the other age groups primarily because of smaller numbers (average of 119 births per year in the 12–16 age group). During the prospective period, fertility rates fell by 39%; there was no statistically significant difference in the ratio of fertility decline between the age groups studied. However the fertility decline at older ages (−46% at age 35–49) was somewhat faster than at younger ages (−36% at age 12–34), the difference being borderline when the larger groups were considered (p=0.081).

A proportionate decline at all ages is typical of the successful introduction of modern family planning to natural fertility situations, and is commonly found in countries with a significant fertility decline such as Kenya or Zimbabwe, and in virtually all recent DHS reports of African countries. Indeed, when modern contraceptive methods are actively promoted, they are likely to be adopted for a variety of reasons by those in need (avoiding a teenage pregnancy, spacing two births, limiting family size), and likely to reach all age groups. This argument was already proposed by Caldwell and colleagues in the 1980s [22] and has been confirmed by recent DHS data.

Net reproduction

The net reproduction rate (NRR) was probably high in pre-transitional years, though was not formally computed since no life table was available prior to 1992. The net reproduction rate was estimated at 1.76 at baseline (1992–93), and declined steadily over the study period to reach 1.02 in 2003–04 (Table II, Figure 3). This is primarily due to the fertility decline documented above, but also, though to a lesser extent, to the mortality increase associated with HIV/AIDS. Survival of women at age 47–50 declined from 0.87 at baseline to 0.62 some 11 years later. This decline in survival rates had an impact on net reproduction, even though the highest burden of mortality is concentrated after the mean age at child-bearing. We estimated that about three-quarters of the decline in net reproduction rate was due to fertility decline and about one-quarter to mortality increase.

A net reproduction rate below one means that, in the long run, population size will decline because of natural causes (excluding the effect of migration). In order to evaluate the

possible effect in the Agincourt population, we projected current trends in age-specific fertility and mortality rates for the next six years: the net reproduction rate would fall to 0.63 by the year 2010, inducing a marked decline in population size.

Discussion

Reaching the below-replacement fertility level is a new situation for rural areas of Africa. For a long time fertility was considered very high and resistant to decline throughout the continent. Cases of fertility decline were assumed to be restricted to urban areas and to more educated women. This is no longer the case, and situations of a net reproduction rate close to one or even lower may prevail in urban and rural areas of South Africa. Even in KwaZulu-Natal, where fertility is somewhat higher, the net reproduction rate is reaching below-replacement levels [14].

The speed of fertility decline in Agincourt is remarkable and consistent over the years, despite many dramatic social changes: an influx of Mozambican refugees, the opening of the political regime in 1994, increasing education, and new economic and employment opportunities in the area. A comparison with rural Kenya provides a scale with which to gauge the changes in Agincourt. In rural Kenya, the total fertility rate was just above 8 children per woman in 1969, and declined to about 5.5 in 1999. Since then, the fertility decline seems to have stalled for reasons that need to be further explored [23]. In Agincourt, the baseline level was lower (6 children), but the full course of the transition was achieved in less time, reaching below-replacement levels.

The other factor of importance in Agincourt is HIV/AIDS, since the disease has a direct effect on fertility. This effect has probably been relatively small over the full study period. However, in recent years, a situation of 25% HIV-positive pregnant women experiencing a 35% negative effect of HIV on TFR could result in a 9% fertility decline – about a fifth of the total decline observed during the prospective period. This effect of HIV/AIDS on fertility could become more marked unless appropriate treatment and prevention measures are taken to mitigate its impact.

Equally important for net reproduction is the mortality effect due to HIV/AIDS [24]. Seroprevalence is already high at young ages in Agincourt, and many women are now dying before age 30, which is close to the average age at marriage in the study area. Even though women have births prior to their first marriage, many in their teenage years, high and early mortality is likely to have an increasing effect unless HAART (highly active anti-retroviral therapy) treatments become widely available and used by women of reproductive age [25].

The effect of HIV/AIDS on cohort fertility could be even higher than on period fertility (discussed above). In Agincourt, women who died of HIV/ AIDS between 1995 and 2003 were 33 years old on average, and had completed only 70% of their potential CFS. Furthermore, women who died of HIV/AIDS had only 1.33 children ever born at time of death, much lower than for their healthy counterparts of the same generation. HIV-infected women thus bear roughly half of their potential offspring before dying. Combining a low CFS, and a high HIV seroprevalence rate, will rapidly lead to very low cohort net reproduction rates.

A strange consequence of the current situation is the indirect incentive to deliver a child as early as possible, before being infected by HIV. Although this was mentioned in interviews conducted by Zwang, it does not yet translate into numbers at the demographic level [26]. Fertility rates among adolescents continued to decline over the years, probably because more and more girls utilize modern contraception.

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The future of population growth in Agincourt looks bleak. However many things may happen to change the current course. In particular, hopes for the proper introduction and take-up of anti-retroviral therapy are high, and this could demonstrably change the course of the epidemic and its demographic impact.

Continuing to monitor fertility trends is a priority for reproductive health research in the study area. It also seems important to initiate study into the demographic and economic consequences of below-replacement fertility for rural areas of South Africa.

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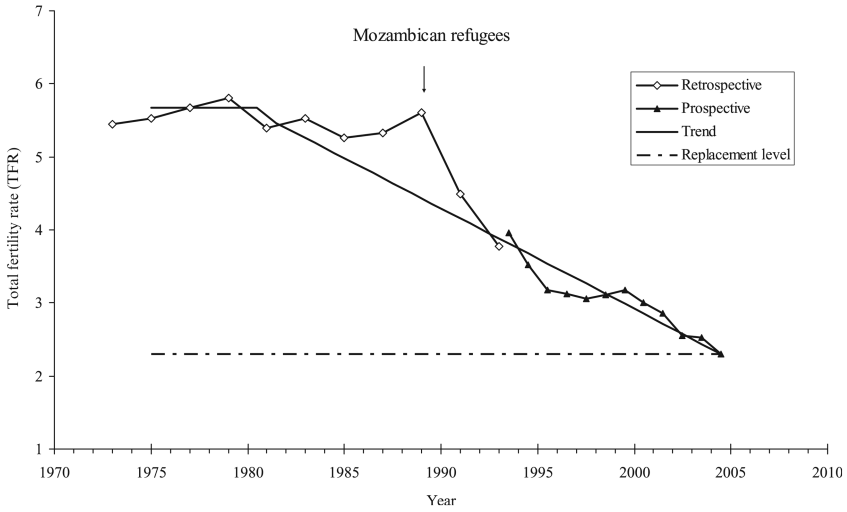

Figure 1.
Fertility trends in Agincourt, 1974–2004 (retrospective and prospective study).

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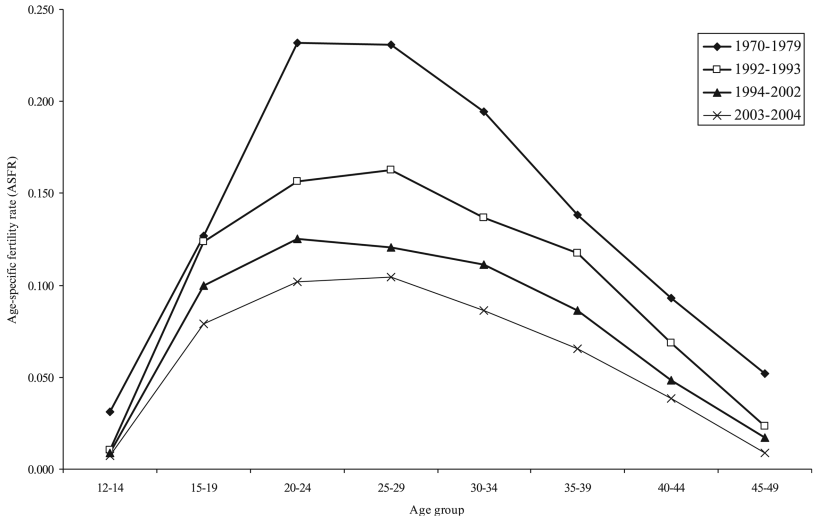

Figure 2.
Age pattern of fertility decline, Agincourt 1992–2004, and comparison with pretransitional situation 1970–79.

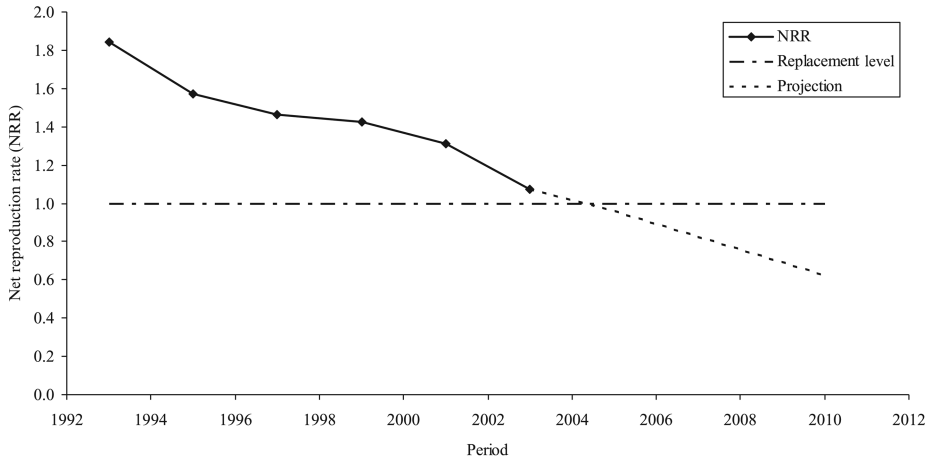

Figure 3.
Trend in net reproduction rate, Agincourt 1992–2004, and projection to 2010.

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Table I

Population dynamics in Agincourt, 1992–2004 (prospective study).

	First 2 years	3-year period			Last 2 years
	1992-1993	1994–1996	1997–1999	2000–2002	2003–2004
Mean population	59,953	64,326	67,259	69,059	69,875
Birth rate	30.9	25.9	25.6	23.7	21.0
Death rate	5.0	5.1	5.8	8.5	10.9
In-migration rate	82.5	62.6	65.9	73.3	56.1
Out-migration rate	65.2	75.9	74.9	86.7	60.0
Rate of natural increase	25.9	20.8	19.8	15.2	10.0
Net migration rate	17.3	−13.4	−9.0	−13.4	−3.9
Population growth rate	43.2	7.5	10.8	1.9	6.1

Updated after the 2004 census. First year (1992) and last year (2004) are incomplete calendar years. All rates are per 1,000 person-years.

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Table II

Trends in fertility, survival, and net reproduction rates, Agincourt 1992–2004 (prospective study).

	First 2 years	3-year period			Last 2 years
Age group	**1992–1993**	**1994–1996**	**1997–1999**	**2000–2002**	**2003–2004**
		Fertility rates			
12–16	0.1729	0.1525	0.1463	0.1500	0.1219
17–21	0.7573	0.6374	0.6230	0.5870	0.4992
22–26	0.7693	0.5849	0.6656	0.5800	0.5261
27–31	0.7495	0.6262	0.5771	0.5396	0.4700
32–36	0.5958	0.5629	0.5080	0.4499	0.3911
37–41	0.5138	0.3743	0.3582	0.3275	0.2990
42–46	0.1911	0.1759	0.1649	0.1290	0.1152
47–50	0.0405	0.0492	0.0352	0.0319	0.0123
		Survival rates			
12–16	0.9500	0.9651	0.9499	0.9390	0.9289
17–21	0.9441	0.9592	0.9446	0.9322	0.9208
22–26	0.9418	0.9531	0.9328	0.9129	0.8962
27–31	0.9335	0.9455	0.9180	0.8824	0.8388
32–36	0.9160	0.9325	0.8999	0.8385	0.7817
37–41	0.9018	0.9162	0.8737	0.7969	0.7228
42–46	0.8836	0.8986	0.8423	0.7586	0.6657
47–50	0.8706	0.8832	0.8227	0.7246	0.6246
		Net reproduction rates			
12–16	0.082	0.074	0.069	0.070	0.057
17–21	0.357	0.306	0.294	0.274	0.230
22–26	0.362	0.279	0.310	0.265	0.236
27–31	0.350	0.296	0.265	0.238	0.197
32–36	0.273	0.262	0.229	0.189	0.153
37–41	0.232	0.171	0.156	0.130	0.108
42–46	0.084	0.079	0.069	0.049	0.038
47–50	0.018	0.022	0.014	0.012	0.004
Total	1.758	1.489	1.408	1.226	1.022