SI for Fertility.

SI 7.1. A male interviewer.

Having a male interviewer collect information on reproductive histories might not be ideal. It certainly restricted the topics that I chose to discuss with the women. A brief experiment with a female interviewer confirmed that she was able to get information on topics I would never expect to be able to ask and get believable responses (for example, what made a good husband? what had attracted you about your husband?). But it also was instantly clear that for the purposes of the demographic interviews, it was more important that the women knew that I knew them, their children, and many of the other answers. In other circumstances, the advantage of a female interviewer might become more evident.

SI 7.2. Adding older women to the sample

I examined the sensitivity of our TFR estimates to the decision to limit the sample to women aged 55 or less. Changing the cut-off age makes very little difference. All of the TFRs were between 5.8 and 6.4. The average of the TFR's with cut off at every age from 45 to 60 (mother's birth years 1940 to 1955) was 6.23 for all fathers and 6.11 for Hadza fathers.

I also looked again at the interview records of the 13 women aged 55 or less who had been interviewed but excluded. Eleven had been excluded because there was not enough information to estimate the year of birth of their children. Two had been excluded because the field notes included comments "very, very bad" and "do not use". One of these, and three more cases were judged as worth including in some test runs to see how much difference our more arbitary decisions had made. Adding all four to the sample of women aged under 55 lowered TFR from 6.28 to 6.22 when Swahili fathers were included, and from 6.17 to 6.09 when women who had any children by Swahili husbands were excluded. These are very small effects. These much agonized decisions turn out to have been unimportant.

SI Table 7.2.1. Total fertility rate (TFR) when sample restricted by woman's age at interview. "Cut off year" 1942 means that interview data from women born in or before 1942 were excluded.

Cut off year	All dads	Hadza dads
1940	6.189	6.074
1941	6.226	6.109
1942	6.226	6.109
1943	6.245	6.123
1944	6.245	6.123
1945	6.284	6.168
1946	6.409	6.317
1947	6.409	6.317
1948	6.276	6.157
1949	6.204	6.068
1950	6.228	6.122
1951	6.228	6.122
1952	6.151	6.024
1953	6.246	6.140
1954	6.043	5.895
1955	6.210	6.059
Average	6.227	6.109

The next table shows completed family size for two samples of older women, born before 1945. The average CFS was 5.56 (all women) and 6.56 (use = 1). The result for all women would be expected to be lower because the sample includes people who even though we interviewed them, gave insufficient information to estimate ages of their children and enter hitherto unknown children in the population register. Our record of their children thus depends on survivors being encountered and entered in our register. Their dead children would not be recorded. The result for the "use = 1" women is rather higher than the TFR. This result could imply that Hadza women used to be more fertile. But since these figures bracket the estimated TFR, one being about half a baby lower, the other half a baby higher, and both have a mode at CFS 6, perhaps we should not be too concerned.

Table 7.2.2. Completed family size (CFS) for the older women interviewed.

Completed Family Size (children ever born)	Interviewed women born 1925-1955 and marked use = 1	All interviewed women born 1925-1955
0	0	1
1	0	4
2	2	5
3	1	9

4	3	5
5	2	11
6	6	13
7	3	7
8	4	7
9	2	3
10	3	3
11	1	4
12	0	0
N	29	72
Average CFS	6.56	5.56

SI 7.3. The program and measure of age specific fertility

With the reproductive histories of this sample, I estimated age specific fertility with a program that first runs through the population register file that lists all known individuals and their estimated date of birth (if any). The program identifies the mothers and creates an array indexed by mother's ID and number of children. Each of her children is identified in this array. The program does the same for fathers. The next routine creates an array of the children in birth order. This array is used by the routine for computing the age – specific fertility and total fertility rate for the interviewed women.

The program selects the 227 eligible women by the criteria listed above (in our file of interview candidates, marked to use "use = 1", do not use (exclude, use = 0), and born in or after 1945). It also gives the option of including all these women, or excluding those who had any children by "Swahili" husbands. The program takes each of these eligible women from the list of candidates, and looks up her estimated date of birth. If this is entered as an exact year the program adds half a year because exact year estimates for adult women imply only that the woman was born sometime during the year. Her birth is taken as occurring on average at mid-year. The program next takes the actual decimal date on which she was last interviewed and computes her age at the last interview. Rounded down to a whole year, (by the Visual Basic function Int(decimal date)) this gives the final year of "risk" which she entered. Because we have no record of whether she completed this year with or without another birth, this year contributes a half year to her years at risk. (The program was also extended to use the exact portion of the year elapsed until the final interview, the effect on age-specific fertility is of course extremely small).

The program builds an array that counts the number of women entering each year of life under observation (from birth to final interview), records the number for whom each year of life was their final year of observation (thus to score only half a year). The program runs through the array of each woman's children, takes the estimated birth date of each child (in decimal years) and calculates mother's age at each birth. It adds her to the count of women giving birth during the year of life obtained by rounding down to a whole year. To finally calculate ASF the program looks at each year of life, and calculates the number of women-years of risk as the number entering that year of life minus half the number for whom this was the final year of data. It then takes the number of births to women in that year of life, divides it by the number of years at risk to give the probability of a birth to a woman in that year of life, the age-specific fertility. These age-specific fertilities are summed for the whole lifespan to give total fertility rate.

SI 7.4. Tribal identity of father.

SI table 7.4.1. Raw data for Age Specific Fertility. All women, married to Hadza or Swahili men. There were 695 births, we failed to ascertain the sex of 10, there were 331 females and 354 males born, for a sex ratio of 1.069. GRR was 3.147 (alldads) (3.138 for hdzdads). Smoothing by logistic regression in annual hazard file: birth or not = age + age^2 .

Age	Enter	Censored	At risk	Births	ASFR	Smoothed
0	227	0	227	0	0.000	0.000
1	227	0	227	0	0.000	0.000
2	227	0	227	0	0.000	0.000
3	227	0	227	0	0.000	0.000
4	227	0	227	0	0.000	0.000
5	227	0	227	0	0.000	0.000
6	227	0	227	0	0.000	0.000
7	227	0	227	0	0.000	0.000
8	227	1	226.5	0	0.000	0.000
9	226	0	226	0	0.000	0.000
10	226	0	226	0	0.000	0.000
11	226	0	226	0	0.000	0.000
12	226	0	226	0	0.000	0.000
13	226	1	225.5	0	0.000	0.000
14	225	2	224	3	0.013	0.000
15	223	9	218.5	6	0.027	0.089
16	214	4	212	30	0.141	0.107
17	210	7	206.5	33	0.160	0.128
18	203	12	197	37	0.188	0.148
19	191	18	182	47	0.258	0.170
20	173	6	170	43	0.253	0.192
21	167	3	165.5	37	0.224	0.213
22	164	9	159.5	37	0.232	0.232

23	155	12	149	40	0.268	0.249
24	143	3	141.5	45	0.318	0.265
25	140	13	133.5	39	0.292	0.277
26	127	10	122	32	0.262	0.287
27	117	10	112	37	0.330	0.293
28	107	3	105.5	27	0.256	0.296
29	104	5	101.5	28	0.276	0.296
30	99	5	96.5	35	0.363	0.292
31	94	1	93.5	17	0.182	0.284
32	93	2	92	16	0.174	0.275
33	91	5	88.5	23	0.260	0.261
34	86	12	80	14	0.175	0.245
35	74	12	68	15	0.221	0.227
36	62	7	58.5	11	0.188	0.207
37	55	8	51	14	0.275	0.186
38	47	2	46	7	0.152	0.165
39	45	6	42	3	0.071	0.143
40	39	7	35.5	8	0.225	0.122
41	32	5	29.5	4	0.136	0.103
42	27	7	23.5	3	0.128	0.084
43	20	3	18.5	3	0.162	0.068
44	17	2	16	0	0.000	0.054
45	15	3	13.5	1	0.074	0.042
46	12	1	11.5	0	0.000	0.032
47	11	2	10	0	0.000	0.024
48	9	1	8.5	0	0.000	0.018
49	8	1	7.5	0	0.000	0.013
50	7	2	6	0	0.000	0.000
51	5	1	4.5	0	0.000	0.000
52	4	2	3	0	0.000	0.000
53	2	1	1.5	0	0.000	0.000
54	1	1	0.5	0	0.000	0.000
55	0	0	0	0	0.000	0.000
56	0	0	0	0	0.000	0.000
57	0	0	0	0	0.000	0.000
58	0	0	0	0	0.000	0.000
59	0	0	0	0	0.000	0.000
60	0	0	0	0	0.000	0.000

SI Table 7.1 Data for age specific fertility of women married only to Hadza men.

Age	N enter yr	N final yr	N at risk	N births	N female births	N male births
0	195	0	195	0	0	0
1	195	0	195	0	0	0
2	195	0	195	0	0	0
3	195	0	195	0	0	0
4	195	0	195	0	0	0
5	195	0	195	0	0	0
6	195	0	195	0	0	0
7	195	0	195	0	0	0
8	195	1	194.5	0	0	0
9	194	0	194	0	0	0
10	194	0	194	0	0	0
11	194	0	194	0	0	0
12	194	0	194	0	0	0
13	194	1	193.5	0	0	0
14	193	2	192	3	1	2
15	191	9	186.5	5	2	3
16	182	4	180	26	10	16
17	178	7	174.5	28	12	15
18	171	12	165	32	16	14
19	159	17	150.5	38	19	18
20	142	6	139	33	14	19
21	136	2	135	30	9	21
22	134	9	129.5	31	15	16
23	125	12	119	28	15	13
24	113	2	112	35	20	15
25	111	11	105.5	28	13	15
26	100	9	95.5	26	15	11
27	91	7	87.5	30	13	17
28	84	3	82.5	18	9	9
29	81	3	79.5	23	13	10
30	78	4	76	25	13	10
31	74	1	73.5	14	7	7
32	73	2	72	14	6	8
33	71	4	69	17	8	8
34	67	10	62	14	7	7
35	57	8	53	13	9	4
36	49	5	46.5	7	3	4
37	44	7	40.5	11	6	5
38	37	1	36.5	5	1	4
39	36	4	34	3	3	0

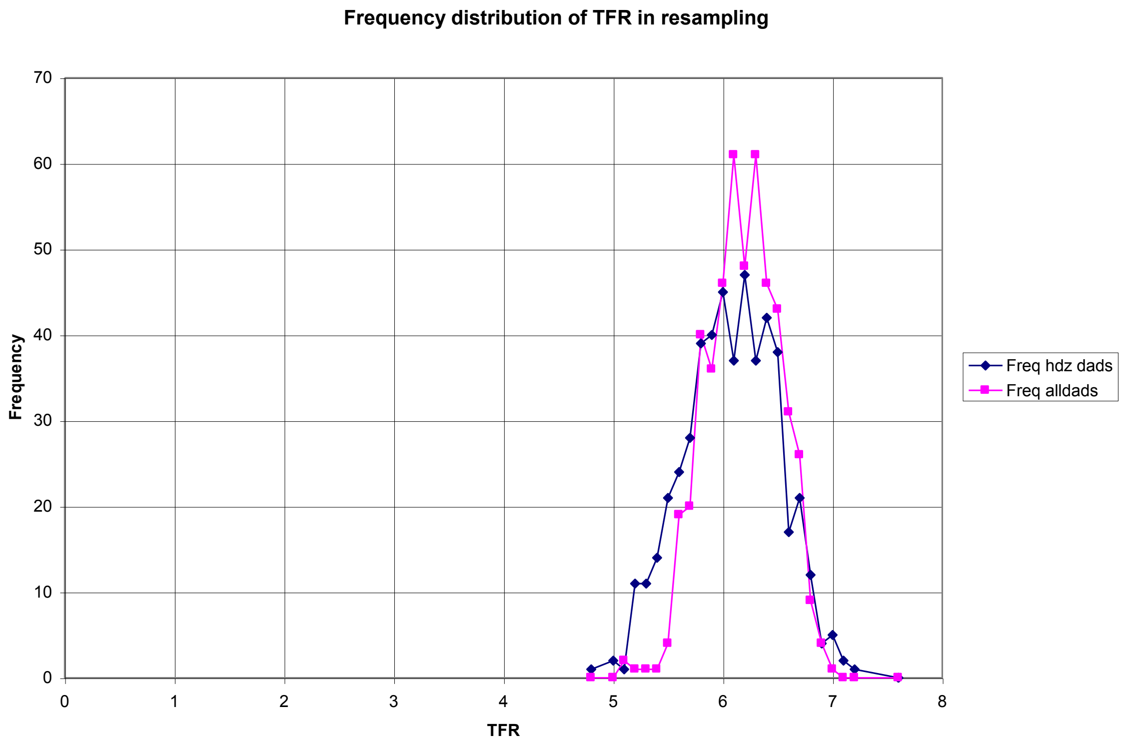
Age	N enter yr	N final yr	N at risk	N births	N female births	N male births
40	32	5	29.5	4	4	0
41	27	3	25.5	3	3	0
42	24	6	21	3	2	1
43	18	3	16.5	3	1	2
44	15	2	14	0	0	0
45	13	2	12	1	0	1
46	11	1	10.5	0	0	0
47	10	2	9	0	0	0
48	8	1	7.5	0	0	0
49	7	1	6.5	0	0	0
50	6	1	5.5	0	0	0
51	5	1	4.5	0	0	0
52	4	2	3	0	0	0
53	2	1	1.5	0	0	0
54	1	1	0.5	0	0	0
55	0	0	0	0	0	0
56	0	0	0	0	0	0
57	0	0	0	0	0	0
58	0	0	0	0	0	0
59	0	0	0	0	0	0
60	0	0	0	0	0	0

SI 7.5. Resampling

Our program for resampling fertility (resamplestructure04-08.vbp) derives the random samples, and runs each sample through the routines that calculated age-specific fertility and TFR for the actual sample. Each random sample was derived as follows. Women in the interview sample were given a new ID number from 1 to 227 and these were stored in an array along with their original ID numbers. [The original ID numbers were not so convenient to use because they were scattered among the numbers 1001 to 1999.].

Random numbers between 1 and 227 were generated using the Visual Basic Randomize, and RND functions. The number was translated into its original ID number and the fertility data for that woman were processed by the original fertility routine. The next random number was generated, and that woman's data processed, and so on, until 227 women had been processed. The number of times each woman was used was recorded and confirms that, as is integral to the resampling process, in each run some women were omitted and some were used more than once. Age-specific fertility and TFR were calculated and recorded. Working arrays were cleared and the next run of 227 random women began. This process was looped through 500 times. The array that had stored the results of the 500 loops was printed as a frequency table.

SI figure 7.5. Confirming the very small effect of father's tribal identity on women's TFR. Resampling TFR x father's tribe. Frequency distribution of TFR found by resampling.



SI Table 7.5 Table of data for graph above. Frequency distribution of TFR from resampling. Mean for Hadza fathers is 6.07, for all fathers mean is 6.18.

TFR	Freq hadza dads	Freq all dads
4.8	1	0
5	2	0
5.1	1	2
5.2	11	1
5.3	11	1
5.4	14	1
5.5	21	4
5.6	24	19
5.7	28	20
5.8	39	40
5.9	40	36
6	45	46
6.1	37	61
6.2	47	48
6.3	37	61
6.4	42	46
6.5	38	43
6.6	17	31
6.7	21	26
6.8	12	9
6.9	4	4
7	5	1
7.1	2	0
7.2	1	0
7.6	0	0
	500	500

SI 7.6. Marital fertility and adolescent sub-fecundity.

I estimated marital fertility from the annual hazard of birth file. The file was combined with the marital histories described in chapter 15. The records in which a woman was married were selected and a logistic regression of "anybirth" on age and age-squared was run. The fitted probabilities of a birth are shown in SI Figure 7.6, along with a lowess smoothing of the original data. The fitted curve indicates lower marital fertility among the under 20s, compatible with adolescent sub-fertility. Multilevel regression controlling for the woman's identity did not change the picture of marital fertility.

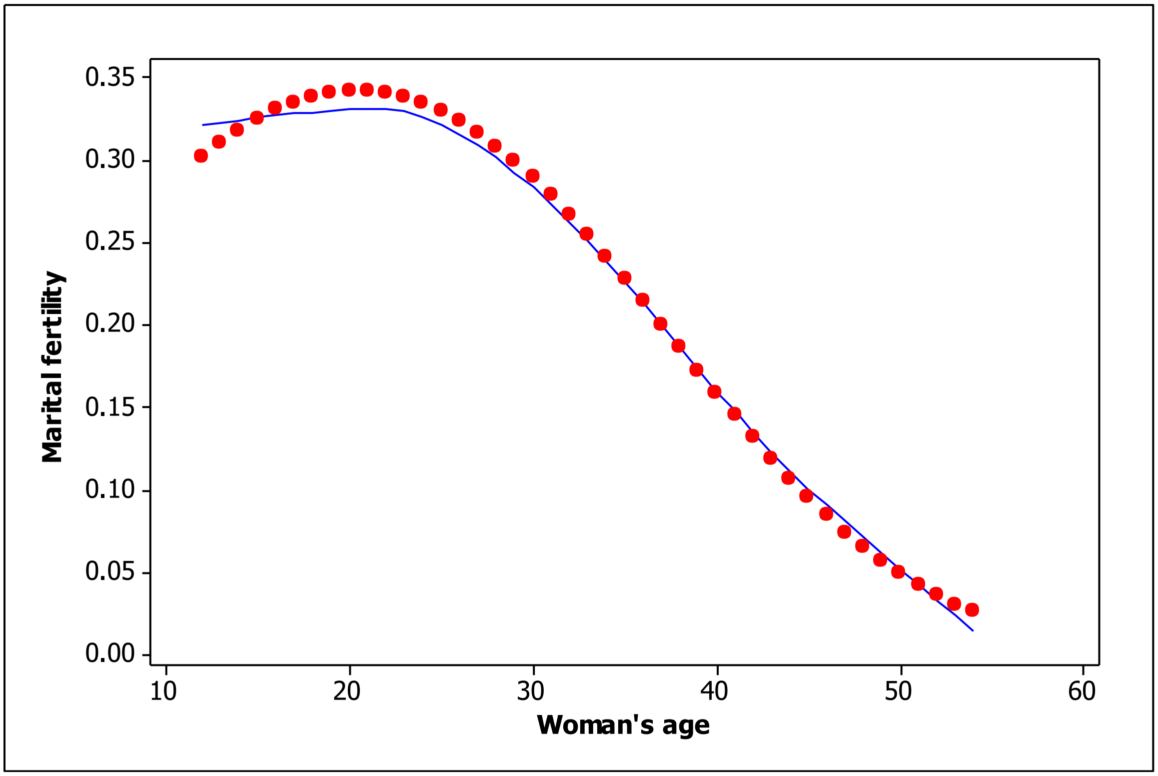
Marital fertility is much higher among the young women, partly as a matter of definition. Among the Hadza, marriages are quite quickly established and quite easily ended (as Woodburn also remarked 1968b p.107). Some marriages appear to follow the arrival of a baby, few women declare themselves as unmarried when they conceived a baby, even though they may readily report the marriage as having ended by the time of the birth. Measuring marital fertility is unimportant for our population model and prediction. It is of more interest when one's aim is to use demographic information as clues to proximate mechanisms and their contribution to variation in fertility or inter-birth interval (examples in Wood 1994). It is also useful when one wishes to assess the fecundability of women of different ages, for instance when testing men's preference for more fertile women.

Table of data for text figure 7.2. Marital fertility.

Woman age	Asf all husbands	Asf Hadza husbands
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0.25	0.27272
15	0.2	0.1923
16	0.50847	0.5
17	0.375	0.35897
18	0.3398	0.3409
19	0.39166	0.37073
20	0.3295	0.29864

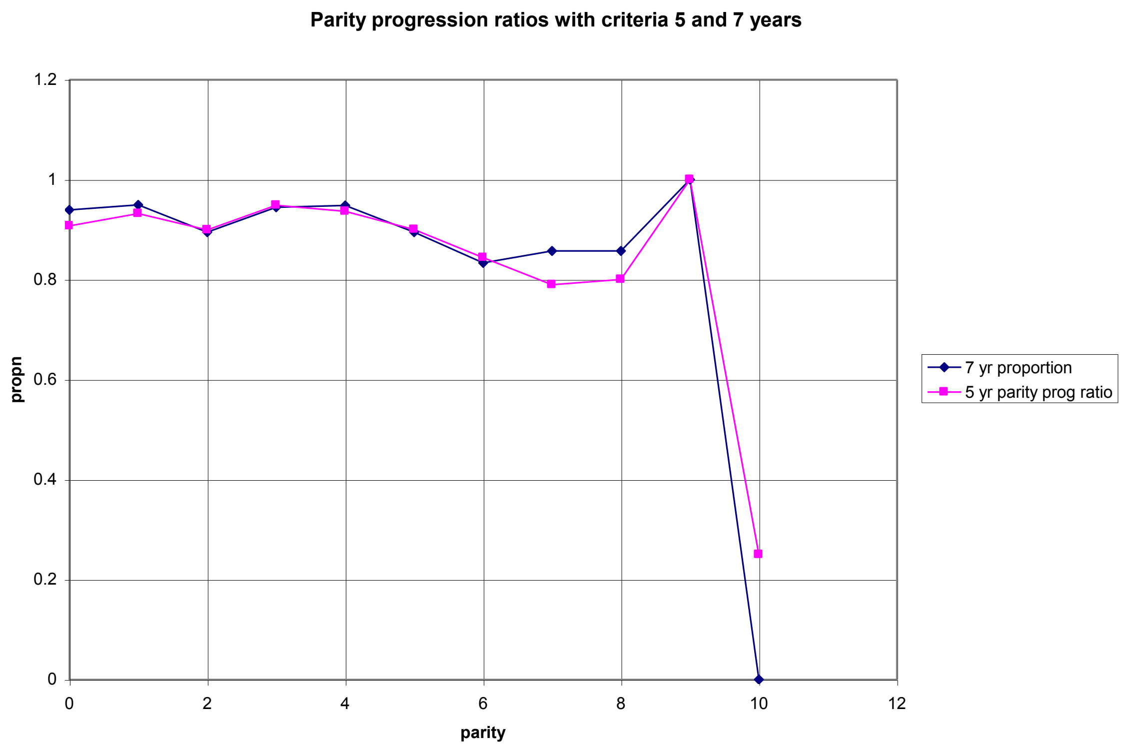
21	0.26909	0.26085
22	0.27205	0.27192
23	0.29962	0.2629
24	0.3295	0.33663
25	0.31324	0.29015
26	0.26609	0.27777
27	0.33944	0.35502
28	0.25837	0.22085
29	0.2786	0.29298
30	0.36649	0.33333
31	0.18378	0.1931
32	0.17582	0.19718
33	0.25141	0.23529
34	0.17721	0.2295
35	0.22058	0.24528
36	0.18803	0.15053
37	0.2745	0.2716
38	0.13042	0.10958
39	0.07142	0.08823
40	0.22535	0.13558
41	0.13558	0.11764
42	0.12765	0.14285
43	0.16216	0.18181
44	0	0
45	0.07407	0.08333
46	0	0
47	0	0
48	0	0
49	0	0
50	0	0
51	0	0
52	0	0
53	0	0
54	0	0
55	0	0
56	0	0
57	0	0
58	0	0
59	0	0
60	0	0

SI figure 7.6. Marital fertility fit by logistic regression to woman's age plus age-squared (orange dots). Blue line is a Lowess fit.



SI 7.7. Comparing two measures of parity progression ratio, B60 and B84.

Hadza parity progression ratios determined by 2 criteria. Reproduction is assumed to have ceased if a woman observed for 5 years from last recorded birth, or observed for 7 years, has no further birth.



SI 7.8. Estimating age at last birth.

Because I interviewed few women who had completed their child-bearing career my data are not well suited to determining age at final birth. But several different approaches allow a rough estimation of the likely parameters.

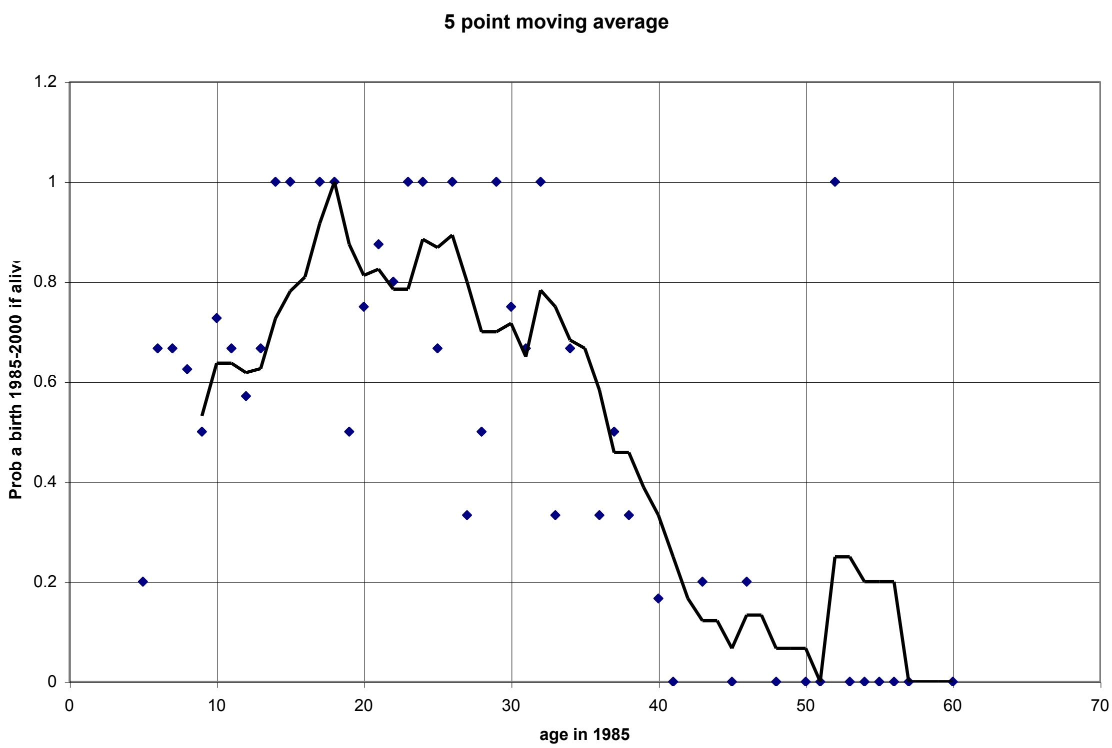
a. Subsequent births to the 1985 cohort lastbth1985s
b. Age of last child of older women lastbtholderwom
c. Five years since last birth lastbthlarsenb60
d. Child bearing life expectancy birthlifeexpecty

SI 7.8.a. Which women in the 1985 census bore no more babies?

I looked at women who had been in our 1985 census, and limited the sample to those seen in at least 2 more censuses after 1989, and who had survived until 2000. This restriction was aimed at increasing the chance that we would know about any babies they had borne subsequent to 1985. SI Figure 7.8.1 shows the results. We can see that most women aged less than 35 in 1985 gave birth subsequently. The fraction giving birth again declined rapidly in the late thirties and early 40s.

We have two surprising records, births to women who were already 46, and 52 in 1985. The obvious way to account for these would be by errors in the estimate of their age or their children's age. It might be possible to adjust the age estimate for the 52 year old (not very much because we know too much about her closest sibling, a younger brother) or for her final child, perhaps as much as 3 years, for whom age information is sparse. Obviously, these should not be taken as serious evidence that Hadza women can regularly bear children in their late 40s or early 50s.

SI Figure 7.8.1. Finding age at last birth. Follow-up of women in 1985 census, how many of each age had a birth during the next 15 years of observation.



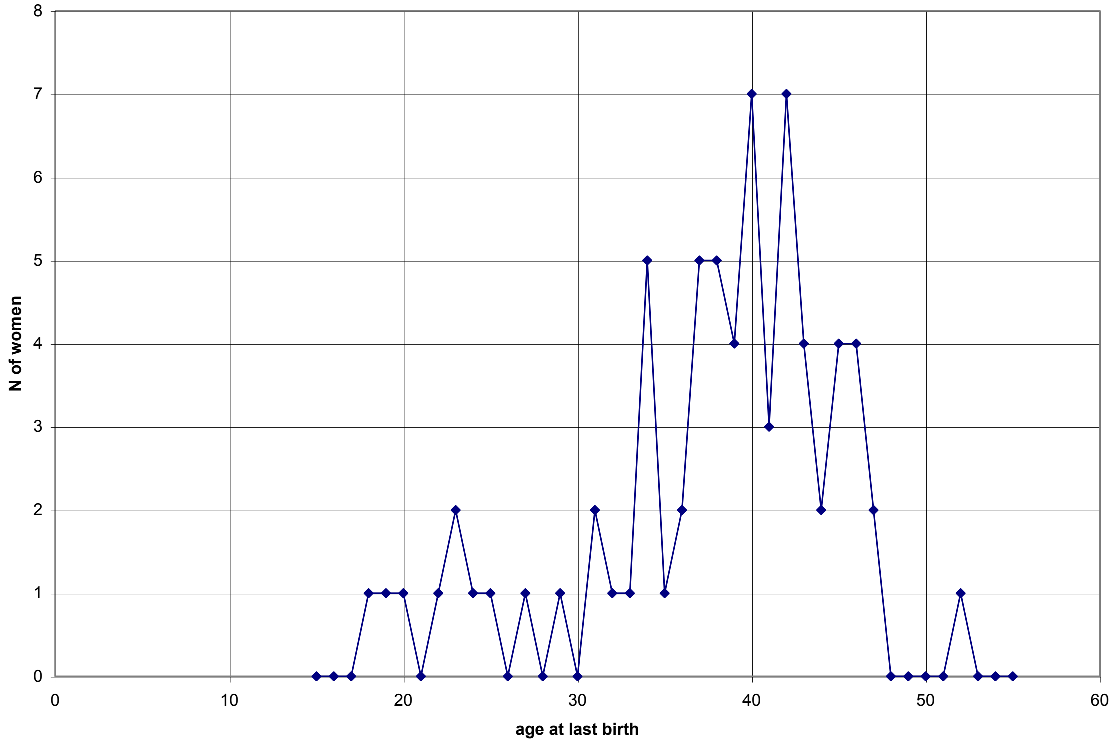
SI 7.8.b. Age of last child of older women.

I looked at a sample of older women, seen in 3 or more censuses, and seen or interviewed beyond the age of 45. Thus some women are included who were not interviewed.

I sought the mother's age at the birth of the last child for whom we had any record (her youngest child in the population register). The mean age at last birth was 37.8. The median age was 39-40, with modes 40 and 42 (SI figure 7.8.2). The distribution has a long lower tail, which might render the mean a less useful indicator of any central tendency (and is perhaps an indicator of secondary sterility). Furthermore, this procedure assumes that every final child survived long enough for us to have a record. This cannot have been the case. The result is likely to be a low estimate of the average age of last birth if we missed children who failed to survive into our study period. But we can conclude that for this sample of women, the lowest possible average age at last birth was 37.8. We ran the program again for women seen in 4 or more censuses, 5, 6, or 8 or more. The sample decreases of course but the result seemed little affected.

The very oldest women have a greater chance that their grown children have died and if the deaths were long ago these children could fail to appear in our records. We ran the program again excluding women born before 1930, thus limiting the sample to those aged 45 to 69 at the end of the study. The mean age of last birth was virtually unaffected at 37.83 instead of 37.81, with modes remaining at 40 and 42 and median at 40.

SI Figure 7.8.2. Finding age at last birth. Women aged over 45. Age at birth of youngest child.

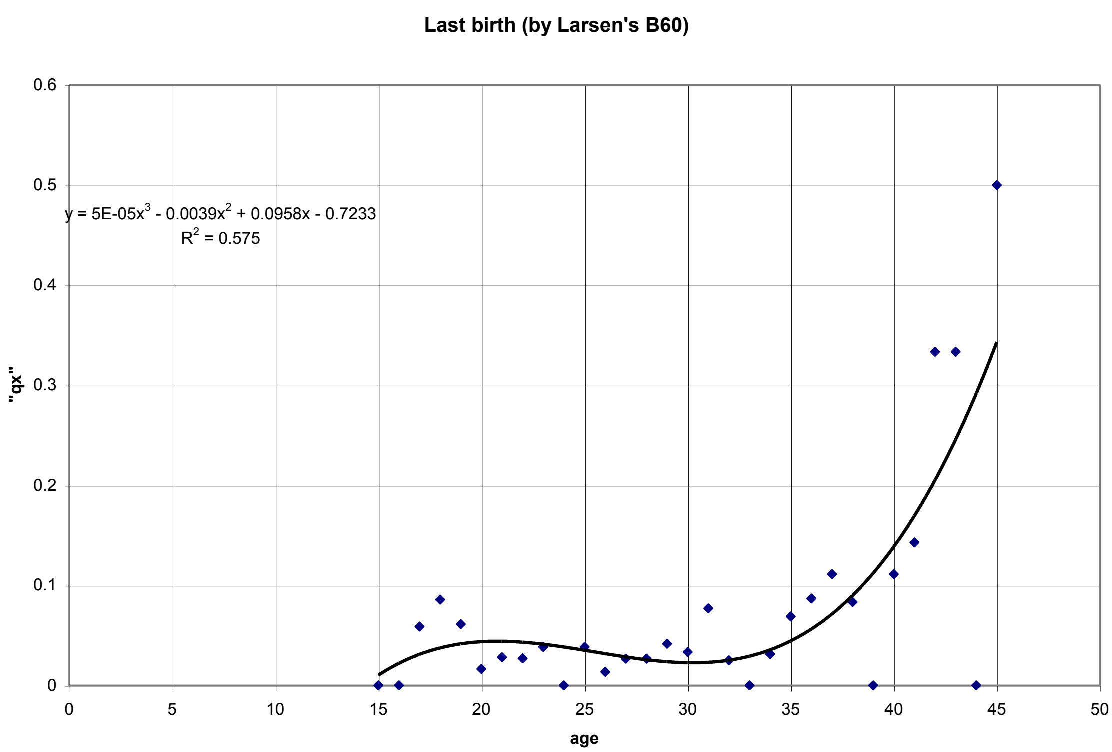


SI 7.8.c. Larsen's "B60", and secondary infertility.

Following Larsen (2003), and noting that among the Hadza very few closed inter-birth intervals were longer than 5 years, I counted as a final birth any birth to a woman of any age, that was followed by 5 or more years of observation without another birth.

SI Figure 7.8.3 shows the proportion of the women who had a birth in year x, and who then did not have another birth during the following 5 years, grouped into 5 year age blocks. The final birth may be borne to even a few very young women but the proportion bearing their final birth climbs rapidly in the late 30s and early 40s. Also plotted in text figure 7.6 are Larsen's results for several west African countries. Hadza appear to have fewer prematurely infertile women than these other populations but as these few accumulate, they can have a significant effect on population fertility.

SI Figure 7.8.3. Finding age at last birth. A birth is counted as a woman's final birth if she was observed for 5 years with no new birth..



SI 7.8.d. The birth "life expectancy" of Hadza women: how long is the average reproductive career?

Using the above method, or to be more conservative, the counts of "B84" (where 7 years of observation follow a birth), and a life table approach, we can calculate the "child-bearing life expectancy" of women of each age. We mimic the procedure for calculating a life table, with birth of the final baby as the equivalent of death. Thus the proportion of parous women who enter year x, and have their final child during this year is labeled "qx". A hypothetical population of 1 has a first birth at age 19. 1-qx of these will not "survive" to the next year, they will have had their final birth. From the lx column we calculate Lx, the number of fertile woman years lived. We assume no relationship between infertility and mortality, perhaps an error where diseases such as chlamydia, chancroid, gonorrhea and syphilis are found. We sum the Lx upward to get Tx, and then divide Tx by lx to get "life expectancy", the number of fertile years ahead of a woman of each age. The result is shown in SI Table 7.8.1. A young woman aged 19 can expect, on average, 17.8 more years of fertile life. This means that the average reproductive career stretches from 19 to about 37 (36.8).

These results show that there are many women who bear their last child in their early 40s, there are also many who bear their last child in their 30s, and some of them bear their last child in their early 30s or even 20s. Hadza are not completely spared the reproductive losses of secondary infertility. But clearly, Hadza have their last birth later than the 34.35 that Howell estimated for her sample of !Kung women interviewed at age 45+. The Hadza figure is earlier than the 42.1 year mean age at last birth that Hill & Hurtado (1996: 254) report for Ache women in the forest period (with median age 43).

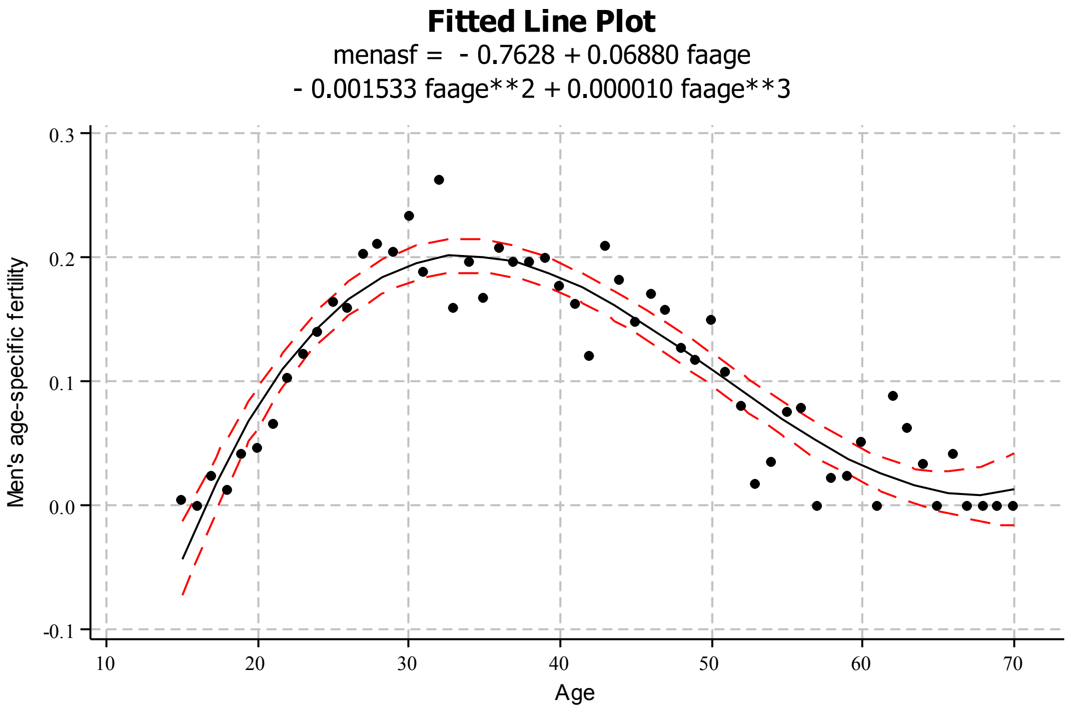
SI Table 7.8.1. "Life table" for continuing fertility, using Larsen's B84.

age	qx	lx	Lx	Tx	ex
15	0	1		17.02801	17.02801
16	0	1	0.961538	17.02801	17.02801
17	0.076923	0.923077	0.892308	16.06647	17.40534
18	0.066667	0.861538	0.833445	15.17416	17.61287
19	0.065217	0.805351	0.805351	14.34072	17.80679
20	0	0.805351	0.798408	13.53537	16.80679
21	0.017241	0.791466	0.779827	12.73696	16.09287
22	0.029412	0.768187	0.752183	11.95713	15.56538
23	0.041667	0.73618	0.73618	11.20495	15.2204
24	0	0.73618	0.721456	10.46877	14.2204
25	0.04	0.706732	0.701892	9.747312	13.79208
26	0.013699	0.697051	0.692142	9.04542	12.9767
27	0.014085	0.687234	0.676325	8.353278	12.15493

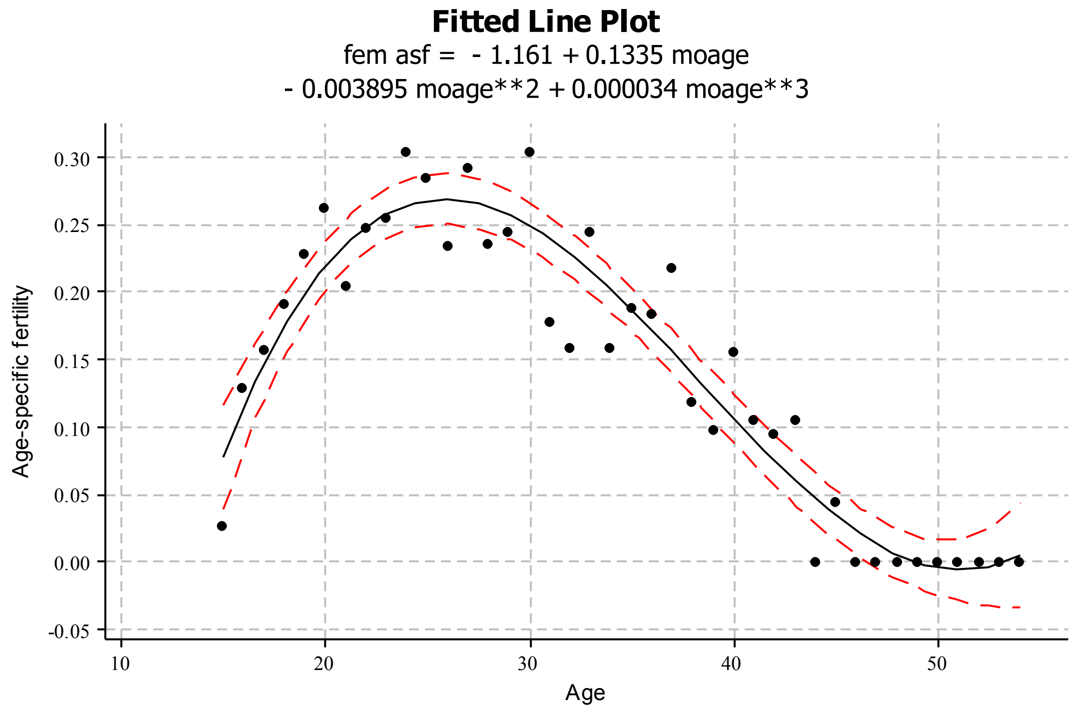
age	qx	lx	Lx	Tx	ex
28	0.031746	0.665417	0.659018	7.676953	11.53706
29	0.019231	0.65262	0.638735	7.017934	10.75348
30	0.042553	0.624849	0.595094	6.3792	10.20919
31	0.095238	0.56534	0.556774	5.784106	10.23121
32	0.030303	0.548208	0.548208	5.227332	9.535305
33	0	0.548208	0.536787	4.679124	8.535305
34	0.041667	0.525366	0.512232	4.142336	7.884667
35	0.05	0.499098	0.482461	3.630105	7.273333
36	0.066667	0.465825	0.432551	3.147643	6.757143
37	0.142857	0.399278	0.379314	2.715092	6.8
38	0.1	0.35935	0.35935	2.335778	6.5
39	0	0.35935	0.35935	1.976427	5.5
40	0	0.35935	0.323415	1.617077	4.5
41	0.2	0.28748	0.239567	1.293661	4.5
42	0.333333	0.191654	0.191654	1.054094	5.5
43	0	0.191654	0.191654	0.862441	4.5
44	0	0.191654	0.14374	0.670787	3.5
45	0.5	0.095827	0.095827	0.527047	5.5
46	0	0.095827	0.095827	0.43122	4.5
47	0	0.095827	0.095827	0.335394	3.5
48	0	0.095827	0.095827	0.239567	2.5
49	0	0.095827	0.095827	0.14374	1.5
50	0	0.095827	0.047913	0.047913	0.5

SI 7.9. Hadza men's fertility.

SI Figure 7.9.2. Cubic fitted regression line for male age-specific fertility with 95% confidence intervals. Adjusted R-squared 86.2%.



SI Figure 7.9.3. Cubic fitted regrsssion line for female age-specififc fertility with 95% confidence intervals. Adjusted R-squared 90.2%



Data for men's age specific fertility. 771 births, TFR 5.93.

faage	enteryr	endyr	risk	nbth	asf
0	320		320	0	0
1	320		320	0	0
2	320		320	0	0
3	320	1	319.5	0	0
4	319	1	318.5	0	0
5	318	3	316.5	0	0
6	315		315	0	0
7	315		315	0	0
8	315	1	314.5	0	0
9	314	7	310.5	0	0
10	307	4	305	0	0
11	303	10	298	0	0
12	293	8	289	0	0
13	285	3	283.5	0	0
14	282	5	279.5	1	0.00357
15	277	11	271.5	1	0.00368

16	266	8	262	0	0
17	258	8	254	6	0.02362
18	250	4	248	3	0.01209
19	246	5	243.5	10	0.04106
20	241	6	238	11	0.04621
21	235	8	231	15	0.06493
22	227	8	223	23	0.10313
23	219	9	214.5	26	0.12121
24	210	5	207.5	29	0.13975
25	205	7	201.5	33	0.16377
26	198	6	195	31	0.15897
27	192	9	187.5	38	0.20266
28	183	14	176	37	0.21022
29	169	5	166.5	34	0.2042
30	164	2	163	38	0.23312
31	162	3	160.5	30	0.18691
32	159	5	156.5	41	0.26198
33	154	7	150.5	24	0.15946
34	147	7	143.5	28	0.19512
35	140	3	138.5	23	0.16606
36	137	3	135.5	28	0.20664
37	134	2	133	26	0.19548
38	132	8	128	25	0.19531
39	124	6	121	24	0.19834
40	118	10	113	20	0.17699
41	108	6	105	17	0.1619
42	102	5	99.5	12	0.1206
43	97	2	96	20	0.20833
44	95	3	93.5	17	0.18181
45	92	8	88	13	0.14772
46	84	4	82	14	0.17073
47	80	7	76.5	12	0.15686
48	73	4	71	9	0.12676
49	69	1	68.5	8	0.11678
50	68	2	67	10	0.14925
51	66	2	65	7	0.10769
52	64	3	62.5	5	0.08
53	61	3	59.5	1	0.0168
54	58	3	56.5	2	0.03539
55	55	3	53.5	4	0.07476
56	52	1	51.5	4	0.07766
57	51	6	48	0	0
58	45	2	44	1	0.02272
59	43		43	1	0.02325
60	43	8	39	2	0.05128

61	35		35	0	0
62	35	2	34	3	0.08823
63	33	1	32.5	2	0.06153
64	32	3	30.5	1	0.03278
65	29	4	27	0	0
66	25	1	24.5	1	0.04081
67	24	5	21.5	0	0
68	19		19	0	0
69	19	1	18.5	0	0
70	18	5	15.5	0	0

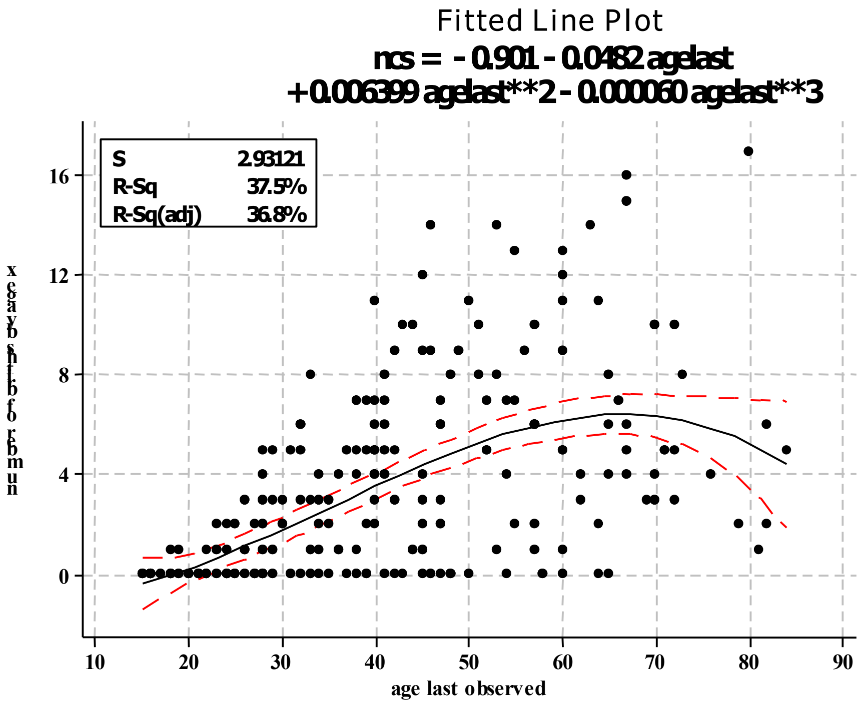
Footnote.
Despite having seen the occasional record of father's of advanced age my first attempt at scoring men's age specific fertility from the population register excluded many of the oldest men. The result was the erroneous impression that the oldest age at which a Hadza man was recorded as having given birth was 55. In fact five men, according to the age estimates, gave birth in their 60s, the oldest at estimated age 66 (with 17 births to his name). Readers should keep in mind that age estimates of the oldest people may be 5 years too young, or 5 years too old.

Comparable data from Census women
TFR = 5.66 and N births 723

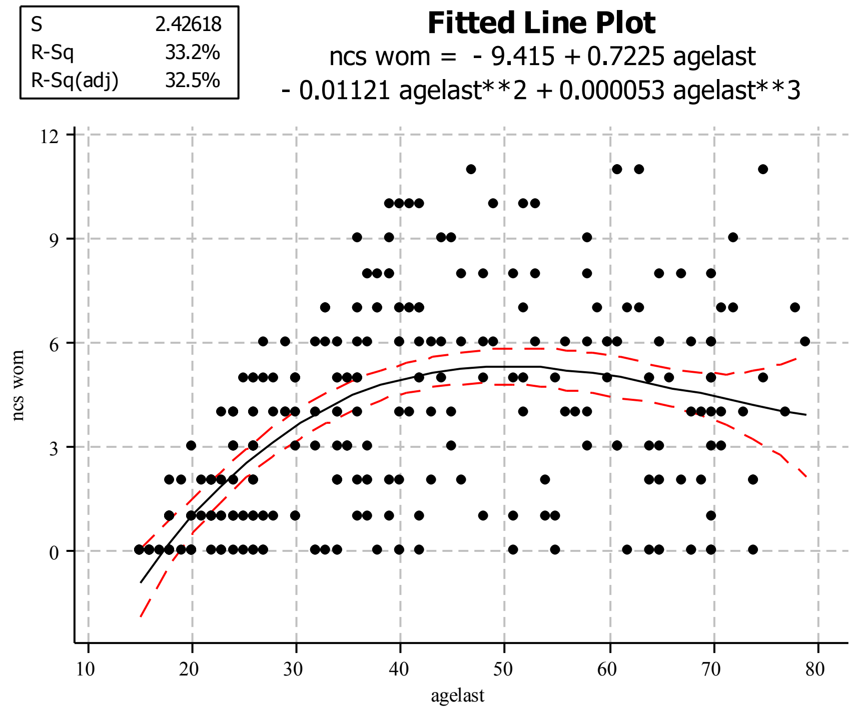
moage	enteryr	endyr	risk	nbth	asf
0	289		289		0
1	289		289		0
2	289		289		0
3	289		289		0
4	289		289		0
5	289		289		0
6	289		289		0
7	289	1	288.5		0
8	288	1	287.5		0
9	287	7	283.5		0
10	280	7	276.5		0
11	273	14	266		0
12	259	6	256	1	0.0039
13	253	7	249.5		0
14	246	9	241.5	3	0.01242
15	237	7	233.5	6	0.02569
16	230	7	226.5	29	0.12803
17	223	12	217	34	0.15668

18	211	14	204	39	0.19117
19	197	9	192.5	44	0.22857
20	188	3	186.5	49	0.26273
21	185	8	181	37	0.20441
22	177	7	173.5	43	0.24783
23	170	11	164.5	42	0.25531
24	159	8	155	47	0.30322
25	151	14	144	41	0.28472
26	137	9	132.5	31	0.23396
27	128	3	126.5	37	0.29249
28	125	3	123.5	29	0.23481
29	122	7	118.5	29	0.24472
30	115		115	35	0.30434
31	115	5	112.5	20	0.17777
32	110	6	107	17	0.15887
33	104	12	98	24	0.24489
34	92	7	88.5	14	0.15819
35	85	10	80	15	0.1875
36	75	8	71	13	0.18309
37	67	5	64.5	14	0.21705
38	62	6	59	7	0.11864
39	56	9	51.5	5	0.09708
40	47	4	45	7	0.15555
41	43	10	38	4	0.10526
42	33	3	31.5	3	0.09523
43	30	3	28.5	3	0.10526
44	27	3	25.5		0
45	24	3	22.5	1	0.04444
46	21	1	20.5		0
47	20	4	18		0
48	16	2	15		0
49	14		14		0
50	14	4	12		0
51	10	4	8		0
52	6	2	5		0
53	4	2	3		0
54	2	2	1		0

Fig 7.9.4. Men's parity x age for the men seen in 3 or more censuses, parity derived from population register. Among the oldest men there is a greater chance that some of their early children will have died or simply never been recorded in the register.



Si figure 7.9.5.
Parity among the women of all ages seen in 3 or more censuses.



SI 7.10. Cohort versus period approaches and anthropological demography.

Because our method for calculating age-specific fertility uses retrospective information gathered between 1992 and 2000, and includes women of all ages, it confounds women's age with calendar time. The women who contribute information on ages 35 to 40 years, also contribute data on their fertility as 20 year olds. But their 20 year-old fertility experience was some 15 or more years before the fertility data contributed by the younger women in our sample. If fertility had changed during this time, our calculated TFR would not represent the reproductive career of an average hypothetical woman who lived to the end of her career, nor the reproductive experience of all women living in say 1990-95, but an uncomfortable mixture of eras and ages. This issue has exercised demographers a great deal more than it has attracted the attention of anthropological demographers. For example basic texts by Barclay (1958) and Hinde(1998) devote several pages to the issue, while both Howell, and Hill & Hurtado (1996) basically ignore it. Anthropological demographers are mostly dealing with small populations and have little choice but to use every subject who will cooperate. In small populations one wishes to get all the data possible and retrospective interview of as many women as one can find seems like the obvious method. Demographers of state-level societies can obtain samples of tens or hundreds of thousands of women and may have the opportunity to explore year to year and other kinds of variation. Their aims often include a study of change whereas anthropologists, perhaps too often, assume constancy. But we need to explore this potential problem before accepting the fertility schedule that I have reported in the text as a satisfactory representation of the Hadza in the late 20th century.

In an abstract world one might consider estimating fertility in either of two ways. We could follow a group of young women (a cohort) from the start to the finish of their childbearing careers. If we followed them year by year we might have a true record of their fertility, including a record of the total fertility rate and completed family size of those who survived to the end. But the study would last 20 years, we would have a lot of difficulty finding each woman frequently enough. We might instead use retrospective interviews, and restrict our attention to the women born in say 1960 to 1965. Either way, we would know a lot about our (very small) cohort of women but we would not have a complete record of the fertility of the population during this time. Throughout the study, new women would be maturing and beginning to bear children, and older ones would be bearing their final children as they finished off their careers. All these would contribute to the future population. In a population like the Hadza our sample would be very small.

Alternatively, we might descend upon the Hadza for a brief period, with a massive team and quickly try to find and interview all the women about their births in the previous year. We would obtain an age cross-section of the fertility experience of the women, the fertility with which they met the single year under study. If we were incautious we might argue that this was a true representation of the reproductive rates of the population. But we would have little reason to believe that it represented more than a single year.

Even if our interest was in causes of variation in fertility, neither kind of sample would cover all the possibilities. The first, the longitudinal study of a single cohort, might be good for following effects of year to year variation in environmental productivity for example. But it would give no evidence about whether such environmental variation affected the fertility of other age cohorts, such as the teenagers who experienced the environmental variations shortly before they began their childbearing careers. Either method seriously limits the amount of information we would gather.

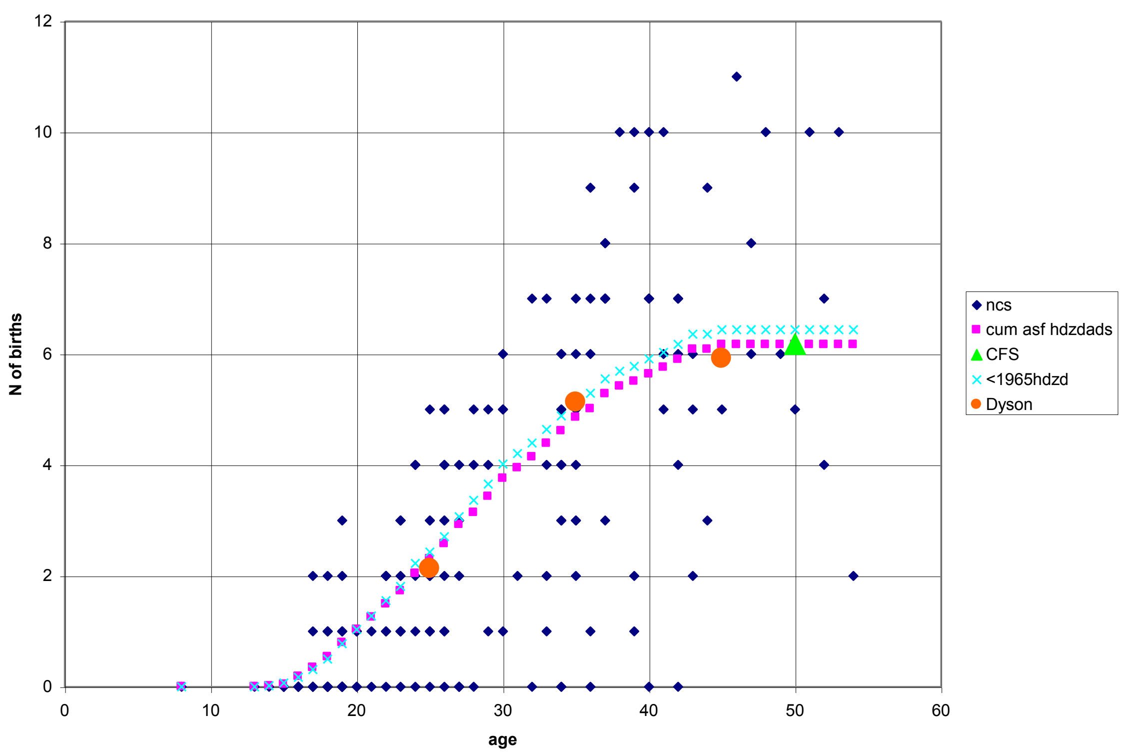
Instead, anthropologists studying small, remote populations such as the Hadza have used mixtures of these methods. Interviewing women past the reproductive years gives good information on CFS, and if the births can be dated, age specific fertility and TFR can be computed. But to gather a reasonable sample, women of a range of ages must be interviewed, and sometimes, as among the Hadza, we may worry about the quality of interviews of 70 year-olds about details of the infants she lost some 50 years ago. Alternatively, one can use the method we used, which tries to gather the greatest amount of information, perhaps the best representation of the fertility rate most relevant to the population's structure, growth or decline. Nonetheless, fertility rates might have changed during the lives of these women (circumstances may have improved, or worsened), and we must try to investigate this possibility.

Our estimates of ASF and TFR result from compiling data from births that occurred between about 1965 and 2000. This is a very long span, during which fertility could easily have changed. Births from this entire period contribute to our estimate of fertility of young women, say 15 to 30. Our estimate for births after the age of 30 is necessarily based only on the older women in our study, the young women had not reached that age by the end of the study. But we have shown that, controlling for the woman's age, Calendar year had no effect on probability of a birth. There was no evidence for a secular change in fertility across the years spanned by our sample of women. We also showed Dyson's analysis of Woodburn's data on women who bore children between 1940 and 1965, which yielded an identical TFR to our study. We may have escaped the dangers of combining period and cohort approaches. This does not entitle us to assume the future. It is possible that the women aged 25-30 years old in 2000 suddenly stopped bearing children. My data would not show this and no amount of digging in the data could show whether or not such a thing happened.

SI 7.11. Evidence about secular change in fertility: Parity x age.

SI 7.11.1. Comparing TFR and CFS.

It has been suggested that when there is secular change in fertility, total fertility rate (TFR the sum of age specific fertility rates) would not match up with completed family size (CFS, the number of children born by women who had reached the end of their reproductive career). So I computed the CFS of the women in the interview sample aged 42 and above, 42 being very near the end of the childbearing years among the Hadza. I counted the total number of births to each woman, and computed the average number for the 24 women aged 42- 55. The resulting CFS was 6.08 for the women who had all their children by Hadza husbands. This is trivially different from the original figure for TFR of 6.17. This suggests little change in fertility. This graph also shows Dyson's figures for parity of women in three age groups in 1967.



SI 7.11.2. Evidence about secular change in fertility: Abbreviated time period.

Another approach was to exclude the long ago, retrospective information from the older women. I calculated ASF and TFR for the observations from 1992-2000, the period during which we conducted reproductive history interviews. This excludes the fertility of the older interviewed women when they were much younger. It represents actual reproduction during the 8 year core period of our study. The result was TFR 6.33, slightly higher than our original figure of 6.17 (women who had all their children by Hadza husbands), suggesting slightly higher fertility in recent years.

SI 7.11.3. Evidence about secular change in fertility: By age of woman.

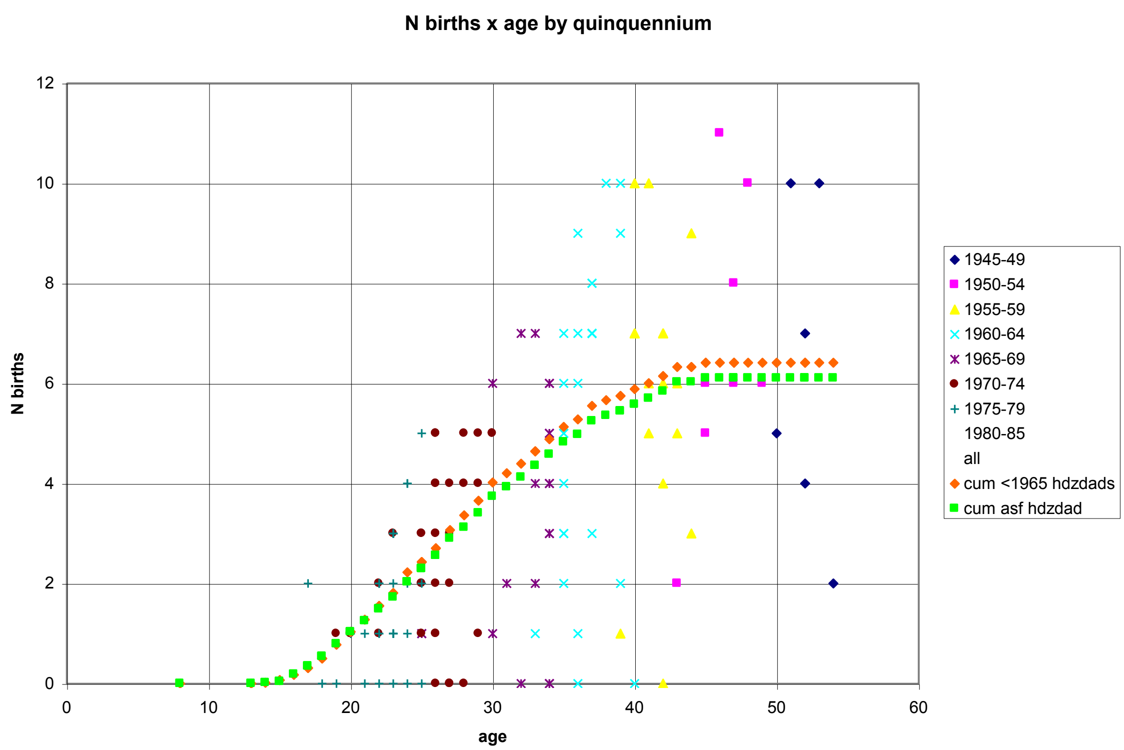
We obtain the opposite result if we divide the sample into women born before 1965, and those born in or after that year (shown on graph above). The older women provide data for most of the reproductive career. The younger women leave us running out of data soon after 30 years old, We can calculate age-specific fertility for both groups up to the age of about 30. Both populations achieve similar fertility in their teens and up to about age 22. After that, from about 23 to 30, the older group shows higher age-specific fertilities in most years. This suggests that the older women achieved higher fertility than the younger group, the younger group was falling behind and would not achieve the high fertility of the older women. The TFR for the older group, 32 of whom reached their 40th year, was 6.44, noticeably higher than our original estimate of 6.17.

Why could this be? Have conditions deteriorated? Looking at the individual data reminds us of the limited sample size and great variation in women's reproductive histories, and suggests two possibilities. The younger group includes 4 out of the 6 women who have passed their 25th birthday without a birth. Perhaps primary sterility has increased, not surprising in view of the increased contact with non-Hadza and with age mates of the opposite sex in school. The older group includes 6 of the 8 women who had 10 births or more. Perhaps these women were much older than we had estimated. We doubt this, in another context we had tried to re-estimate ages of middle aged women and bias them upward. We could not increase the ages.

Another plot may stop us worrying excessively about these slightly contradictory findings. Figure SI 7.11.2 shows number of births at last interview x age, for cohorts of women born 1945-49, 1950-54, 1955-58, and so on until 1985. Plotted with these are the cumulative ASF for the whole sample, and for the women born before 1965. The deviation of the latter from the whole sample cumulative ASF is very small when compared to the individual variation in number of births. Nor does any particular cohort stand out as deviating more than others from the population curve.

Our "mixed longitudinal" method is evidently not wildly misleading, and there is no strong evidence for change in fertility during the study period, and possibly in the previous 10-20 years. We can go farther back in time thanks to previous records by other researchers, notably the report by Dyson (1977) based on reproductive history interviews conducted by James Woodburn in 1966-67. This was described in the main body of the chapter and illustrated above.

SI Figure 7.11.2.



SI 7.11.4. Looking for secular change in fertility earlier in the 20^{th} century.

Table SI 7.11.4. Hadza mean parity in 1966 and 1967. From Dyson (1977) Table 2.

Age of woman	N of women	N of births	N dead	Mean parity	Proportion dead
20 – 29	31	66	25	2.13	37.9
30 – 39	32	164	61	5.13	37.2
40 – 49	12	71	29	5.92	40.8

Knowing more about the fertility of Hadza women yet earlier in the 20^{th} century would help us assess whether we were studying a stable population, and might allow us to see possible affects of recent changes in the environment. But there are no obvious methods or data that allow us to look further back than the IBP data. Some indirect methods were worth considering, such as asking women about their mother's reproduction, or matching observed numbers of living adult siblings against numbers predicted by contemporary observed fertility and mortality (SI 9.7).

I commented that the oldest Hadza women seemed to be poor informants, forgetting children who died early, and even, from time to time, forgetting some children still alive (Howell 1979:112 seems to have encountered women who had difficulty remembering the death of children who died long ago). So we can put little faith in our information on the completed family size of the small number of women in their 70s and 80s (born 1910 - 1930).

In SI to chapter 9 (SI 9.7) I report a simulation of number of live siblings of women of each age to be expected from our estimate of fertility and mortality. This is matched to observed numbers of live siblings. The results give no strong indication of substantially different fertility at any time in the 20^{th} century.

Table for text figure 7.3 and SI figure 7.11.1. N of births to 227 women of different ages. Comparing Dyson's 1977 analysis of 1967 data with our 1985-2000 data on women born 1945-1985.

Candidate	Age last observed	Number of births	Dyson
1698	54	2	*
1390	53	10	*
1073	52	7	*
1140	52	4	*
1209	51	10	*
1298	50	8	*
1498	50	5	*
1059	49	6	*
1185	48	10	*
1210	47	8	*
1294	47	6	*
1344	46	11	*
1066	45	8	5.92
1081	45	5	*
1343	45	6	*
1111	44	9	*
1456	44	3	*
1231	43	2	*
1239	43	5	*
1324	43	6	*
1062	42	0	*
1295	42	6	*
1296	42	7	*
1356	42	7	*
1425	42	7	*
1437	42	7	*
1451	42	4	*
1021	41	5	*
1072	41	10	*
1292	41	6	*
1370	41	5	*
1712	41	4	*
1001	40	10	*
1097	40	7	*
1148	40	7	*
1196	40	6	*
1282	40	6	*
1380	40	7	*
1474	40	0	*

1017	39	10	*
1025	39	1	*
1302	39	2	*
1353	39	9	*
1423	39	8	*
1700	39	2	*
1243	38	10	*
1434	38	8	*
1005	37	7	*
1022	37	8	*
1032	37	7	*
1045	37	3	*
1117	37	2	*
1254	37	7	*
1377	37	7	*
1409	37	8	*
1071	36	9	*
1104	36	8	*
1164	36	7	*
1246	36	6	*
1336	36	1	*
1342	36	7	*
1701	36	0	*
1015	35	7	5.13
1092	35	3	*
1114	35	2	*
1133	35	5	*
1134	35	4	*
1152	35	5	*
1158	35	3	*
1235	35	6	*
1249	35	5	*
1548	35	3	*
1556	35	3	*
1711	35	5	*
1163	34	5	*
1200	34	4	*
1201	34	5	*
1211	34	4	*
1331	34	6	*
1400	34	3	*
1415	34	0	*
1443	34	3	*
1445	34	5	*
1482	34	0	*

1491	34	6	*
1540	34	6	*
1230	33	7	*
1317	33	2	*
1407	33	2	*
1448	33	4	*
1705	33	1	*
1037	32	7	*
1506	32	0	*
1338	31	2	*
1020	30	1	*
1036	30	6	*
1213	30	2	*
1332	30	5	*
1362	30	5	*
1122	29	4	*
1223	29	5	*
1248	29	4	*
1348	29	3	*
1426	29	1	*
1076	28	5	*
1225	28	4	*
1657	28	0	*
1121	27	1	*
1123	27	2	*
1154	27	6	*
1181	27	0	*
1192	27	5	*
1321	27	0	*
1322	27	3	*
1439	27	0	*
1512	27	4	*
1661	27	0	*
1130	26	1	*
1147	26	0	*
1229	26	4	*
1241	26	5	*
1360	26	5	*
1417	26	3	*
1444	26	3	*
1467	26	2	*
1480	26	1	*
1525	26	4	*
1658	26	5	*
1109	25	5	2.13

1155	25	1	*
1191	25	3	*
1193	25	2	*
1212	25	3	*
1273	25	3	*
1275	25	2	*
1435	25	1	*
1459	25	0	*
1654	25	1	*
1720	25	1	*
1810	25	2	*
1060	24	4	*
1086	24	0	*
1128	24	4	*
1167	24	1	*
1372	24	4	*
1429	24	2	*
1049	23	3	*
1070	23	0	*
1106	23	3	*
1233	23	1	*
1318	23	3	*
1347	23	1	*
1349	23	2	*
1361	23	3	*
1394	23	1	*
1436	23	3	*
1624	23	1	*
1129	22	1	*
1261	22	2	*
1287	22	2	*
1420	22	2	*
1550	22	1	*
1663	22	2	*
1695	22	0	*
1821	22	1	*
1291	21	0	*
1476	21	1	*
1819	21	1	*
1042	20	1	*
1428	20	0	*
1465	20	1	*
1466	20	1	*
1646	20	1	*
1854	20	0	*

1039	19	0	*
1040	19	1	*
1080	19	3	*
1084	19	0	*
1183	19	0	*
1406	19	1	*
1431	19	0	*
1433	19	0	*
1442	19	1	*
1469	19	1	*
1601	19	0	*
1631	19	0	*
1639	19	0	*
1653	19	0	*
1668	19	0	*
1707	19	0	*
1816	19	0	*
1818	19	2	*
1113	18	0	*
1244	18	0	*
1286	18	0	*
1438	18	1	*
1460	18	1	*
1477	18	0	*
1484	18	0	*
1619	18	0	*
1666	18	0	*
1671	18	1	*
1673	18	0	*
1812	18	2	*
1143	17	2	*
1432	17	0	*
1615	17	0	*
1641	17	1	*
1669	17	0	*
1817	17	0	*
1043	16	0	*
1110	16	0	*
1392	16	0	*
1411	16	0	*
1535	16	0	*
1602	16	0	*
1749	16	0	*
1132	15	0	*
1645	15	0	*

1665	15	0	*
1667	15	0	*
1675	15	0	*
1773	15	0	*
1811	15	0	*
1792	14	0	*
1815	13	0	*
1625	8	0	*

SI 7.12. A pilot study of endocrine measures of menopause. Comment on Phillips, Worthman et al 1991.

Phillips, Worthman & colleagues (copy accessible from SI contents list) tested for endocrine indications of menopause among a small sample of Hadza women in 1990. Their Table 3 shows prevalence of elevated LH which they suggest as a field criterion for menopause. Menopause is characterized by enduringly elevated LH whereas in pre-menopausal women LH peaks only during mid-cycle near the time of ovulation. Given the low probability of a measurement catching a woman at exactly this time, proportion of cases with a raised LH level would seem to be a fair way to make a population estimate of average age at menopause. Phillips anyway measured a number of the women twice after an interval of in many cases 15 days. Phillips' table uses estimates of women's age provided by me at the time and based on our 1985 age ranking. These estimates may not exactly match the final estimates on the same women but I do not suspect a systematic difference. While only 18% of 30-39 year olds showed elevated LH the proportion was 69% for 40-49 year olds, 91% for 50-59 year olds and 100 percent for older women. Median age at LH elevation was 41.9 years. Phillips remarks "Even if one uses a 1.5 – year correction factor for pre-menopausal LH rises, the median age at menopause is 43.4 years. This is early: by contrast, the median age of menopause has been found to be 49.6 years for European women (Brand & Lehert 1978)." For our purposes here, Phillips' findings can give us an independent line of evidence about the upper limit to the length of the average Hadza reproductive career.