Male and Female Subfecundity in Zambia

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Abstract

Background

Traditionally population measures, based on birth histories, are only constructed for women, though fertility or infertility is a condition of the couple. As sterility, primary or secondary, is potentially related to either the male or female member of the couple, estimating of male subfecundity would provide a fuller picture of population-level subfecundity than female-only estimates alone.

Objective

To estimate male subfecundity for the Gwembe Tonga of Zambia using male birth histories for men collected by the Gwembe Tonga Research Project from 1957 to 1995, while providing context by estimate female subfecundity for the Gwembe Tonga as well as female subfecundity in all of Zambia from DHS data from 1992, 1997, 2001-02, and 2007.

Methods

The Larson-Menken subsequently infertile measure was used, with estimates produced using discrete time event history analysis.

Results

The odds of infertility increased steadily with age for both men and women, and across all datasets. However, women's probability of infertility increased much more sharply with age than men's and women's odds of infertility were 3 times that of men's. Odds of infertility also increased over time, with highest odds of being infertile found in the latest time periods.

1. Introduction

Population measures of fertility and subfecundity are usually constructed from birth histories of women and thus limited to the population of women rather than the general population. However, fertility or its absence are conditions experienced by a couple, with causes that could be related to the male partner, female partner or both partners; medical studies (Folkvord et al, 2005) and anthropological studies (Gerrits, 1997; Dryer et al 2004) provide direct evidence of male subfecundity in multiple locations in Africa. Determining whether subfecundity is due to male or female disorders is often difficult in part due to a general reluctance to take responsibility for it, and generally less is known about male subfecundity prevalence (McFalls and McFalls, 1984). McFalls and McFalls (1984) estimate between 20 and 60% of subfecundity is accounted for in whole or in part by male subfecundity across populations. As sterility, primary or secondary, is potentially related to either the male or female member of the couple, estimating male subfecundity would provide a fuller picture of population-level subfecundity than female-only estimates alone.

This analysis aims to describe the subfecundity of Gwembe Tonga men by applying Larsen's and Menken's (1989, 1991) subsequently infertile measure using incomplete birth histories. Juxtaposed with measurement of subfecundity for the women in the same population, this analysis seeks to describe subfecundity among the entire Gwembe Tonga population. Measures of female subfecundity from Demographic and Health Surveys (DHS) data from 1992, 1996, 2001-02, and 2007 will also be presented to provide context for the Gwembe Tonga analysis and describe the effects of increases in contraceptive prevalence on the measure.

2. Background

2.1 Subfecundity in Africa

Fertility rates vary widely across and within countries in sub-Saharan Africa (for example, Bongaarts et al, 1984), and evidence from demographic measurement of subfecundity has shown wide variation across the continent. Larsen (2000) found relatively low rates of primary sterility but high rates of secondary sterility. These rates of secondary sterility ranged from less than 10% to 25% for women age 25-44 (Larsen, 2000). Other researchers have found similar levels of variation (Ericksen and Brunette, 1996). Frank (1983) found great variance in rates of primary sterility by country and also by ethnic group in Africa. Bongaarts et al (1984) cite substantial variation in measured primary sterility across Africa, varying from 3% to 20% or higher, and noted substantial variation within countries. Similarly, Jensen (1995) found substantial differences in secondary sterility rates in two Kenyan communities using anthropological.

2.2 Subsequently Infertile Measures

This analysis uses Larsen's and Menken's (1989) method for measuring the proportion of women who are subsequently infertile after a certain age using incomplete birth histories, which was based on earlier complete birth history methods developed by Vassen and Henry. Those categorized as subsequently infertile are experiencing secondary sterility. For this measure, infertility is defined as a woman being observed for a specified time, T, without having a live birth despite being sexually active and not using contraception. This method estimates the proportion of women who become sterile between age *a* and age *a*+T, at some age *a**. Five years is generally used for T's value, as birth intervals are usually no longer than five years. However, women with open birth intervals longer than five years will be categorized as infertile using this method, risking overestimation in populations with wider than average birth intervals. Larsen and Menken (1991) argue that women who had subsequent birth intervals outside of the interval were likely subfecund, and in both the male and female Gwembe Tonga data as well as all DHS datasets, average birth intervals were below five years (see Table 1).

There are some notable limitations to this measure. Some sexually inactive individuals may be included even if limited to those continuously married. Excluding never married and divorced individuals from the measure likely underestimates infertility; evidence suggests that subfecund women are more likely to be divorced than fecund women (Larsen and Menken, 1994). Contraception further complicates the measure as women who are practicing contraception could be counted as infertile despite being fecund. Larsen (1994) outlined contraceptive use conditions in which the subsequently infertile measure could be estimated with negligible bias, but data with adequate detail about contraceptive use for determining whether these conditions are met is often unavailable (and not available for the data used in this analysis). In this analysis, two ways of dealing with contraceptive use were used for the ZDHS data (see 3).

Table 1. Population size, marital and birth history descriptive statistics for women and men in the Gwembe Tonga and Zambia DHS (1992, 1996, 2001-02, and 2007) datasets

	Women					***Men***			
	Gwembe Tonga	**1992 DHS***	**1996 DHS**	**2001-02 DHS**	**2007 DHS**	**Gwembe Tonga**	**1996 DHS**	**2001-02 DHS**	**2007 DHS**
Individuals aged 20 and over	2206	4800	5637	5487	5269	1900	1307	1591	4829
Ever married	1768	4516	5219	5063	4747	1258	1041	1341	3910
Married individuals used in analysis**	1405	3615	4071	3416	2264	1021	***Not included in analysis***		
Mean age first marriage (SE)	19.9 (0.16)	17.2 (0.05)	17.5 (0.05)	17.7 (0.05)	18.1 (0.05)	25.6 (0.24)	22.8 (0.13)	22.6 (0.11)	22.9 (0.07)
Women married more than once (%)	143 (8%)	1186 (26%)	1346 (26%)	1240 (25%)	1009 (21%)	1,083 (84%)	349 (34%)	524 (39%)	994 (27%)
Men with more than 1 wife (%)	***Not applicable***					337 (27%)	93 (10%)	122 (10%)	284 (8%)
Percent of polygynists with exactly 2 wives						68%	94%	84%	91%
Mean age in years at first birth (SE)	20.4 (0.07)	18.1 (0.05)	18.3 (0.04)	18.3 (0.04)	18.5 (0.04)	25.0 (0.18)	***Not available***		
Mean birth interval (SE)	2.7 (0.02)	2.8 (0.97)	2.8 (1.04)	2.9 (1.01)	3.0 (1.02)	2.4 (0.02)			
Mean number of live births (SE)	4.1 (0.08)	4.6 (0.04)	4.5 (0.04)	4.4 (0.04)	4.3 (0.04)	4.5 (0.16)	4.8 (0.12)	5.0 (0.11)	4.7 (0.05)
Mean number of living children (SE)	3.1 (0.06)	3.8 (0.4)	3.6 (0.03)	3.7 (0.03)	3.6 (0.03)	3.3 (0.11)	3.9 (0.10)	4.1 (0.09)	4.0 (0.05)
Proportion childless§	8.10%	2.41%	2.73%	2.74%	2.53%	17.10%	***Not available***		

*The 1992 DHS did not contain a male sample.

**For the Gwembe Tonga, these are people continuously married for 5 years preceding each observation included in analysis; for the DHS, these are women who married at least 5 years prior to the observation and were still married at the time of the survey.

§Proportion childless was estimated for those married at least 7 years before last observation using Larsen's method (Larsen, 2000).

2.3 Zambia and the Gwembe Tonga

Zambia, a land locked country in southern Africa, had an estimated mid-year 2011 population of over 13 million. Life expectancy remains among the lowest in the world (52 years) with maternal mortality and infant mortality rates among the highest (*World Factbook*, 2009). Fertility rates in Zambia are high; total fertility was estimated to be 6.2 in 2007. Contraception use has increased from 15% of women in 1992 to 41% in 2007, 33% using a modern method in 2007 (CSO et al, 2009). Relatively little information about sterility in Zambia has been published. Sunil and Pillai (2002) found that the proportion of women who were sterile increased from 0.12 in 1980 to 0.15 in 1990, with evidence of regional variation. The authors estimated that sterility rates in Southern Province, where the Gwembe Tonga live, increased from 0.11 to 0.14 between 1980 and 1990 (Sunil and Pillai, 2002).

This analysis estimates subfecundity among the Gwembe Tonga using a data set collected from 1956-1995 (Clark, 2001). The Gwembe Tonga traditionally resided in the valley of the Zambezi River but many were forced to relocate in the late 1950s for the Kariba Dam Project. Gwembe Tonga women marry early (mean age of 16.5 years) and nearly universally (97% married by age 45). Gwembe Tonga fertility rates have remained high (total fertility of 6) through the 1980s (Clark et al, 1995). In the late 1950s as many as 40% of men practiced polygyny (Colson, 1971). Polygyny is still practiced, though less common (Clark, 2001). The period covered by this data was tumultuous for the Gwembe Tonga and evidence shows that social organization and behaviors changed over this period in ways that may impact not only fertility desires and practices but also fecundity (Clark et al, 1995). For analysis, time periods were selected to capture key events for the Gwembe Tonga and Zambia though consultation with the Gwembe Tonga Research Project (Thayer Scudder, personal communication). Period one, 1950 to 1963, covers a brief period before the Kariba dam project and relocation and resettlement. Period two, 1964 to 1972, covers nine years of relative stability and economic growth. 1973 to 1981, period three, saw dramatic deterioration of the Zambian political economy and the war from Zimbabwe Independence, which undermined economic and social services for the Gwembe Tonga. In period four, 1982 to 1990, health conditions deteriorated and HIV/AIDS became a large problem in Zambia. During period five, 1991 to 1999, health problems and the burden of HIV/AIDS continued as the economy stagnated and there were a series of floods and droughts. In the final period, 2000 to 2008, the economy improved and access to HIV care and treatment improved. No data used for the Gwembe Tonga fell in the last period, though some of this period is captured in the 2001-02 and 2007 ZDHS data.

3. Data

Data for the Gwembe Tonga come from the Gwembe Tonga Research Project, begun by Elizabeth Colson and Thayer Scudder in 1956, with yearly data on unions and births through 1995. Four villages are included in the dataset, and the sample includes all the inhabitants of these villages as well as individuals born to or marrying members of the sample or migrating into the villages. Individuals left the sample through death or moving away (Clark, 2001). These data are ideal for estimating subfecundity for men because birth histories are separately available for both men and women in the sample. To compare subfecundity estimates for the Gwembe Tonga with Zambia, Demographic and Health Survey data from 1992 (ZDHS 1992), 1996 (ZDHS 1996), 2001-02 (ZDHS 2001-02) and 2007 (ZDHS 2007) are used. Analysis was restricted to currently married individuals at least age 20 years in the DHS analysis since the marriage history data available was inadequate to allow exit and re-entry into the sample based on divorces. All ever married individuals over age 20 years were included from the Gwembe Tonga data, with analysis limited to observations for which the individual had been married the prior five years. Later DHS datasets did not have observations for the earliest time periods. Over 50% of observations in the 2007 DHS were in the last time period and for the 2007 DHS time periods were collapsed to 1973-1999 and 2000-07 to accommodate sparseness in certain age and time period categories.

4. Methods

This analysis uses discrete-time event history analysis (Allison, 1984) and estimates the hazard of being subfecund by age and time period for all populations under study with logistic regression. This approach incorporates covariates for age and time period, and sex for the pooled Gwembe Tonga data for direct comparison of male and female subfecundity. Being subfecund was measured with the subsequently infertile measure (Larsen and Menken, 1989, 1991), which was assigned for each person year of observation that individuals were observed and had been married at least five consecutive, immediately prior observation years. Probabilities of being subfecund were predicted for five year age categories spanning reproductive age; the last category for women being 40 years plus or 45 years plus and for men 55 years plus.

5. Results

Contraception use among the Gwembe Tonga was negligible during the period under analysis (Sam Clark and Thayer Scudder, personal communication) so was ignored in the estimates, but modern contraception use was increasing throughout Zambia in the period covered by the DHS surveys. The predicted probabilities of being infertile by age are presented in Figure 1 for each ZDHS data set for both approaches to addressing contraception use. Models that considered all contracepting women fertile (the blue curves) represent a minimum level of infertility in the populations as presumably a non-negligible proportion of contracepting women may be infertile but considered fecund. The first scenario, where all modern contraception users are excluded entirely from the risk set, shows the risk of being infertile only for women who were not using contraception at the time of the survey. In 1992, when only 16% of married women were using any method at the time of the survey, the estimated probability of infertility is very close between the two approaches, but by 2007, when 33% of married women were using contraception the curves have diverged substantially, indicating a sizeable effect of contraception use on the measure (which was thoroughly documented by Larsen, 2000). For comparison and discussion, only the estimates treating all contraception users as fertile were used in Figure 2 (and in Table 2), representing the minimum estimate of infertility.

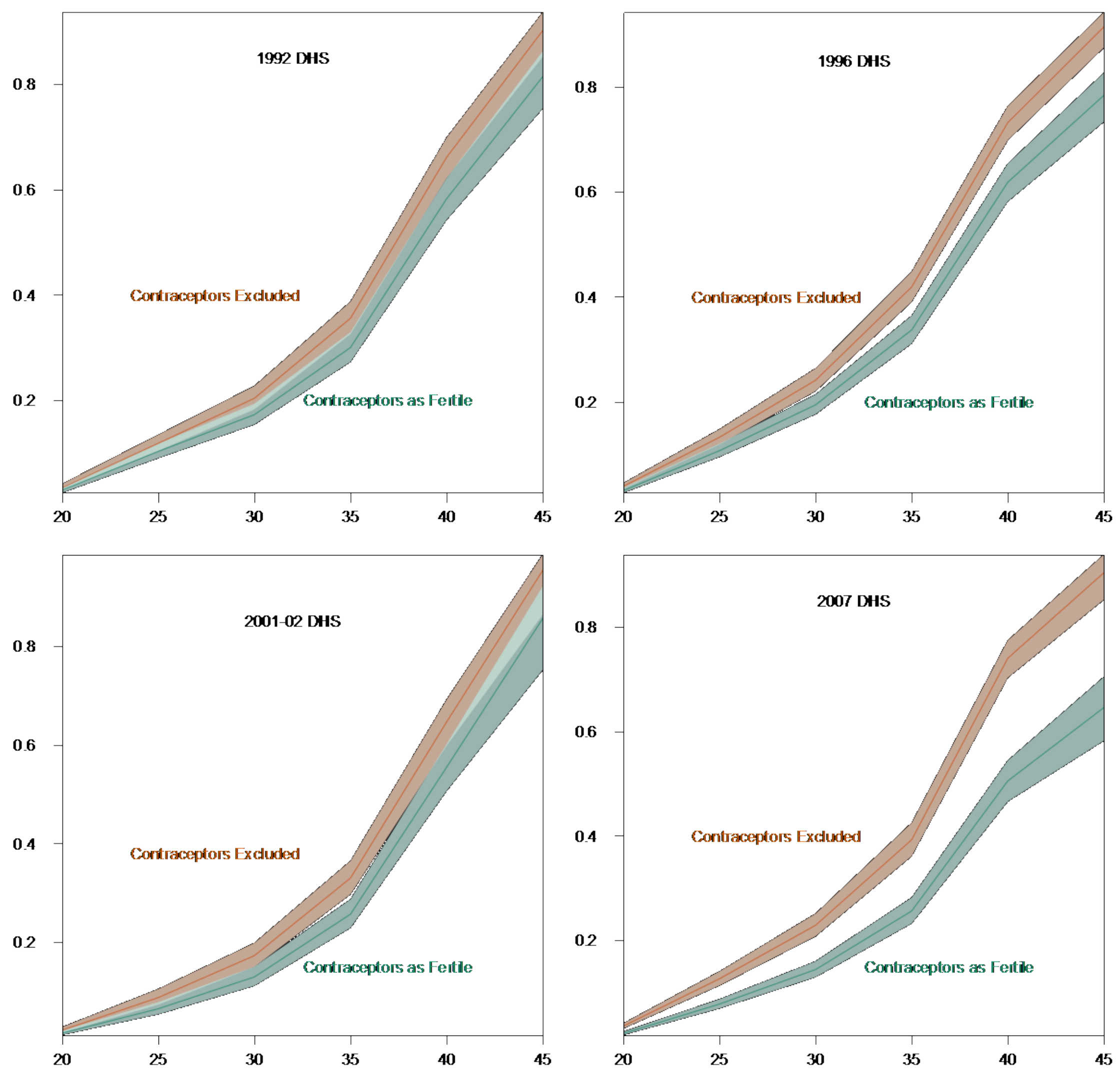

Figure 1. Predicted probabilities (with 95% confidence intervals shaded) for being infertile by age for both approaches for addressing contraception, by DHS data set

Table 2. Odds ratios (with standard errors) for being infertile obtained through logistic regression for women from the **1992, 1996, 2001-02 and 2007 DHS surveys**, treating women using contraception as though they were fertile

	1992	*1996*	*2001-02*	*2007*
Age group				
20-24		*Reference group*		
25-29	3.5 (0.3)*	3.5 (0.2)*	3.5 (0.3)*	3.8 (0.3)*
30-34	5.7 (0.5)*	6.5 (0.5)*	5.8 (0.5)*	7.3 (0.7)*
35-39	10.4 (1.1)*	12.3 (1.1)*	11.0(1.2)*	14.3 (1.6)*
40-44	31.0 (3.8)*	33.2 (3.7)*	31.2 (3.9)*	37.9 (5.2)*
45 and older	83.0 (17.4)*	65.1 (11.1)*	70.6 (13.9)*	66.7 (12.4)*
Time Period**				
1964-1972	*Reference group*		*No observations*	
1973-1981	1.8 (0.5)	10.6 (7.4)*	*Reference group*	
1982-1990	3.8 (1.2)*	22.9 (16.5)*	1.6 (0.4)	*Reference group*
1991-1999	5.7 (1.8)*	45.2 (32.9)*	2.6 (0.8)*	
2000-2007	N/A	N/A	4.2 (1.3)*	1.5 (0.2)*
Intercept	0.01 (0.0)*	0.001 (0.0)*	0.01 (0.0)*	0.02 (0.0)*
Pseudo R2	0.19	0.22	0.19	0.18
Cases	3399	3813	3744	3636
Observations	40233	45708	44099	43040

*Significant at the p<0.01 level

**For the 2007 DHS most observations were in the latest time period and earlier time periods were combined to adjust for the relatively few observations.

For men and women, across all models, the odds of being infertile increased steadily with age, with near certainty of infertility at the oldest ages (which was an open interval and included all the oldest respondents under study) (see Table 3 and Figure 2). This steady increase was true in the pooled model for men and women as well. When pooling men and women, the odds of women being infertile were three times the odds of men being infertile. Odds of infertility increased over time for all models as well (Tables 2 and 3). The odds of being infertile were lowest in the earliest period, 1950-1963, for the Gwembe Tonga and increased incrementally until a very large increase in the last time period, 1991-1999. The 1992 and 1996 DHS populations showed similar patterns, with the lowest odds of infertility being for the reference time period, 1964-1972, but with more pronounced increases through the time periods. Odds of infertility increased more incrementally over time in the model for the 2001-02 DHS population, though the highest odds were seen in the 2000-2007 group. The model using the 2007 DHS data only included two time periods, 1972-1999 and 2000-2007, to deal with the lack of observations for older women in the earlier time periods; the odds of infertility were 1.6 that of the odds in the earlier one

Table 3. Odds ratios (with standard errors) for subsequent infertility obtained through logistic regression for **Gwembe Tonga** women, men and men and women combined.

	Women	***Men***	***Pooled Men and Women***
Age Group			
20-24		*Reference group*	
25-29	3.5 (0.3)*	10.7 (2.4)*	4.3 (0.3)*
30-34	5.5 (0.6)*	22.8 (5.4)*	7.8 (0.7)
35-39	12.3 (1.4)*	40.8 (10.0)*	16.1 (1.6)*
40-44**	86.0 (10.5)*	64.5 (16.2)*	44.7 (4.6)*
45-49§		106.4 (27.2)*	108.6 (12.7)*
50-54		158.4 (42.8)*	
55+		338.5 (96.7)*	
Time Period			
1950-1963		*Reference group*	
1964-1972	2.0 (0 .4)*	2.1 (0.6)*	2.2 (0.3)*
1973-1981	2.3 (0.5)*	3.2 (1.0)*	2.7 (0.5)*
1982-1990	3.5 (0.8)*	5.6 (1.7)*	4.4 (0.8)*
1991-1999	12.5 (2.8)*	18.5 (5.8)*	15.5 (2.8)*
Sex			
Female			3.1 (0.3)*
Intercept	0.01 (0.0)*	0.002 (0.0)*	.003 (0.0)*
Pseudo R^2	0.32	0.29	0.31
Cases	1405	1021	2426
Observations	20069	16141	36210

*Significant at the p<0.01 level
**For women only, the 40-44 age group includes all women age 40 and over.
§For the pooled model, the 45-49 age group includes all individuals age 45 and over

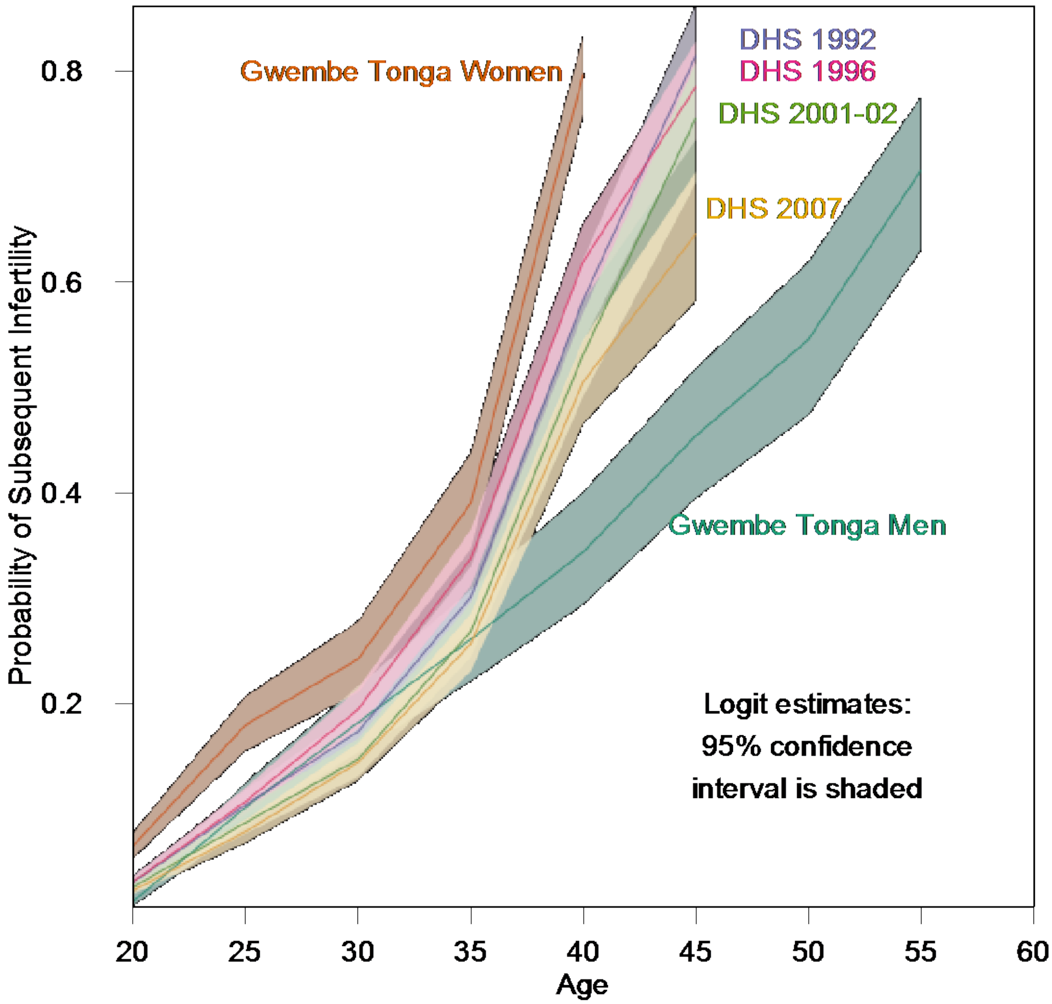

Figure 2. Predicted probability of being infertile by age with 95% confidence intervals.

6. Discussion

This method for measuring infertility does not distinguish between the potential causes of infertility, be it a failure to have sexual intercourse, a failure to conceive, or a failure to carry a pregnancy to term and successfully deliver. Instead, this measure captures the proportion of a population at risk for pregnancy that does not have. However, there are some limitations to the use of this measure in the populations used in this analysis. The reliability of paternity reporting is a potential limitation to any study of male infertility at the population level. In addition to the potential confusion of social and biological paternity, men may be unaware of children or choose to deny paternity. However, data from both the Gwembe Tonga and ZDHS surveys indicate that most men reported at least one child. Data for the Gwembe Tonga were collected as part of annual census of the four villages and thus limits recall bias that could undermine cross-sectional birth histories from men regarding fertility outside of stable, long duration unions. Another potential limitation for estimates made with the more recent ZDHS survey data is the increasing prevalence of contraception and its affect on this measure of population infertility. The divergence of the two approaches for addressing contraception demonstrates that the measurement of subfecundity becomes increasingly less precise as contraceptive use increases in the population. Obviously, high rates of female-controlled contraception would greatly complicate attempts to measure male infertility through birth histories, though for the period understudy for the Gwembe Tonga contraception use was negligible (Communication with the Gwembe Tonga Research Project).

This study has shown that men's infertility increases with age similar to women's increase in infertility with age. However men's probability of infertility increases much more slowly than women's, which was expected due to men's longer reproductive period. Though, in the final age, men like women, reached very high probabilities of infertility.

This analysis also shows an increase in infertility in recent years not out of line with previous research showing a slight increase since the 1990s (Sunil and Pillai, 2002) though this finding bears more investigation, particularly in understanding the role increased contraception use is playing on both the measure itself as well as determinants of fertility, the substantial HIV epidemic in the country, Zambia's persistent high infant mortality, and changing marriage practices. Zambia has experienced substantial epidemiological and social changes over the past 50 years and these findings suggest there may be some impact on fecundity in both the male and female population.

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