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Primary and secondary infertility in sub-Saharan Africa

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Background	No previous study has provided national estimates of the prevalence of primary and secondary infertility in sizeable areas of sub-Saharan Africa.
Methods	Primary infertility is measured by the proportion childless among women who entered their first marriage at least 7 years before date of censoring. Secondary infertility is measured by the 'subsequently infertile estimator' from parous ever-married women. Exposure begins at the age of the woman at the birth of her first child, and exposure ends when the woman is of an age, which is 5 years lower than her age at censoring. These last 5 years are used to determine her status as infertile or fertile at the last observation 5 years before censoring. A woman is considered infertile at last observation if she has had no livebirths during the last 5 years before censoring, otherwise she is considered fertile. A woman who has not given birth at age *a* or later is defined as being 'infertile subsequent to age *a*'. The index of the proportion subsequently infertile at age *a* is estimated as the number of women infertile subsequent to age *a*, divided by the total number of women observed at that age. Infertility is estimated for women age 20–44.
Results	Primary infertility is relatively low and it exceeds 3% in less than a third of the 28 African countries analysed. In contrast, elevated levels of secondary infertility prevail in most countries. Secondary infertility for women age 20–44 ranges from 5% in Togo to 23% in Central African Republic.
Conclusions	It is feasible to gauge national levels of primary and secondary infertility from population based surveys including a birth history. The prevalence of infertility of pathological origin is so high in sub-Saharan Africa that infertility is not merely an individual concern, it is a public health problem.

Keywords	Primary and secondary infertility, childlessness, demographic analysis, survey birth history data
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The World Health Organization (WHO) has repeatedly requested research on infertility in Africa.[1–5] From 1978 to 1985 WHO directed a worldwide epidemiological study in order to provide a standard approach for the investigation of infertile couples.[6] This study documented that infections, either from a sexually transmitted disease (STD), after a childbirth, or an abortion, were the major causes of infertility in sub-Saharan Africa.[7] Couples defined as infertile in this study had not conceived after more than one year of unprotected sexual activity. It is well known that this epidemiological definition of infertility is not very specific, i.e. a substantial fraction of couples defined as infertile because they had not conceived after one year of unprotected intercourse, go on to conceive without ever receiving any treatment.[8] Thus, the levels of infertility obtained using this epidemiological definition of infertility will lead to higher estimates of infertility, compared to estimates obtained using a demographic definition of infertility.[9]

Demographers have modified the epidemiological definition of infertility, and they define infertility as the inability of a non-contracepting sexually active woman to have a livebirth.[10] Demographers have shifted the endpoint from conceptions to livebirths, because it is difficult to collect complete data about conceptions in population based studies. Furthermore, demographic analyses of infertility are often based on secondary data, such as the Demographic and Health Surveys (DHS), that contain complete birth histories, but no information about

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miscarriages and stillbirths. Larsen and Menken[11,12] recommend, based on simulation studies, to use 7 years of exposure to measure primary infertility, i.e. infertility of nulliparous women, and 5 years of exposure to measure secondary infertility, i.e. infertility of parous women. Demographic estimates of infertility are based on relatively long periods of exposure (5 and 7 years) because it is difficult to assess exposure, i.e. regular sexual intercourse of non-contracepting women, in population based studies of survey data. Estimates of primary infertility need longer periods of exposure because it is, in particular, difficult to assess onset of regular sexual activity from population based surveys. Comparative studies of infertility are hampered by the fact that different definitions of infertility are being employed in epidemiological and demographic research.

The WHO study[6,7] is addressing the aetiology of infertility, and it cannot be used to make inferences about the prevalence of infertility in the community. That is, because the WHO study centres were not selected at random, they were not representative of their region or country, and for instance, Africa was represented by only four centres in Ibadan (Nigeria), Lusaka (Zambia), Nairobi (Kenya) and Yaounde (Cameroon), respectively. Furthermore, all infertile couples probably did not seek treatment and both partners were probably not diagnosed in all infertile couples (these two criteria were used to include an infertile case in the study sample). To this date, no study has provided national estimates of the prevalence of primary and secondary infertility in sizeable areas of sub-Saharan Africa.

Methods

Most demographic work on infertility has been based on data collected from women, and infertility of the couple has been inferred from women's birth experiences.[11,12] This paper follows the tradition of inferring about couple's infertility from information about women's birth histories.

The analysis of infertility is confined to ever-married women to enhance the chance that all women analysed are in a regular sexual union. The analysis is not based on currently married women because in sub-Saharan Africa infertile women are more likely to be separated or divorced.[13] Exposure to childbearing is assumed to end at censoring, which is the month of survey or the month of last sexual intercourse, whichever comes first, and to begin the month of first marriage although we recognize that month of marriage is not a well-defined concept in a sub-Saharan African context. Exposure is not assumed to start the month of first intercourse because this information is not available for each survey analysed, the completeness and accuracy of information about age at first intercourse are questionable, and age at first intercourse may not reflect onset of regular sexual activity.

The prevalence and age pattern of infertility (primary and secondary) are estimated by the 'subsequently infertile estimator'.[11] This measure uses all information available for a woman until she is of an age which is 5 years lower than her age at censoring. These last 5 years are used to determine her status as infertile or fertile at the last observation 5 years before censoring. A woman is considered infertile at last observation if she has had no livebirths during the last 5 years before censoring, otherwise she is considered fertile. A woman who has not given birth at age a or later is defined as being 'infertile subsequent to age a'. The index of the proportion subsequently infertile at age a is estimated as the number of women infertile subsequent to age a, divided by the total number of women observed at that age. Infertility is estimated for the age range 20–44. The analysis is initiated at age 20 to circumvent the difficulties of separating adolescent sub-fertility from infertility. The analysis ends at age 44, because most of the surveys analysed include women age 15–49, and the 'subsequently infertile estimator' uses all information available for a woman until she is of an age, which is 5 years lower than her age at censoring. All estimates are based on monthly dates, and sample weights are used in the calculations.

Secondary infertility is measured by the 'subsequently infertile estimator' from women with at least one child, and exposure begins at the birth date of the woman's first child. Primary infertility is measured by the proportion childless among women who entered their first marriage at least 7 years before end of exposure. Estimates of primary infertility need at least 7 years of exposure, or they are sensitive to variations in fecundability, i.e. variations in the monthly probability of conception, which often is equated with variations in frequency of intercourse.[11]

Estimates of infertility may be biased, because we cannot distinguish women who are infertile from pathological causes from women who have deliberately prevented a birth for more than 5 years (7 years when primary infertility is estimated). Information about ever use and current use of contraception, as well as the type of method used is available, but there are usually no data about the duration of contraceptive use during the open birth interval. A lower and an upper bound estimate of infertility are calculated to capture the effects of contraception on estimates of infertility. First, it is assumed that all current users of a modern contraceptive (the pill, intra-uterine device, injectables, condom and female sterilization) are fertile at interview, and a lower bound infertility estimate is obtained, because some contraceptors may be infertile from pathological causes. Next, the use of contraception is ignored, and an upper bound estimate of infertility is obtained, because some contraceptors may have deliberately prevented a livebirth for more than 5 years (7 years in the analysis of primary infertility), and been falsely classified as infertile. The discrepancy between the lower and the upper bound estimates of infertility is compared to assess the countries where contraceptive use biases estimates of infertility. (This analysis was replicated using ever use of contraception, instead of current use, and there was no substantial difference in the lower bound estimates of infertility. The lower bound estimates also did not change noticeably when we considered all contraceptives, instead of only modern contraceptives). The bias from contraception on infertility estimates cannot be circumvented by restricting the analysis to women who are not using contraception, because non-contraceptors are usually selected for lower fertility and higher infertility.

Data

The analysis is based on the following nationally representative surveys: the 1996 Demographic and Health Survey (DHS) in

Benin; the 1988 DHS in Botswana; the 1993 DHS in Burkina Faso; the 1987 DHS in Burundi; the 1991 DHS in Cameroon; the 1994–1995 DHS in Central African Republic; the 1996 DHS in Comoros; the 1994 DHS in Côte d'Ivoire; the 1993 DHS in Ghana; the 1993 DHS in Kenya; the 1977 World Fertility Survey (WFS) in Lesotho; the 1986 DHS in Liberia; the 1992 DHS in Madagascar; the 1992 DHS in Malawi; the 1995–1996 DHS in Mali; the 1982 WFS in Mauretania; the 1997 DHS in Mozambique; the 1992 DHS in Namibia; the 1992 DHS in Niger; the 1990 DHS in Nigeria; the 1992 DHS in Rwanda; the 1992–1993 DHS in Senegal; the 1989–1990 DHS in Sudan; the 1996 DHS in Tanzania; the 1988 DHS in Togo; the 1995 DHS in Uganda; the 1992 DHS in Zambia; and the 1994 DHS in Zimbabwe.[14,15] The WFS and DHS surveys have comparable questionnaires, they contain complete birth histories, as well as information on the respondent's age and birth date, contraceptive use, marriage and cohabitation.

The response rate is very high in each of the DHS and WFS surveys analysed covering more than 85% of eligible women (the response rate is listed in the respective country reports). Analyses of WFS and DHS data quality, associated with the preparation of the individual country reports, demonstrate consistent and reliable reporting (see, the respective country reports). A further assessment of the DHS-I data quality concludes that the birth history data are flawed, but the probable effects on fertility are minimal.[16(p.2),17(pp.3–7,29–42,61–77)] For instance, it appears that interviewers tended to misrecord the birth dates of some children in order to avoid asking the health questions (which are limited to births born within 5 years of the survey date). Even so, the extent of this problem is so minor that it rarely results in women becoming classified falsely as infertile because the dates of their most recent births have been displaced back in time. Birth dates from more recent DHS-II surveys should suffer less from the problem of displacement.[18] Information about women's age and the birth dates of their children is less complete in the WFS surveys for Lesotho and Mauretania, compared to the DHS surveys for the other sub-Saharan African countries analysed, but a DHS survey has not yet been conducted in Lesotho or Mauretania. That is, more monthly dates are computed, and displacement of births to older women is a concern. In spite of some deficiencies, the WFS data are deemed reasonably accurate.[15] Information from the WFS and DHS surveys is comparable enabling a comparative study of the level and age pattern of infertility in 28 countries.

The thrust of this analysis concerns infertility of young and middle-aged women, i.e. women aged 25–49 at survey. Estimates of infertility rely on information about only the month or year of the last birth (or of marriage, if childless), the age of the woman and the date of her first marriage. Most women had their last child relatively close to the date of interview, which reduces the risk of an erroneous response. Furthermore, the interpretation of the results obtained focuses more on directions and relative levels of infertility, than on the actual values of the infertility estimates. For instance, data about childlessness are known to be particularly poor. In sub-Saharan Africa, having children is very highly valued and barren women tend to hide their childlessness. Thus, childless women may avoid being interviewed, report 'Don't know' to questions about children ever born, or do not distinguish between bearing and rearing children. Therefore, infertility estimates from childlessness may be underestimated, and these estimates provide merely lower bounds of primary infertility. We emphasize that estimates of primary infertility are only rough summary statistics, and they should be interpreted with some caution.

Results

As a first step, the potential bias in infertility estimates from contraception is ascertained. Table 1 presents age-specific estimates of infertility by country, as measured by the proportion subsequently infertile.

Table 1 shows a discernible difference between the lower and the upper bound estimate of infertility in a number of countries. For instance, in Kenya at age 35–39 the percentage infertile ranges from 32 to 45 from the 1993 DHS. The countries where contraception has the greatest impact on estimates of infertility include Botswana, Comoros, Ghana, Kenya, Liberia, Namibia, Tanzania and Zimbabwe, and it is generally countries where contraceptive prevalence of modern methods exceeds 10%.

Levels and age patterns of infertility

Figure 1 presents the percentage infertile by age for each of the countries analysed. The estimates presented are the lower bound estimates, where all current users of a modern method are considered fertile at interview. The prevalence of infertility falls within a relatively wide range being high in the Central African countries of Cameroon and Central African Republic, and low in the East African countries of Rwanda and Burundi and the West African country of Togo. For example, at age 35–39 the percentage infertile is 20 in Rwanda and 54 in Central African Republic. The age pattern of infertility also varies quite markedly across the countries analysed. For instance, in Burkina Faso infertility is relatively low up to age 35, and then at older ages infertility increases quite rapidly, while in Liberia infertility is relatively high in the 20s, but the increase in infertility is modest in the 30s and 40s.

Primary infertility

The prevalence of primary infertility is relatively low throughout sub-Saharan Africa (Table 2 and Figure 2). It is generally deemed that about 3% of all couples cannot have children due to immunological incompatibility, genetic abnormality, anatomic anomalies, or other conditions that prevent conception or reduce fetal viability.[19] If we use 3% as a threshold, then we may conclude that primary infertility is currently a problem in relatively few sub-Saharan African countries mainly in Central and West Africa. The highest prevalence of primary infertility reaches 6% in Cameroon and in Central African Republic. Estimates of primary infertility are not affected by contraception because virtually none of the women deemed to have primary infertility used contraception.

Secondary infertility

The prevalence of secondary infertility spans a wide range in sub-Saharan Africa (Table 3 and Figure 3). The estimates of

Table 1 Percentage infertile by age in selected sub-Saharan African countries: modified estimates, when all current users of a modern contraceptive are assigned as fertile at interview shown in parentheses

	Age						
Country and survey date	20–24	25–29	30–34	35–39	40–44	20–44	**Unweighted sample size**
Benin 1996	4(4)	8(8)	18(18)	40(39)	66(63)	13(13)	3107
Botswana 1988	8(6)	13(10)	25(18)	41(29)	56(47)	17(13)	1063
Burkina Faso 1993	5(5)	9(9)	16(15)	35(34)	67(66)	12(12)	3427
Burundi 1987	4(4)	6(6)	10(10)	24(24)	41(41)	8(8)	1501
Cameroon 1991	15(14)	23(22)	35(33)	53(50)	75(73)	25(24)	1920
Central African Rep. 1994/95	17(17)	26(25)	38(37)	55(54)	76(75)	29(28)	3138
Comoros 1996	11(10)	17(15)	28(24)	45(40)	68(62)	21(19)	1361
Côte d'Ivoire 1994	9(9)	15(15)	26(25)	43(41)	66(64)	19(18)	3952
Ghana 1993	7(7)	13(12)	23(21)	41(38)	62(59)	16(15)	2656
Kenya 1993	6(5)	12(9)	24(17)	45(32)	65(52)	16(12)	3628
Lesotho 1977	13(13)	23(22)	35(35)	53(53)	76(75)	27(27)	2149
Liberia 1986	10(10)	16(15)	26(24)	39(35)	52(47)	18(17)	2229
Madagascar 1992	12(12)	19(18)	30(28)	48(45)	77(74)	22(21)	3004
Malawi 1992	8(8)	13(13)	24(23)	39(37)	61(59)	18(17)	2626
Mali 1995/96	7(7)	11(11)	19(19)	39(37)	70(69)	15(14)	5869
Mauretania 1982	10(10)	19(19)	33(33)	53(52)	68(68)	22(22)	2112
Mozambique 1997	11(11)	20(19)	33(31)	51(47)	73(69)	23(22)	4621
Namibia 1992	8(7)	16(12)	27(18)	43(31)	68(53)	22(16)	1856
Niger 1992	9(9)	15(15)	25(25)	42(41)	63(62)	17(17)	3675
Nigeria 1990	9(9)	14(13)	27(26)	42(40)	65(63)	17(17)	4864
Rwanda 1992	2(2)	5(4)	9(9)	21(20)	49(46)	7(7)	3215
Senegal 1992/93	7(6)	12(11)	21(20)	38(36)	64(62)	15(14)	3314
Sudan 1989/90	8(7)	15(14)	28(27)	51(49)	76(74)	18(18)	3093
Tanzania 1996	9(8)	14(13)	23(20)	41(35)	66(61)	18(16)	3914
Togo 1988	3(3)	6(5)	9(8)	20(19)	47(46)	7(6)	1189
Uganda 1995	9(9)	13(12)	22(21)	41(37)	64(61)	16(15)	3098
Zambia 1992	8(8)	13(12)	21(18)	37(34)	64(60)	16(15)	3381
Zimbabwe 1994	9(7)	15(12)	26(20)	47(36)	72(61)	19(15)	3005

secondary infertility presented in Figure 3 are lower bound estimates where current users of a modern contraceptive are considered fertile at interview. Cameroon and Central African Republic rank among the countries with the highest prevalence of secondary infertility reaching, respectively, 20 and 25% of women age 20–44. Secondary infertility is also prevalent in Lesotho, Mozambique and Mauretania, where it counts 25, 21 and 21% of women age 20–44. The lowest levels of secondary infertility prevail in Burundi, Rwanda and Togo, where 5–7% of women age 20–44 have secondary infertility. The remaining countries analysed have secondary infertility in the middle range from 10% to 18% for women age 20–44.

Discussion

This study showed that infertility is prevalent in sizeable areas of sub-Saharan Africa. Primary infertility exceeds 3% in less than a third of the 28 countries analysed, but elevated levels of secondary infertility prevail in most countries.

Several limitations of the data affect the estimates of infertility. Foremost, the WFS and DHS surveys do not include any questions about 'how long have you tried to have a child'. Instead, estimates of infertility are based on information about the date of last birth. However, some women might not engage regularly in sexual intercourse and have a lower chance of having a child. We concluded, based on simulation analysis, that women who have not had a live birth 5 years subsequent to their previous livebirth be considered infertile, and estimates of 'subsequent infertility' are obtained, as described above. Because we use a period as long as 5 years to determine the woman's status as infertile or fertile, we obtain a measure that is not sensitive to variations in fecundability (frequency of intercourse) and variations in the duration of postpartum amenorrhoea.[11]

Some estimates of primary infertility may be underestimates, because in some countries the percentage infertile (primary and

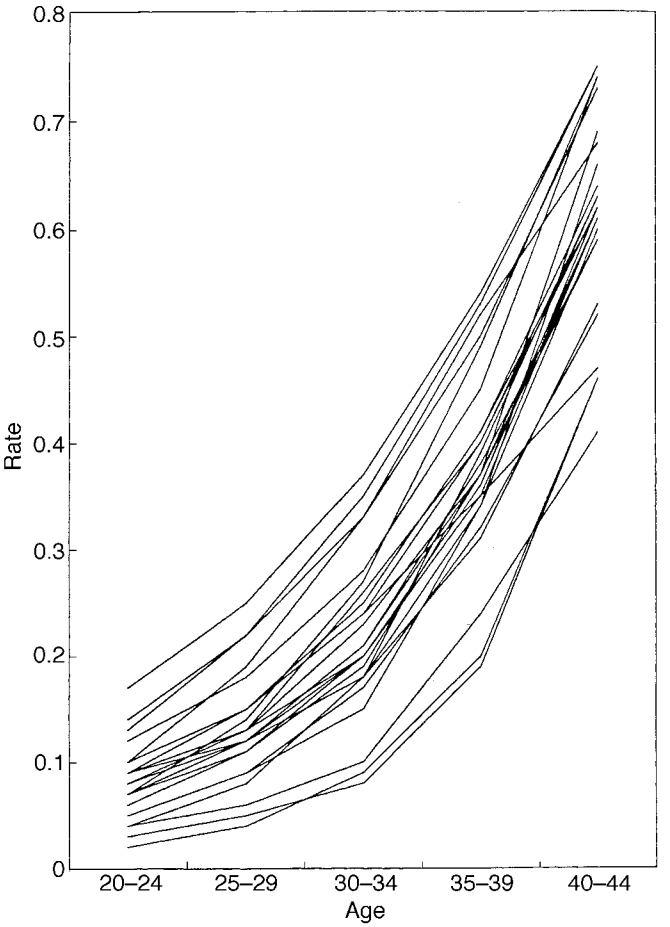

Figure 1 Age-specific infertility rates in selected sub-Saharan African countries

Table 2 Percentage with primary infertility in selected sub-Saharan African countries for all women based on the proportion childless after at least 7 years since first marriage

Country and survey date	Percentage childless	Unweighted sample size
Benin 1996	1	3083
Botswana 1988	2	984
Burkina Faso 1993	3	3574
Burundi 1987	2	1436
Cameroon 1991	6	2037
Central African Rep. 1994/95	6	3338
Comoros 1996	4	1346
Côte d'Ivoire 1994	3	4081
Ghana 1993	2	2610
Kenya 1993	2	3597
Lesotho 1977	4	2317
Liberia 1986	3	2363
Madagascar 1992	4	3010
Malawi 1992	2	2759
Mali 1995/96	3	6226
Mauretania 1982	5	2509
Mozambique 1997	4	4873
Namibia 1992	3	1727
Niger 1992	4	4231
Nigeria 1990	4	5127
Rwanda 1992	1	3037
Senegal 1992/93	3	3508
Sudan 1989/90	3	3262
Tanzania 1996	2	3888
Togo 1988	2	1229
Uganda 1995	3	3182
Zambia 1992	2	3489
Zimbabwe 1994	2	2974

secondary) at age 20–24 is substantially higher than the percentage with primary infertility. Most African women initiate childbearing at relatively young ages, and it is plausible that the women, who were infertile at age 20–24, did indeed have a child at a younger age. Alternately, some childless women have falsely reported that they have children, when they have foster children, and they are falsely considered to have become infertile at a young age after they have had a child. Also, some childless women may be omitted from fertility surveys.[20] Assessments of DHS data quality have shown that for some countries the birth history data are flawed, but the effects of response errors on fertility estimates are minimal.[16–18] We deem, despite data limitations, that inferences may be drawn from WFS and DHS data about relative levels of infertility.

The strength of using fertility surveys, like the WFS and DHS, is that they facilitate community estimates of the prevalence of primary and secondary infertility. The extent of primary and secondary infertility of pathological origin was not known for most of the countries analysed. Previous studies of infertility at the national level have focused on primary infertility or combined primary and secondary infertility.[20,21] This study showed that infertility at age 20–24 is not negligible, even though primary infertility is relatively low. A better understanding of the association between parity and infertility may provide clues to determine the extent to which complications at delivery lead to subsequent infertility. For instance, if a relatively large proportion of couples became infertile after they had their first child, then this would suggest that poor access to health care during the first pregnancy and delivery, poor resources for midwifery care, possible poor midwifery practices, and a high incidence of complications that cannot be remedied or prevented may be important causes of secondary infertility.

Analyses of infertility based on censuses or nationally representative surveys, like the present study, provide knowledge about the prevalence of infertility in sub-Saharan Africa. Further studies are needed to clarify the aetiology and geographical variations in the incidence and prevalence of infertility. It is also not known how infertility affects each woman and man's life in terms of social stigma and ostracism, how the implications of infertility for the individuals involved vary from society to society and whether infertile individuals seek and receive appropriate health care. Because of these far reaching consequences of infertility for the individual and for the general public health, infertility merits further study.

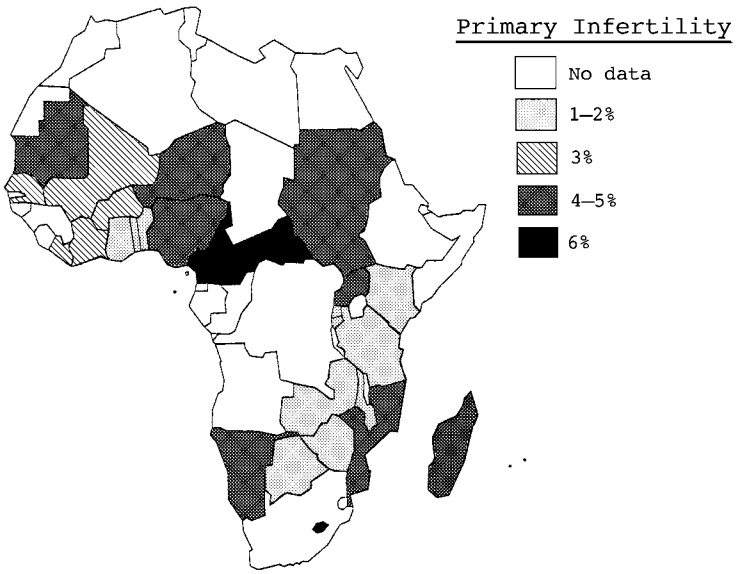

Figure 2 Percentage with primary infertility in selected sub-Saharan African countries

Table 3 Percentage with secondary infertility in selected sub-Saharan African countries based on the 'subsequently infertile estimator' and parous women: modified estimates, when all current users of a modern contraceptive are assigned as fertile at interview shown in parentheses

	Age						
Country and survey date	20–24	25–29	30–34	35–39	40–44	20–44	**Unweighted sample size**
Benin 1996	4(3)	7(7)	17(17)	39(38)	65(63)	13(12)	2950
Botswana 1988	6(4)	11(8)	23(16)	39(27)	53(43)	14(10)	1013
Burkina Faso 1992/93	4(3)	7(7)	14(13)	33(32)	66(65)	11(10)	3208
Burundi 1987	3(3)	5(5)	9(9)	23(23)	40(40)	7(7)	1386
Cameroon 1991	11(10)	18(17)	30(28)	49(46)	72(69)	21(20)	1736
Central African Rep. 1994/95	14(13)	23(22)	34(33)	51(50)	74(73)	26(25)	2799
Comoros 1996	9(9)	15(13)	26(23)	44(38)	68(62)	20(18)	1230
Côte d'Ivoire 1994	7(7)	13(13)	23(23)	41(39)	65(63)	17(16)	3746
Ghana 1993	6(6)	11(10)	20(18)	39(36)	61(58)	15(14)	2461
Kenya 1993	5(4)	11(8)	23(15)	44(31)	65(51)	15(11)	3499
Lesotho 1977	11(11)	20(20)	32(32)	51(51)	75(74)	25(25)	1941
Liberia 1986	10(9)	15(14)	25(23)	38(34)	51(46)	18(17)	2049
Madagascar 1992	9(9)	15(14)	25(23)	44(41)	75(72)	18(17)	2769
Malawi 1992	7(7)	13(12)	23(22)	39(37)	60(58)	17(17)	2498
Mali 1995	5(5)	9(9)	18(17)	37(36)	69(68)	14(13)	5501
Mauretania 1982	8(8)	17(17)	32(32)	52(51)	67(67)	21(21)	1910
Mozambique 1997	10(9)	18(17)	30(28)	48(44)	72(68)	22(21)	4234
Namibia 1992	6(5)	13(9)	24(16)	40(28)	67(51)	19(13)	1732
Niger 1992	6(6)	13(12)	23(22)	41(40)	63(62)	16(15)	3415
Nigeria 1990	6(6)	11(11)	24(23)	41(38)	64(62)	16(15)	4439
Rwanda 1992	2(2)	4(4)	9(8)	21(20)	49(46)	7(7)	3006
Senegal 1992/93	5(5)	10(10)	19(18)	37(35)	64(61)	14(13)	3112
Sudan 1989/90	6(6)	13(12)	26(25)	49(47)	75(74)	17(16)	2813
Tanzania 1996	7(7)	12(11)	21(19)	40(34)	65(60)	16(15)	3708
Togo 1988	2(2)	5(4)	7(6)	18(17)	46(45)	6(5)	1113
Uganda 1995	7(6)	11(10)	21(19)	39(36)	63(60)	14(13)	2900
Zambia 1992	7(6)	12(11)	20(17)	36(33)	63(59)	15(14)	3210
Zimbabwe 1994	8(6)	14(11)	25(19)	46(35)	72(61)	19(14)	2891

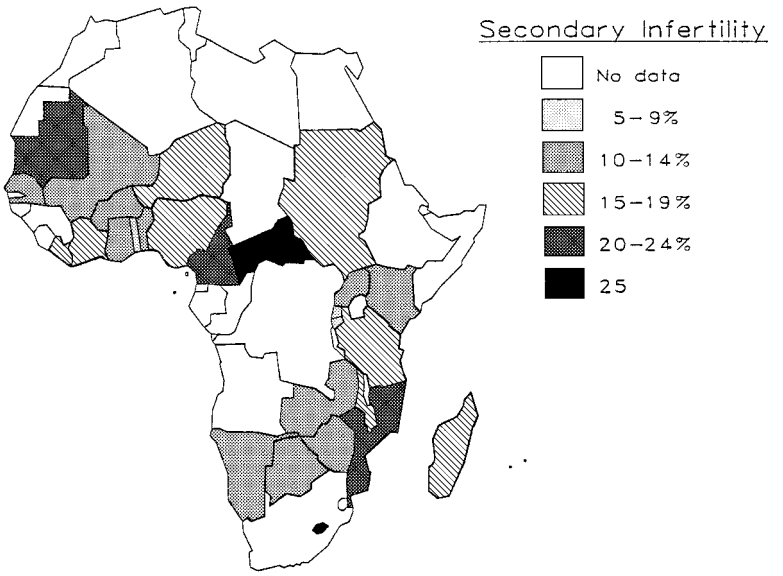

Figure 3 Percentage with secondary infertility in selected sub-Saharan African countries

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