PREFACE

This report is Volume III of the Final Report on the 1969 Census of Population and Housing, and deals with demographic analysis of Census data. Estimates of vital rates, and smoothed age distributions, are derived. The basic data used can be found in Volumes I and II of the Final Report.

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C O N T E N T S

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INTRODUCTION

This volume deals with attempts to estimate the levels of fertility and mortality of the population from data obtained from the Census, and also with attempts to estimate the true age distribution of the population (since it is apparent that people's reported ages were very frequently inaccurate).

Since the very small non-African segment of the population is thought to differ considerably in its vital rates from the African segment, and also to be affected by international migration to such an extent that its population structure is very much distorted, it was thought advisable to consider only the African population in this volume. Thus, unless otherwise stated, "population" should be taken to mean "African population" throughout this volume.

CHAPTER 1

FERTILITY

1.1 Fertility Data from the Census

In the Census, each worman aged 15 years or more was asked how many children she had borne alive (the question being asked in three parts, namely how many were living with her, how many were living elsewhere, and how many had died), and also what was the date of her last live birth. From the replies to each of these two questions an estimate of the level of fertility can be obtained, and thus two separate estimates can be compared with each other. Estimates of total fertility obtained from both questions, and of the crude birth rate, gross reproduction rate, and general fertility rate (for women aged 15-49) obtained from the latter question, are given in Table 1.1. It can be seen that the fertility level implied by these estimates is implausibly low.

1.2 Brass's Method of Estimating Fertility

The results of asking the two questions described above in African countries generally exhibit considerable errors, but of different kinds for the two questions. The reported date of last birth is generally very inaccurate for women of all ages, and so the reported number of births during the last year is frequently far too small (or for a few populations far too large). On the other hand, the reported mean numbers of children ever born to women of different ages often increase too gradually with the age of the women, especially above 30 or 35 years, and sometimes decline at higher ages; there is a very strong probability that this is due to the omission of an increasing proportion of the children born from the reports as women become older. It is clear from Table 1.1 that these characteristics are exhibited by the data from the Census.

In Brass et al (1968) is developed a technique due to Brass for estimating total fertility from those parts of the two sets of data obtained from the two questions which are likely to be the most reliable.

The technique depends on the propositions that, firstly, the major source of error in the reported number of births in the last year is imprecision in dating the last birth, which imprecision is independent of the age of the woman; and, secondly, that the number of children ever born is reported with good accuracy by younger women, since the births of these children are of fairly recent date and few in number. On the basis of these propositions, the age pattern of fertility rates obtained from the reports of current births is accepted, but the level of fertility is estimated from the mean number of children ever born reported by the younger women. In the application of the procedure the number of children ever born implied by the current fertility rates is compared for each age group with the retrospective value obtained from the reported number of children ever born. The ratio of the retrospective to the cumulated current value for the age group 20-24 gives a factor which is applied to the current fertility rates for all age groups to adjust the fertility to the revised level.

Table 1.2 shows the result of the application of Brass's method to the data from the Census relating to births in the last year (obtained from the question on date of last birth) and to the total number of children born alive to the women enumerated. Since the question on date of last birth also gives data on births in the year September 1967 to August 1968 (the year immediately preceding that considered above), it is possible to apply Brass's method to the fertility rates calculated for this year also. The result of this is shown in Table 1.3. The wide difference between both the levels and the age patterns of fertility obtained for the two years appears to indicate considerable errors in the dating of the last birth.

Brass's method, however, makes no allowance for the distortion of the age distribution due to age misreporting, which appears to be very pronounced in the Census. Van de Walle has shown in Brass et al (1968) that age misreporting, even if the errors in reported age are independent of parity and fertility, can have a very considerable effect on the estimates of fertility obtained by the application of Brass's method. It seems, therefore, that the implausibly high adjusted fertility rates obtained in Tables 1.2 and 1.3 are probably considerably in error in consequence of the considerable degree of age misreporting which appears to have taken place, and which renders Brass's method an inappropriate means of estimating fertility in this case.

1.3 Brass's Alternative Method

In the type of situation where age misreporting is considerable, it has been suggested by Brass (in Brass et al (1968)) that probably a better estimate of the multiplication factor needed to compensate for the time-scale error can be obtained by comparing the cumulated current first-birth rates with the proportion of women who are mothers.

The reporting of first births in a year will be affected by the time-scale error, but becuse of the importance of a first birth omissions are likely to be very few. Also age differentials in the reference period (if these exist) and age misreporting are likely to have much less influence on the correction factor, compared with that in the method described in the previous section. The latter utilises the ratio of the specific fertility rates in the age groups 15-19 and 20-24 in order to interpolate the cumulated fertility rates for the younger age groups, and so is likely to be severely affected by age differentials in the reference period and by age misreporting. The possible degree of inaccuracy due to interpolation is much reduced in the alternative method - as the proportion of women who first become mothers after age 30 is very small in African countries, little error is likely to be introduced by adopting an inappropriate method of interpolating the series of cumulated first-birth rates above this age. Further, the classification of a woman as a mother will be considerably less subject to error than the determination of the number of children born to her (although the data in the last column of Table 1.4 suggest that a number of older women whose children have all reached adulthood and left home report themselves as having no children). Therefore, to minimise errors caused by, one the one hand, using a possibly inappropriate method of interpolation and, on the other hand, possible understatement of proportion of mothers, the ratio of the proportion of ever-fertile women in the age group 30-34 to the corresponding cumulated first-birth rate is used to estimate the correction factor for the time-scale error. Table 1.4 shows the method of obtaining the correction factor, and Table 1.5 the effect of applying it to the various fertility measures derived from the crude data on current fertility given in Table 1.1. The level of fertility implied by these revised estimates appears considerably more plausible than those implied by the fertility estimates derived in Tables 1.2 and 1.3. These estimates will later in this volume be compared with estimates arising from the use of model stable populations.

Table 1.1

Estimates of Fertility Measures (Unadjusted)

Age group	Total Women	Total births in last year	Estimated fertility in last year	Cumulated fertility	Total children everborne	Average parity
15-19	181,954	13,659	.0751	.3755	62,838	.3454
20-24	187,116	34,323	.1834	1.2925	362,782	1.9388
25-29	157,984	27,311	.1729	2.1570	542,158	3.4317
30-34	139,760	20,598	.1474	2.8940	644,141	4.6089
35-39	116,660	13,380	.1147	3.4675	598,808	5.1329
40-44	84,248	5,616	.0667	3.8010	431,056	5.1165
45-49	74,944	3,592	.0479	4.0405	373,680	4.9861
15-49	942,666	118,479	.1257			
All ages	2,042,223					

Average parity at end of reproductive period (total fertility) =4.986

Total fertility (from current births) =4.040

Crude birth rate (females) =28.3

Gross reproduction rate =1.971

General fertility rate =125.7

Note 1. A sex ratio at birth of 1.05 is assumed.

2. Cumulated fertility is obtained by multiplying estimated fertility in last year by 5, and cumulating.

Table 1.2

Estimates of Fertility by Brass's Method (1969)

Age group	Age specific fertility (f)	Cumulated	current	fertility	Average parity (p)	P/F	Adjusted age-specific fertility
		Cumulated fertility (c)	Interpolation factor (k)	Average cumulated fertility (F=c+kf)			
15-19	.0751	.	2.166	.1627	.3454	2.1229	.1614
20-24	.1834	.3755	2.870	.9018	1.9388	2.1499	.3943
25-29	.1729	1.2925	3.025	1.8155	3.4317	1.8902	.3717
30-34	.1474	2.1570	3.095	2.6132	4.6089	1.7637	.3169
35-39	.1147	2.8940	3.215	3.2628	5.1329	1.5732	.2466
40-44	.0667	3.4675	3.435	3.6966	5.1165	1.3841	.1434
45-49	.0479	3.8010	4.150	3.9998	4.9861	1.2466	.1030
		4.0405					

m (mean of fertility schedule) = 29.69

Total fertility (adjusted) = 8.687

GRR (29.7) (adjusted) = 4.238

Note: Sex ratio at birth taken to be 1.05

Table 1.3

Estimates of Fertility by Brass's Method (1968)

Age group	Age-specific fertility (f)	Cumulated current fertility			Average parity (p)	P/F	Adjusted age-specific fertility
		Cumulated fertility (c)	Interpo-lation factor (k)	Average cumlated fertility (F=c+kf)			
14-18	.0690		1.898	.1310	.2710	2.0687	.1246
19-23	.2212	.3450	2.831	.9712	1.7534	1.8054	.3994
24-28	.2281	1.4510	3.006	2.1367	3.2555	1.5236	.4118
29-33	.2011	2.5935	3.089	3.2127	4.4581	1.3876	.3631
34-38	.1516	3.5970	3.208	4.0833	5.0150	1.2282	.2737
39-43	.0923	4.3550	3.417	4.6704	5.0476	1.0808	.1666
44-48	.0485	4.8165	4.074	5.0141	4.9353	.9843	.0876
		5.0590					

m (mean of fertility schedule) = 29.04

Total fertility (adjusted) = 9.134

GRR (29.0) (adjusted) = 4.456

Table 1.4

Estimation of Multiplication Factor Using First - Birth Rates

Age-group	Total women	Total first births	Age-specific first birth rate	Cumulated first birth rate	Average cumulated first birth rate	Total mothers	Proportion of mothers
15-19	181,954	8,522	0468		.1170	41,180	.2263
20-24	187,116	6,712	.0359	.2340	.3238	140,871	.7529
25-29	157,984	1,579	.0100	.4135	.4385	134,780	.8531
30-34	139,760	601	.0043	.4635	.4742	121,249	.8676
35-39	116,660	544	.0047	.4850	.4968	100,360	.8603
40-44	84,248	278	.0033	.5085	.5168	70,049	.8315
45-49	74,944	381	.0051	.5250	.5378	60,857	.8120
				.5505			

Time-scale correction factor = .8676/.4742 =1.8296

Table 1.5

Estimated Fertility Measures, Corrected for Time Scale Error

Measure	Unadjusted	Adjusted
Total fertility	4.040	7.392
Crude birth rate (females)	28.3	51.8
Gross reproduction rate	1.971	3.606
General fertility rate	125.7	230.0

CHAPTER 2

MORTALITY

2.1 Mortality Data from the Census

In the Census each head of a household was asked how many deaths had occurred in the household during the previous year. It was found, however, that in very many cases the information obtained was unsatisfactory, this question frequently having been misunderstood or confused with another question. This information cannot therefore be used, and it is not possible to obtain a direct estimate of mortality.

2.2 Brass's Method of Estimating Childhood Mortality

Brass has developed a method, described in Brass et al (1968), for estimating childhood mortality from information obtained by asking each woman how many children she has borne, and how many of them have died. The mortality estimates are derived from the reported proportions dead among children ever born to women in various age groups. If D(i) is the proportion dead among children born to women in the i th 5 - year age group, where 15-19 is the first age group, 20-24 the second, and so on; and if q(a) is the proportion of people born who die before they reach age a, then by applying appropriate multiplication factors D(1) can be converted to an estimate of q(1), D(2) to q(2), D(3) to q(3), D(4) to q(5), D(5) to q(10),--------D(10) to q(35). The results of the application of this procedure to the data obtained from the Census are given in Table 2.1.

The estimate for q(1) is generally very unreliable, as it is particularly sensitive to variations in fertility and mortality patterns; and the estimates of q(10)-------q(35) are also very unreliable as they are based chiefly on the memory of remote events, by women whose responses are likely to be unrepresentative of the experience of their complete birth cohorts (very many of the members of which will now be dead). The biases chiefly affecting the estimates of q(2), q(3) and q(5) are the omission of dead children, particularly those who died shortly after birth, the omission of children born to mothers now dead, who are likely to exhibit higher mortality than children of surviving mothers, and age misreporting by mothers. Thus it appears that the overall bias in these estimates is such as to make them underestimates, and they can reasonably be accepted as lower limits for the true values. The best estimates are likely to be those of q(2) and q(3). These estimates will be utilised later in this volume in connection with the use of model stable populations.

Table 2.1

Estimates of Mortality by Brass's Method

Age group of mother	Total children born	Total Children dead	Proportion dead	Multiplying factor	Estimated q(a)	a
15 - 19	62,838	9,168	.1459	1.005	.1466	1
20 - 24	362,782	60,889	.1678	1.024	.1719	2
25 - 29	542,158	103,620	.1911	1.002	.1915	3
30 - 34	644,141	138,815	.2155	1.031	.2222	5
35 - 39	598,808	148,094	.2473	1.040	.2572	10
40 - 44	431,056	123,498	.2865	1.021	.2925	15
45 - 49	373,680	116,237	.3111	1.021	.3176	20
50 - 54	250,519	91,264	.3643	1.036	.3774	25
55 - 59	180,311	68,466	.3797	1.039	.3945	30
60 - 64	104,633	42,393	.4052	1.034	.4190	35

CHAPTER 3

AGE DISTRIBUTION

3.1 Age Distribution Data from the Census.

In the Census each person was asked to give his or her date of birth or age. The distribution of the population by age derived from the information thus obtained, however, exhibits very considerable irregularities, (as is clear from Table 3.1 and Figure 3.1), which appear to have been caused by widespread age misreporting. It is therefore necessary to attempt to estimate the true age distribution of the population.

One difficulty arises owing to the comparatively large proportion of the population who did not state their ages at all. Two separate assumptions concerning the ages of these persons were used; firstly that they were all at least 60 (Case A), and secondly that they were distributed among all ages in the same proportions as were the ages of persons who stated their ages (Case B). The proportions in the various age groups, and the cumulative proportions under various ages, for the two cases are given in Table 3.2.

It is pointed out in United Nations (1967) that the female age distributions obtained from populations showing large-scale age misreporting commonly have implausibly high proportions in the age groups 5-9, 25-29 and 30-34 and implausibly low proportions in the age groups 10-14 and 15-19. It is apparent from Figure 3.1 that these characteristics are exhibited by the population under consideration. It is further pointed out in United Nations (1967) that for populations of this kind, the male age distribution is commonly even more distorted than the female (as is clearly the case in this instance), and in less consistent patterns, and that consequently the female age distribution is a better source of estimated population characteristics than the male.

Because of the very considerable extent of the distortions of the age distribution caused by age misreporting, the various smoothing formulae which have been developed are unsatisfactory for estimating the true age distribution. (They have been in general developed for application to populations where age misreporting is of comparatively small incidence and small extent, so that their application to a considerably distorted age distribution has little effect). The most promising approach appears to be the use of model stable populations, using the female population for the reason given above.

3.2 Coale and Demeny Model Stable Populations

Coale and Demeny have produced four sets, called the West, North, East and South models, of model life tables and their associated stable populations, published in Coale and Demeny (1966). Three of these models (the exception being South, which was at an early stage found to be inappropriate), were considered in the attempt to identify a suitable model stable population with which to smoothe the age distribution obtained from the Census.

For each level of mortality (within a reasonable range of possibilities) for each of the three models, a model stable population which appeared to give the closest fit to the recorded age distribution (for females) was chosen, for both case A and Case B. Initially, as is suggested in United Nations (1967), a stable population was chosen by matching the proportions under age 35.

A procedure due to Brass and described in Brass et al (1968) for checking the fit of the chosen stable populations was then applied. According to this procedure, the differences in the cumulated proportions under the ages 5, 10, 15 ..... between the recorded and stable age distributions are converted into statements of the incremental number of years of age needed to equalise the proportions. For example, a reported proportion of .40 under age 10 compared to .38 in the stable population would be explained if children up to 10.8 rather than 10.0 years of age were reported as under 10, and so in this case the number of years of age needed to equalise the proportions would be 0.8. The age differences can be obtained by using the approximate relation.

$$Da = \frac{DC(a)}{c(a)}$$

where DC(a) is the discrepancy between the proportions under age a in the reported and stable distributions, c(a) da the proportion from age a to a+da in the stable distribution, and Da the desired age difference. c(a) can readily be calculated from Lotka's formula.

$$c(a) = b \exp(-ra)p(a)$$

where r is the rate of natural increase, b the crude birth rate, and p(a) the proportion of all people born surviving to age a.

The differences obtained are then represented graphically, together with the age differences needed to convert the stable population used into stables that would fit the two most deviant points (high and low) in the reported distribution. If the areas between the curves corresponding to these high and low stables and the age axis are in rough balance, then it can be said that the reported age distribution is consistent with the chosen stable population.

The results of this procedure for (as an example) West model, level 11 (expectation of life at birth 45.0), for Case A and Case B are given in Table 3.3 and 3.4 and Figure 3.2. It is clear from these (and similar results were obtained for all the levels of the models considered) that the model chosen for Case B is not satisfactory, whereas that for Case A is. It was therefore decided to use Case A for choosing the model stable populations. The stable populations thus chosen for the various levels of the three model sets are given in Table 3.5

3.3 Brass Model Stable Populations.

Brass has derived a set of model life tables, described in Brass et al (1968), which have certain characteristics which appear to be common in African mortality experience. Carrier and Hobcraft have derived from these model life tables stable populations, published in Carrier and Hobcraft (1971). An attempt was made to chose a suitable stable population to fit the recorded age distribution for females from this set also.

Initially, for each reasonable level of mortality, and for Case A and Case B separately, a stable population was chosen by the following method, which utilises a graduation procedure due to Brass, described in Carrier and Hobcraft (1971). The logits (defined by logit $(x) = 1/2 \log_e (1-x)/x$) of the proportions of the population under ages 5, 10, 15,.....for Case A and B were calculated, and plotted against the logits of the proportions under the same ages of the Brass model stationary population (i.e. the stable population having zero natural increase) of level 45 (expectation of life at birth 42.5). On the assumption that the population should be smooth, the points on the graph should lie on a smooth curve, usually adequately approximated by a straight line. Hence for each case a straight line was fitted to the points on the graph. These graphs are shown in Figure 3.3. For each case, two points lay on the straight line obtained, and stable populations from each level were chosen by equating the proportions under the ages corresponding to the points lying on the straight line. The stable populations thus chosen are given in Table 3.6. For each case, the stables chosen using the two ages are the same or very close for all levels. Where the two differ, the stable identified by the mean of the CRRs was chosen.

These stable populations having been chosen, their consistency with the reported age distribution was checked by the method of age differences described in section 3.2 above. The graphs obtained for (as an example) level 45 (expectation of life at birth 42.5) for Case A and Case B are shown in Figure 3.4. It is clear from this (similar results having been obtained for all five levels considered) that as was found in section 3.2 for the Coale - Demeny models, the model for Case B is not satisfactory, but that for Case A is. Case A was therefore used as before for choosing the model stable populations. The stable populations chosen for the various levels are given in Table 3.7.

3.4 Final Choice of Model Stable Population

As was mentioned in Chapter 2, the estimates of q(2) and q (3) obtained in that Chapter are likely to be fairly good estimates, possibly erring somewhat on the low side. Therefore for each set of model stable populations considered, a level was chosen for which the values of q (2) and q(3) were the smallest which were greater than the estimates obtained in Chapter 2. The values of q(2) and q(3) involved are shown in Table 3.8. (The estimated values in Chapter 2 are for both sexes, and so estimated values for females only were obtained by subtracting .01 from each of q(2) and q(3).

Various characteristics of the four model stable populations (one from each set) thus chosen are shown in Table 3.9. Comparing the values of various fertility measures with the estimated values obtained in Chapter 1, it can be seen that the estimates relate to a higher level of fertility than is found in any of the chosen models, but that of the North model approaches the estimated level most closely and is the most plausible level. The fertility levels of the West, East and Brass models are implausibly low, and in addition the mortality level of the East model (which is the most plausible of these three with respect to fertility) is also implausibly low. Consequently the North model was chosen.

3.5 Smoothing of Age Distribution - Total Zambia

The smoothed female age distribution was obtained immediately from that of the chosen stable population. The distribution obtained is given in Table 3.10.

The male age distribution can be obtained from the female by use of a set of sex ratios for the various age groups. These sex ratios for age groups can be obtained directly from the model, given a value for the sex ratio at birth.

Commonly, the value of the sex ratio at birth used for Zambian populations is either 1.05 or 1.03. However, information on the sex of children born in various Zambian hospitals during one full year (over 40,000 births) given a sex ratio of 1.078. Since these births all took place in hospitals, there is the possibility of some bias. Nevertheless, the evidence seems sufficient to reject a value of 1.03 for the sex ratio at birth in favour of the alternative value of 1.05.

The sex ratios in the various age groups obtained for this value of the sex ratio at birth are given in Table 3.11. It can be seen from this table that the overall sex ratio implied by the model is .999, wheras the overall sex ratio in the population under consideration is .958. It seems probable, considering both the pattern of sex ratios derived from the reported age distributions (given in Table 3.11) and the probable effects of the high incidence of labour migration found in this country in the comparatively recent past, that this discrepancy is the effect of past out-migration of young adult males. In the absence of information which

would enable one to estimate the age distribution of these (hypothetically) missing men, the approach used was to assume that the proportions missing in the age groups 15-19, 20-24, 25-29, 30-34, 35-39 and 40-44 are in the ratios 2: 10: 9: 8: 4: 2. Under this assumption, the adjusted sex ratios obtained are those given in the last column of Table 3.11.

The smoothed age distribution for the male population was therefore derived by applying these adjusted sex ratios to the smoothed age distribution for the female population. The distribution obtained is given in Table 3.12.

3.6 Smoothing of Age Distributions - Provinces

The age distributions of the populations of individual provinces are likely to have been much affected by inter-province migration, and so the age distribution obtained from the model stable population cannot be applied directly to them. The approach used, therefore, in smoothing the age distributions of the populations of provinces was to calculate what degree of mis-statement was implied by the smoothing of the age distribution of the whole country (in terms of the proportion of people reported in each age group who were moved to an adjacent age group by the smoothing procedure), and to assume that this pattern of age mis-statement was applicable to each province. (It was necessary first to make some arrangement for the distribution of the "age not stated" category, and for convenience it was decided to distribute this category pro rata among the age groups for the population of the whole country, and to distribute it in the same proportions as this for each province. This is probably a fairly unrealistic assumption, but the choice of an assumption as to the distribution of the "age not stated" category is not likely to make much difference to the final smoothed age distributions.) Table 3.13 gives the adjustments implied by the smoothing procedure for the whole country, Table 3.14 the recorded age distributions of the provinces, and Table 3.15 the resulting smoothed age distributions of the provinces. Figures 3.5 to 3.13 show the reported and smoothed age distributions for each province and whole country in the form of population pyramids.

Table 3.1

Reported Age Distribution

Age Group	Population	
	Male	Female
0-4	363,648	378,178
5-9	321,098	323,552
10-14	234,473	219,371
15-19	170,760	181,954
20-24	130,603	187,116
25-29	122,121	157,984
30-34	112,695	139,760
35-39	114,264	116,660
40-44	85,010	84,248
45-49	83,146	74,944
50-54	58,110	52,852
55-59	62,067	40,064
60-64	28,655	25,270
65-69	28,047	21,206
70-74	8,483	7,686
75-79	4,474	3,864
80+	7,554	6,448
Not stated	21,213	21,066
Total	1,956,421	2,042,223

Figure 3.1

Reported Age Distribution

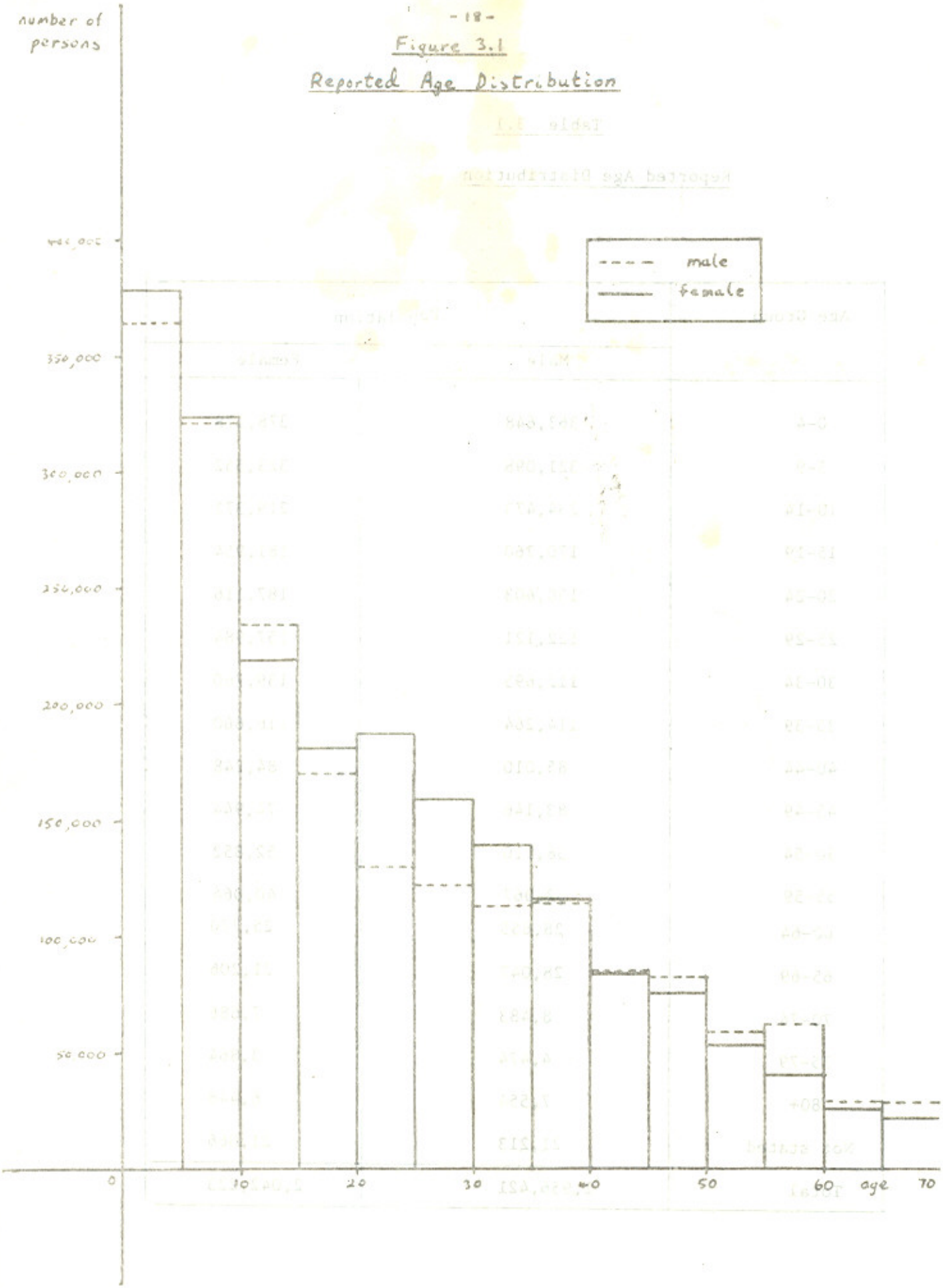


Table 3.2

Reported Proportions in Age Groups

Age Group	Proportions in age groups			
	Male		Female	
	Case A	Case B	Case A	Case B
0-4	.1859	.1879	.1852	.1871
5-9	.1641	.1659	.1584	.1601
10-14	.1179	.1212	.1074	.1085
15-19	.0873	.0882	.0891	.0900
20-24	.0668	.0675	.0916	.0926
25-29	.0624	.0631	.0774	.0782
30-34	.0576	.0582	.0684	.0691
35-39	.0584	.0590	.0571	.0577
40-44	.0434	.0439	.0413	.0417
45-49	.0425	.0430	.0367	.0371
50-54	.0297	.0300	.0259	.0261
55-59	.0317	.0321	.0196	.0198

Upper age	Cumulative proportions			
	Male		Female	
	Case A	Case B	Case A	Case B
5	.1859	.1879	.1852	.1871
10	.3500	.3538	.3436	.3472
15	.4679	.4750	.4510	.4557
20	.5552	.5632	.5401	.5457
25	.6220	.6307	.6317	.6383
30	.6844	.6938	.7091	.7165
35	.7420	.7520	.7775	.7856
40	.8004	.8110	.8346	.8433
45	.8438	.8549	.8759	.8850
50	.8863	.8979	.9126	.9221
55	.9160	.9279	.9385	.9482
60	.9477	.9600	.9581	.9680

Table 3.3

Age Differences Check-West Model, Level II, Case A

Upper age a	Proportion reported	Proportion in stable	DC(a)	c(a)	Da
5	.1852	.1799	+.0053	.0316	+.17
10	.3436	.3252	+.0184	.0268	+.69
15	.4510	.4488	+.0022	.0229	+.10
20	.5401	.5538	-.0137	.0193	-.71
25	.6317	.6423	-.0106	.0162	-.65
30	.7091	.7166	-.0075	.0136	-.55
35	.7775	.7784	-.0009	.0113	-.08
40	.8346	.8298	+.0048	.0094	+.51
45	.8759	.8722	+.0037	.0077	+.48
50	.9126	.9070	+.0056	.0063	+.89
55	.9385	.9351	+.0034	.0050	+.68
60	.9581	.9572	+.0009	.0039	+.23

Note Stable population defined by rate of increase = .0275

Table 3.4

Age Difference Check-West Model, Level II, Case B

Upper age a	Proportion reported	Proportion in stable	DC(a)	c(a)	Da
5	.1871	.1835	+.0036	.0321	+.11
10	.3472	.3309	+.0163	.0271	+.60
15	.4557	.4556	+.0001	.0230	.00
20	.5457	.5610	-.0153	.0194	-.79
25	.6383	.6495	-.0112	.0162	-.69
30	.7165	.7234	-.0069	.0135	-.51
35	.7856	.7846	+.0010	.0112	+.09
40	.8433	.8352	+.0081	.0092	+.88
45	.8850	.8767	+.0083	.0075	+1.09
50	.9221	.9106	+.0115	.0061	+1.89
55	.9482	.9379	+.0103	.0049	+2.10
60	.9680	.9592	+.0088	.0037	+2.38

Note Stable population defined by rate of increase = .0285

Figure 3.2
Age Differences Check – West Model, Level 11
Graphical Representation

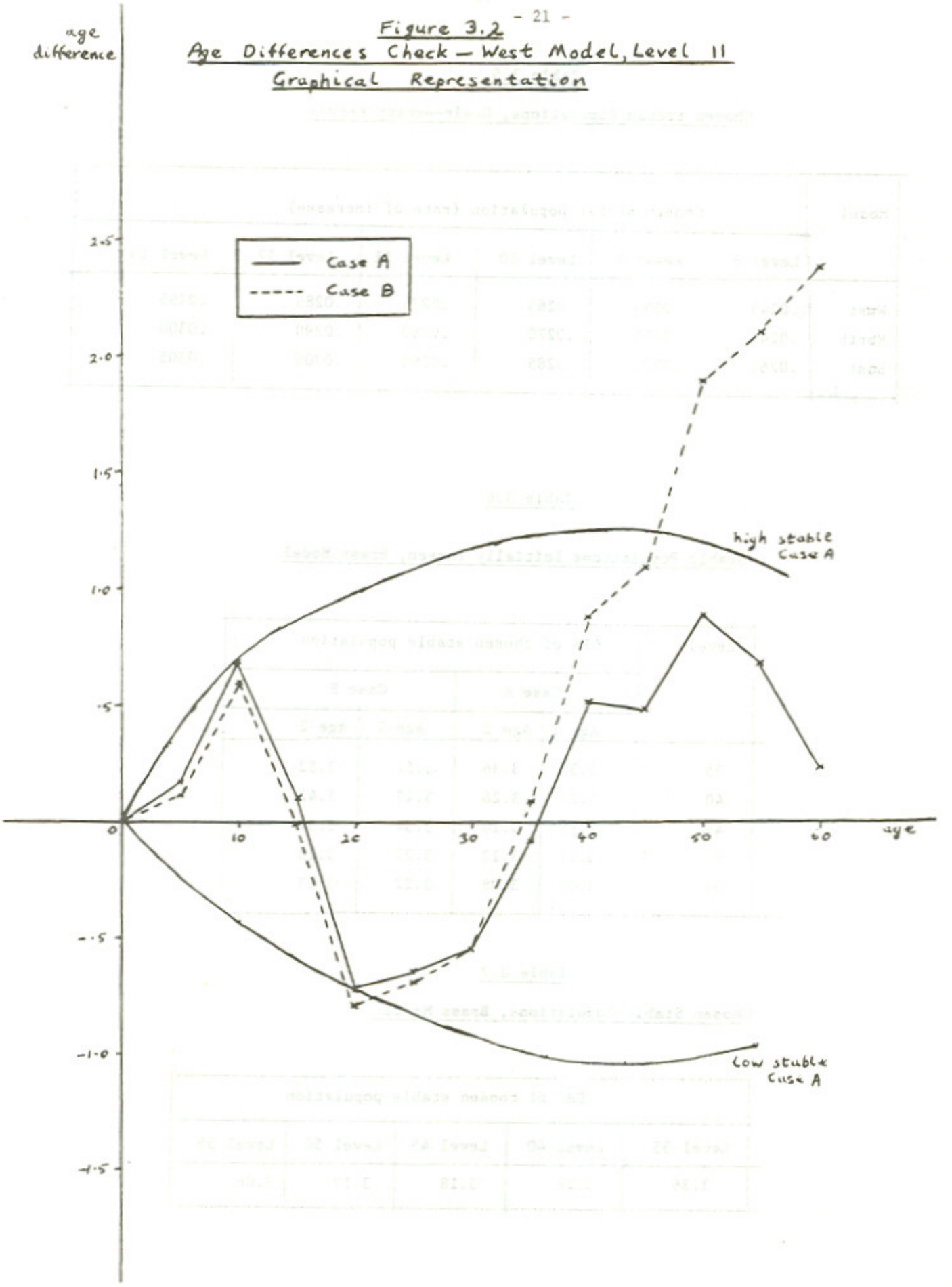


Table 3.5

Chosen Stable Populations, Coale-Demeny Models

Model	Chosen stable population (rate of increase)					
	Level 8	Level 9	Level 10	Level 11	Level 12	Level 13
West	.0245	.0255	.0265	.0275	.0285	.0295
North	.0245	.0255	.0270	.0280	.0290	.0300
East	.0265	.0275	.0285	.0290	.0300	.0305

Table 3.6

Stable Populations Initially chosen, Brass Model

Level	GRR of chosen stable population			
	Case A		Case B	
	Age 1	Age 2	Age 1	Age 2
35	3.37	3.36	3.52	3.52
40	3.27	3.26	3.42	3.42
45	3.18	3.18	3.34	3.34
50	3.11	3.12	3.27	3.28
55	3.05	3.08	3.22	3.23

Table 3.7

Chosen Stable Populations, Brass Model

GRR of chosen stable population				
Level 35	Level 40	Level 45	Level 50	Level 55
3.36	3.26	3.18	3.12	3.06

Figure 3.3

Logits of Reported Age Distribution against Standard

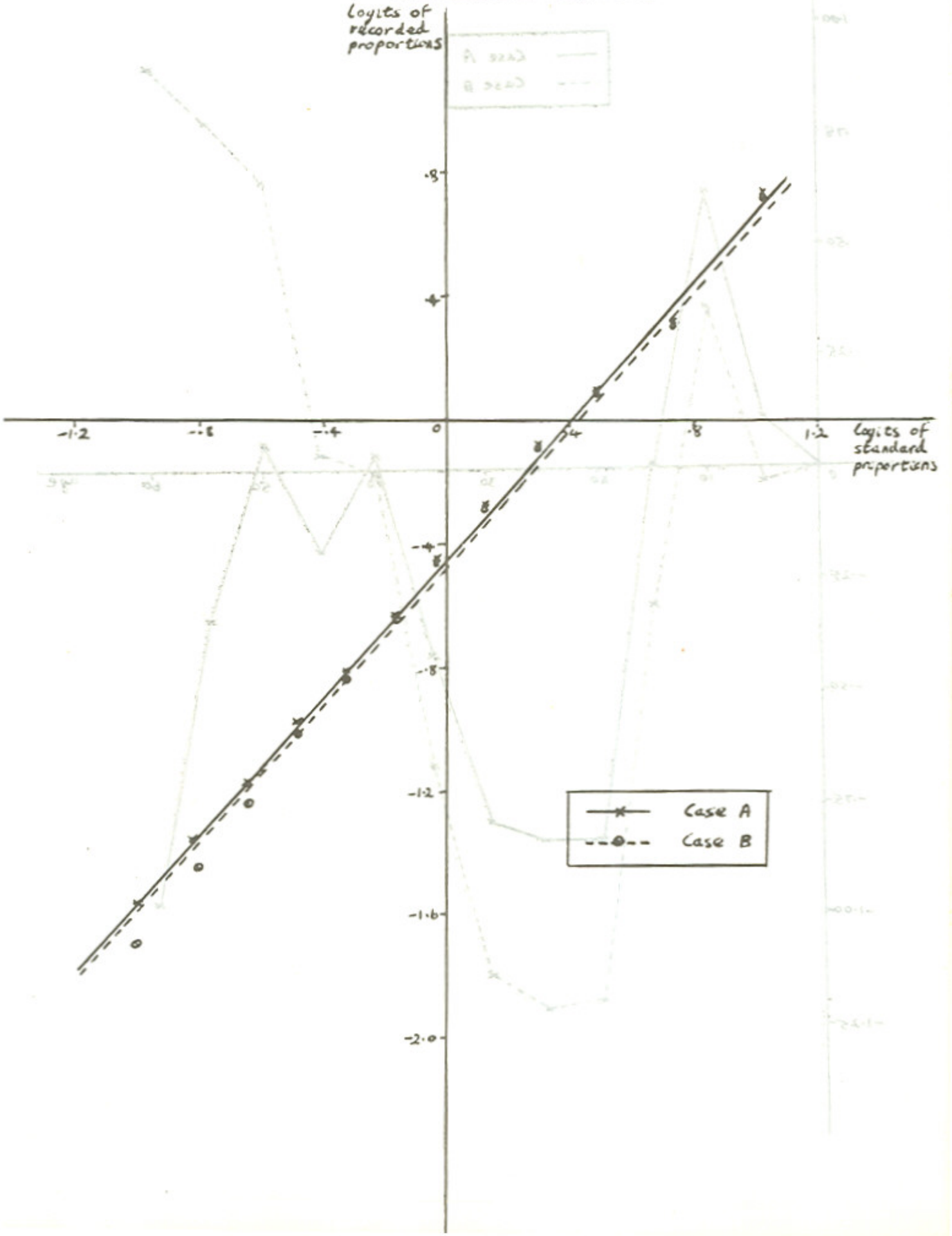


Figure 3.4

Age Differences Check – Brass Model, Level 45

Graphical Representation

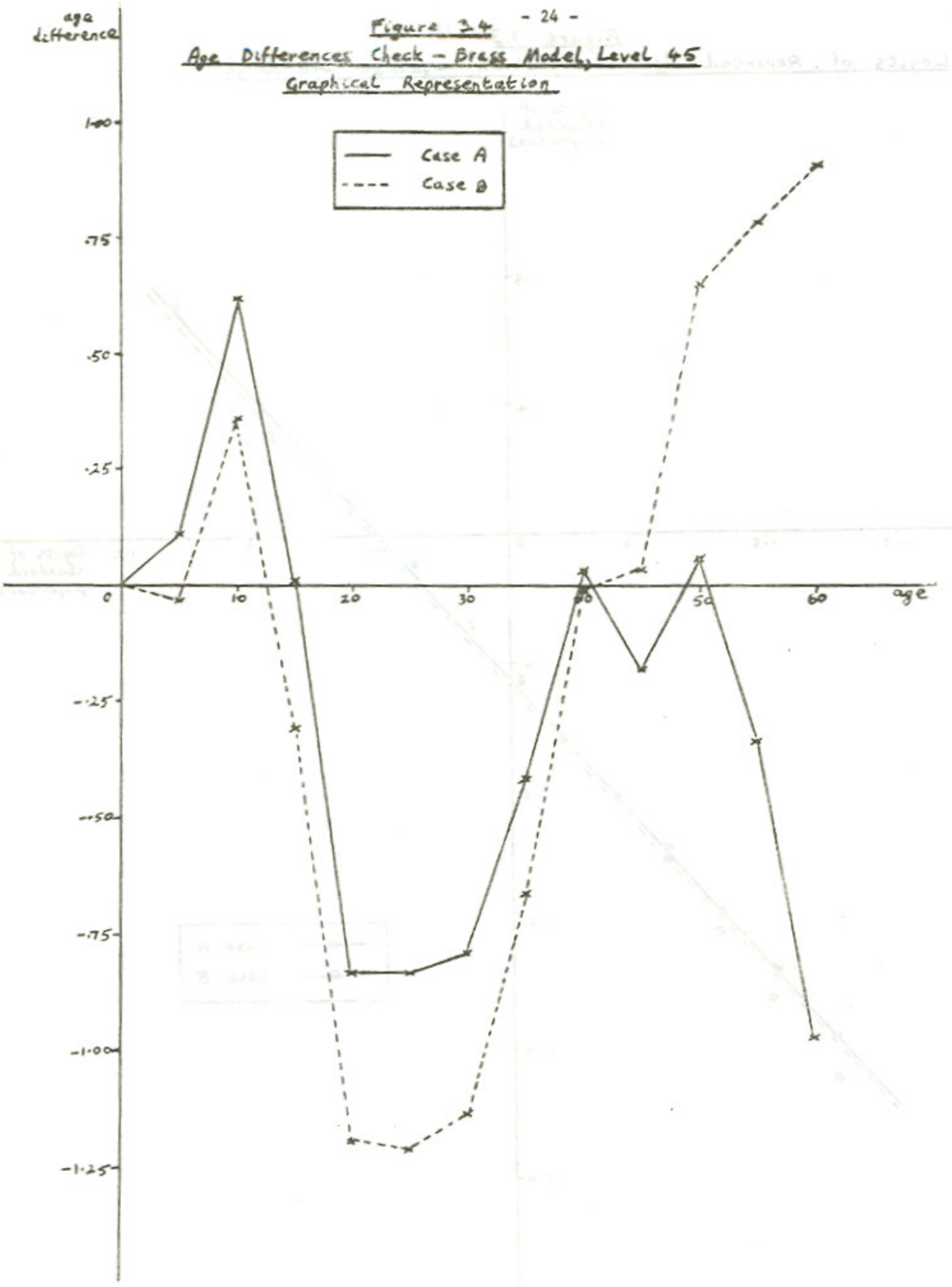


Table 3.8

Choice of Best Level for Each Set of Models, Using Estimates of Child Mortality

	Estimated values	Values from Models							
		West model		North model		East model		Brass model	
		Level 12	Level 13	Level 11	Level 12	Level 13	Level 14	Level 45	level 50
q(2)	.1618	.1684	.1506	.1688	.1526	.1767	.1574	.1757	.1551
q(3)	.1815	.1848	.1651	.1931	.1746	.1893	.1683	.2001	.1772

Table 3.9

Various characteristics of the Four Chosen Stables

	West	North	East	Brass
Level	12	11	13	45
Expectation of life at birth	47.5	45.0	50.0	42.5
Crude birth rate	45.9	47.7	46.7	46.7
Crude death rate	17.4	19.7	16.2	20.7
Natural increase rate	2.85	2.80	3.05	2.60
Gross reproduction rate (mean age 29)	3.20	3.35	3.26	3.18
Births/population 15-44	.109	.114	.111	.109

Note Mean age for GRR for Brass model is 28.7

Table 3.10

Smoothed Age Distribution - Female

Age group	Proportion	Number
0-4	.1854	378,628
5-9	.1460	298,165
10-14	.1221	249,355
15-19	.1034	211,166
20-24	.0872	178,082
25-29	.0732	149,491
30-34	.0611	124,780
35-39	.0508	103,745
40-44	.0419	85,569
45-49	.0344	70,252
50-54	.0279	56,978
55-59	.0222	45,337
60-64	.0171	34,922
65-69	.0123	25,119
70-74	.0080	16,336
75-79	.0043	8,790
80+	.0025	5,104
Total	1.0000	2,042,223

Table 3.11

Sex Ratios in Age Groups

Age group	Proportion (female) in model	Proportion (male) in model	Sex ration in model	Reported sex ratio	Adjusted sex ratio
0-4	.1854	.1896	1.02141	.962	1.02141
5-9	.1460	.1485	1.01589	.992	1.01589
10-14	.1221	.1242	1.01596	1.069	1.01596
15-19	.1034	.1050	1.01724	.938	.93138
20-24	.0872	.0881	1.00909	.698	.84563
25-29	.0732	.0733	1.00015	.773	.85434
30-34	.0611	.0609	.99552	.806	.86651
35-39	.0508	.0503	.98895	.979	.92487
40-44	.0419	.0413	.98448	1.009	.95259
45-49	.0344	.0335	.97265	1.109	.97265
50-54	.0279	.0266	.95225	1.099	.95225
55-59	.0222	.0206	.92680	1.549	.92680
60-64	.0171	.0154	.89949	1.134	.89949
65-69	.0123	.0107	.86886	1.323	.86886
70-74	.0080	.0067	.83648	1.104	.83648
75-79	.0045	.0036	.79902	1.158	.79902
80+	.0025	.0017	.67917	1.172	.67917
All ages	1.0000	1.0000	.99879	.958	.95799

Table 3.12

Smoothed Age Distribution - Male

Age group	Proportion	Number
0-4	.1977	386,735
5-9	.1548	302,903
10-14	.1295	253,335
15-19	.1059	207,234
20-24	.0770	150,592
25-29	.0653	127,716
30-34	.0553	108,123
35-39	.0490	95,951
40-44	.0417	81,512
45-49	.0349	68,331
50-54	.0277	54,257
55-59	.0215	42,018
60-64	.0161	31,412
65-69	.0111	21,825
70-74	.0070	13,666
75-79	.0037	7,343
80+	.0018	3,468
Total	1.0000	1,956,421

Table 3.13

Adjustments to Recorded Age Distribution Implied by Smoothed Distribution

Age group	Recorded population	Smoothed population	Difference (smoothed-recorded)	Adjusted difference	Proportion to lower age group	Proportion to higher age group
Male						
0-4	367,634	386,735	+ 19,101			
5-9	324,618	302,903	- 21,715	- 2,614	.05884	.00805
10-14	237,043	253,335	+ 16,292	+ 13,678		
15-19	172,632	207,234	+ 34,602	+ 48,280	.07923	
20-24	132,[illegible]	150,592	+ 18,557	+ 66,837	.36566	
25-29	123,460	127,716	+ 4,256	+ 71,093	.54137	
30-34	113,930	108,123	- 5,807	+ 65,286	.62401	
35-39	115,517	95,951	- 19,566	+ 45,720	.56516	
40-44	85,942	81,512	- 4,430	+ 41,290	.53199	
45-49	84,057	68,331	- 15,726	+ 25,564	.49121	
50-54	58,747	54,257	- 4,490	+ 21,074	.43515	
55-59	62,747	42,018	- 20,729	+ 345	.33586	
60-64	28,969	31,412	+ 2,443	+ 2,788	.01191	
65-69	28,354	21,825	- 6,529	- 3,741	.09833	.13194
70-74	8,576	13,666	+ 5,090	+ 1,349		
75-79	4,523	7,343	+ 2,820	+ 4,169	.29825	
80+	7,637	3,468	- 4,169	0	.54589	
Female						
0-4	382,120	378,628	- 3,492			.00914
5-9	326,924	298,165	- 28,759	- 32,251		.09865
10-14	221.657	249,355	+ 27,698	- 4,553		.02054
15-19	183,850	211,166	+ 27,316	+ 22,763		
20-24	[illegible]	178,082	- 10,984	- 33,779	.12040	
25-29	159,631	149,491	- 10,140	+ 1,639	.07379	
30-34	141,217	124,780	- 16,437	- 14,798	.01161	.10479
35-39	117,876	103,745	- 14,131	- 28,929		,24542
40-44	85,126	85,569	+ 443	- 28,486		.33463
45-49	75,725	70,252	- 5,473	- 33,959		.44845
50-54	53,403	56,978	+ 3,575	- 30,384		.56896
55-59	40,482	45-337	+ 4,855	- 25,529		.63063
60-64	25,533	34,922	+ 9,389	- 16,140		.63212
65-69	21,427	25,119	+ 3,692	- 12,448		.58095
70-74	7,766	16,338	+ 8,572	- 3,876		.49910
75-79	3,905	9,190	+ 5,285	+ 1,409		
80+	6,515	5,106	- 1,409	0	.21627	

Table 3.14

Recorded Age Distributions - Provinces

Age group	Province			
	Central	Copperbelt	Eastern	Luapula
Male				
0-4	64,696	82,647	43,617	30,691
5-9	53,704	62,487	42,674	28,353
10-14	37,212	43,522	31,593	22,614
15-19	31,494	36,554	21,434	14,987
20-24	29,948	34,887	13,217	9,238
25-29	28,341	33,133	12,364	8,093
30-34	23,974	31,184	10,319	8,032
35-39	23,814	29,011	11,183	8,129
40-44	16,620	19,547	8,689	6,585
45-49	15,272	16,460	9,712	6,430
50-54	9,554	8,620	7,304	4,763
55-59	9,727	7,706	9,013	6,758
60-64	4,115	2,285	4,334	2,337
65-69	4,000	1,875	4,223	2,416
70-74	1,028	427	1,376	676
75-79	582	194	746	333
80+	1,024	562	1,367	423
Total	355,165	410,901	233,165	160,858
Female				
0-4	67,218	84,620	45,563	32,388
5-9	54,517	64,813	42,158	28,171
10-14	35,740	42,975	27,882	20,424
15-19	33,638	38,023	22,638	15,975
20-24	34,298	40,157	24,144	15,366
25-29	28,508	32,025	21,125	11,864
30-34	23,088	26,363	19,034	11,107
35-39	18,304	18,604	16,807	9,713
40-44	12,235	10,468	13,253	7,596
45-49	10,498	7,732	13,005	7,138
50-54	6,625	4,159	9,199	5,266
55-59	5,100	2,974	7,319	4,101
60-64	2,952	1,648	4,711	2,276
65-69	2,504	1,219	4,011	1,830
70-74	810	333	1,594	569
75-79	460	160	784	242
80+	717	323	1,388	307
Total	337,412	376,596	274,615	174,333

Table 3.14

Recorded Age Distributions - Provinces

Age group	Province			
	Northern	N-Western	Southern	Western
Male				
0-4	51,702	18,008	45,277	30,996
5-9	47,273	17,822	42,051	30,254
10-14	36,127	12,385	31,206	22,384
15-19	23,524	8,409	21,212	15,018
20-24	13,969	5,713	15,289	9,774
25-29	12,471	5,639	14,085	9,334
30-34	11,478	5,650	13,605	9,688
35-39	11,825	6,514	13,836	11,205
40-44	8,739	5,369	10,799	9,594
45-49	9,151	6,423	10,437	10,172
50-54	6,460	4,673	7,504	9,869
55-59	10,895	4,437	6,541	7,670
60-64	4,057	3,200	3,558	5,083
65-69	4,499	2,682	3,530	5,069
70-74	1,412	981	1,032	1,644
75-79	673	522	604	869
80+	985	907	1,038	1,531
Total	255,240	109,334	241,604	190,154
Female				
0-4	53,926	18,711	47,079	32,615
5-9	47,729	17,462	42,102	29,972
10-14	34,180	10,727	29,420	20,309
15-19	25,672	8,948	22,220	16,736
20-24	24,390	10,072	21,672	18,967
25-29	19,708	9,775	19,168	17,458
30-34	18,760	9,351	17,232	16,282
35-39	15,813	8,978	13,964	15,493
40-44	12,159	7,101	9,798	12,516
45-49	10,890	6,483	8,452	11,527
50-54	8,225	4,652	5,861	9,416
55-59	7,290	3,362	3,992	6,344
60-64	4,051	2,493	2,968	4,434
65-69	3,549	1,868	2,520	3,926
70-74	1,196	779	990	1,495
75-79	580	394	559	726
80+	823	764	984	1,209
Total	288,941	121,920	248,981	219,425

Table 3.15

Smoothed Age Distributions - Provinces.

Age group	Province							
	Central	Copperbelt	Eastern	Luapula	Northern	N-Western	Southern	Western
Male								
0-4	67,856	86,324	46,128	32,359	54,484	19,057	47,751	32,776
5-9	50-112	56,307	39,819	26,457	44,110	16,630	39,238	28,230
10-14	40,140	46,921	33,635	24,029	38,372	13,194	33,226	23,818
15-19	39,949	46,414	24,569	17,178	26,768	9,832	25,122	17,402
20-24	34,340	40,068	15,078	10,241	15,612	6,677	17,323	11,253
25-29	27,958	34,655	12,109	8,724	12,882	6,112	14,950	10,326
30-34	22,473	28,121	10,200	7,614	10,999	5,805	12,935	9,976
35-39	19,197	23,014	9,485	7,038	9,791	5,689	11,761	9,976
40-44	15,280	17,233	8,838	6,240	8,585	5,668	10,181	9,487
45-49	11,927	12,176	8,119	5,346	7,468	5,301	8,575	9,469
50-54	8,664	7,457	7,153	4,959	7,307	4,130	6,436	8,151
55-59	6,509	5,145	6,038	4,516	7,284	2,985	4,386	5,155
60-64	4,465	2,442	4,697	2,547	4,451	3,427	3,863	5,520
65-69	3,125	1,444	3,251	1,859	3,463	2,064	2,717	3,902
70-74	1,738	732	2,157	1,094	2,207	1,490	1,677	2,571
75-79	967	334	1,268	465	1,010	861	992	1,446
80+	465	164	623	192	447	712	471	696
Total	355,165	430,902	222,165	160,858	255,240	109,334	241,604	190,154
Female.								
0-4	66,603	83,847	45,147	32,092	53,433	18,540	46,649	32,317
5-9	49,754	59,192	38,415	25,688	43,514	15,910	38,379	27,313
10-14	40,384	48,486	31,468	22,783	38,186	12,230	32,969	22,849
15-19	38,501	45,746	26,118	18,245	29,311	10,381	25,433	19,427
20-24	32,273	37,686	22,797	14,391	22,907	9,580	20,477	17,971
25-29	26,672	29,968	19,786	11,117	18,472	9,163	17,954	16,359
30-34	20,401	23,294	16,818	9,815	16,577	8,262	15,226	14,387
35-39	16,382	16,801	14,677	8,493	13,897	7,755	12,343	13,397
40-44	12,682	11,553	12,943	7,436	11,571	6,928	9,946	12,120
45-49	9,884	7,768	11,608	6,479	10,075	5,951	7,941	10,546
50-54	7,564	5,260	9,797	5,471	8,429	4,913	6,316	9,228
55-59	5,653	3,465	7,937	4,511	7,373	3,889	4,809	7,700
60-64	4,302	2,481	6,349	3,423	6,087	3,037	3,610	5,623
65-69	2,915	1,554	4,659	2,206	4,048	2,359	2,932	4,447
70-74	1,861	875	3,178	1,348	2,661	1,475	1,960	3,030
75-79	1,019	396	1,880	592	1,355	948	1,266	1,734
80+	562	253	1,088	241	645	599	771	947
Total	337,432	376,596	274,615	174,333	288,941	121,920	248,981	219,425

Figure 3.5

Population Pyramids – Reported and Smoothed Age Distributions

Total Zambia

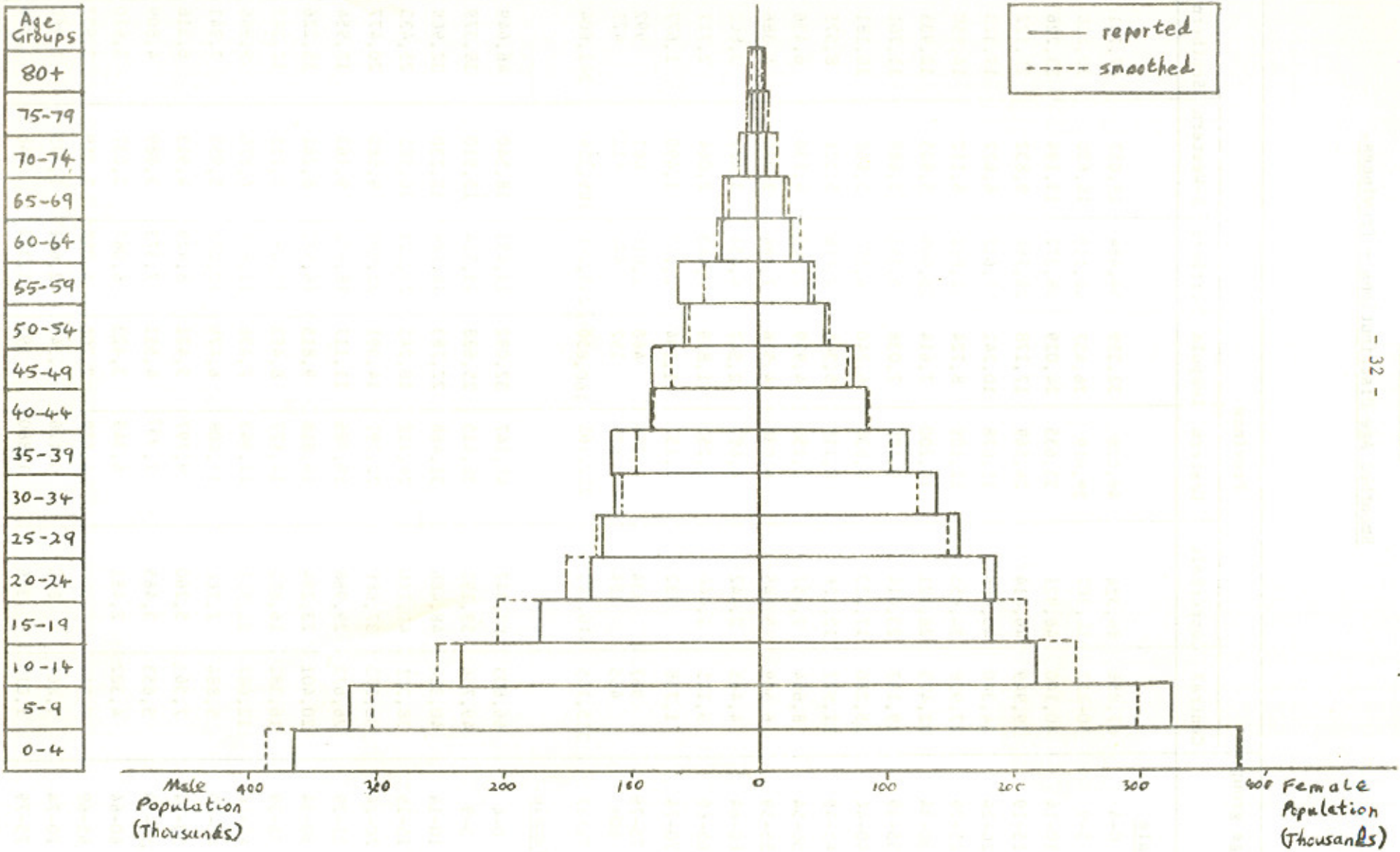


Figure 3.6

Population Pyramids - Reported and Smoothed Age Distributions

Central Province

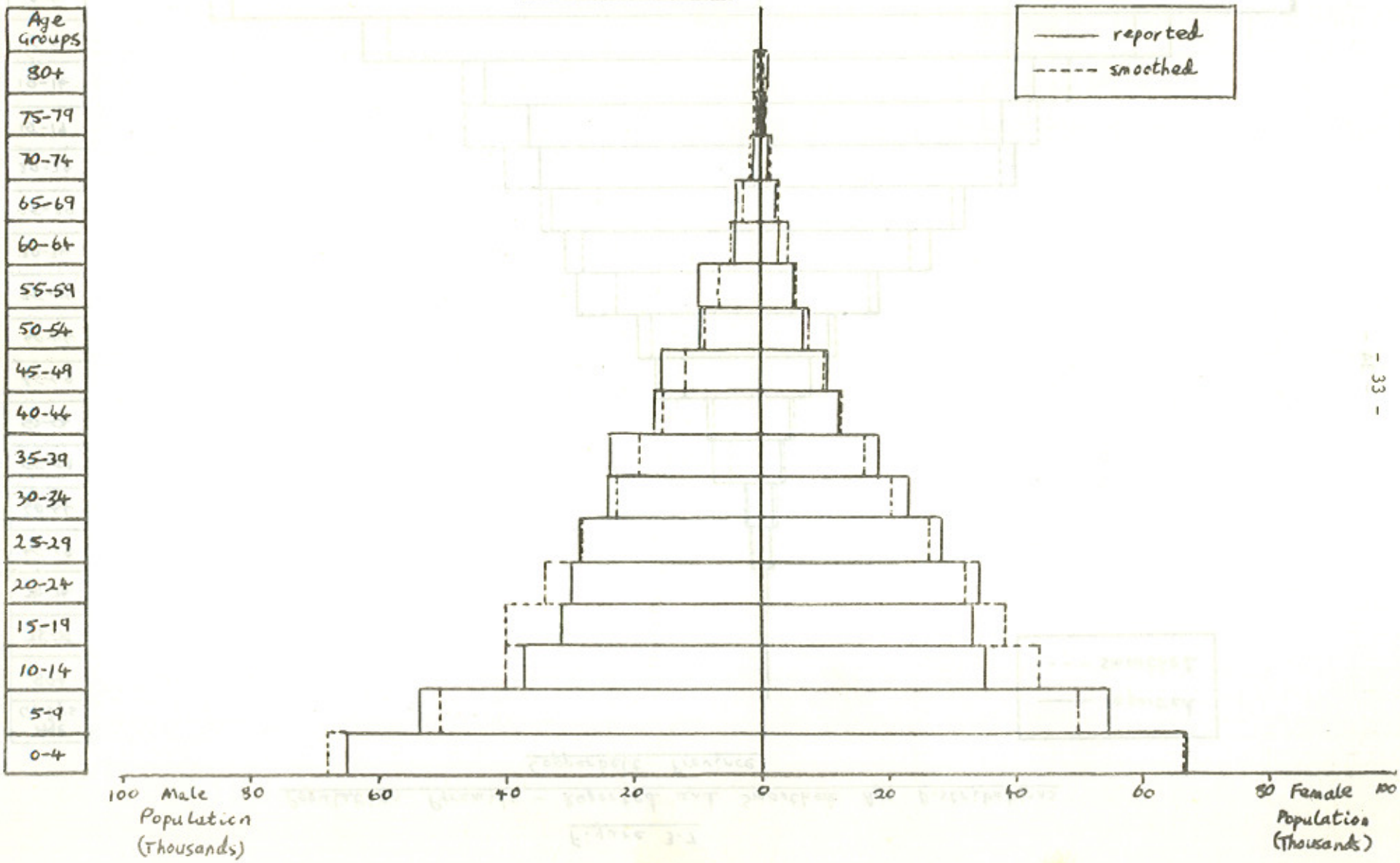


Figure 3.7

Population Pyramids - Reported and Smoothed Age Distributions

Copperbelt Province

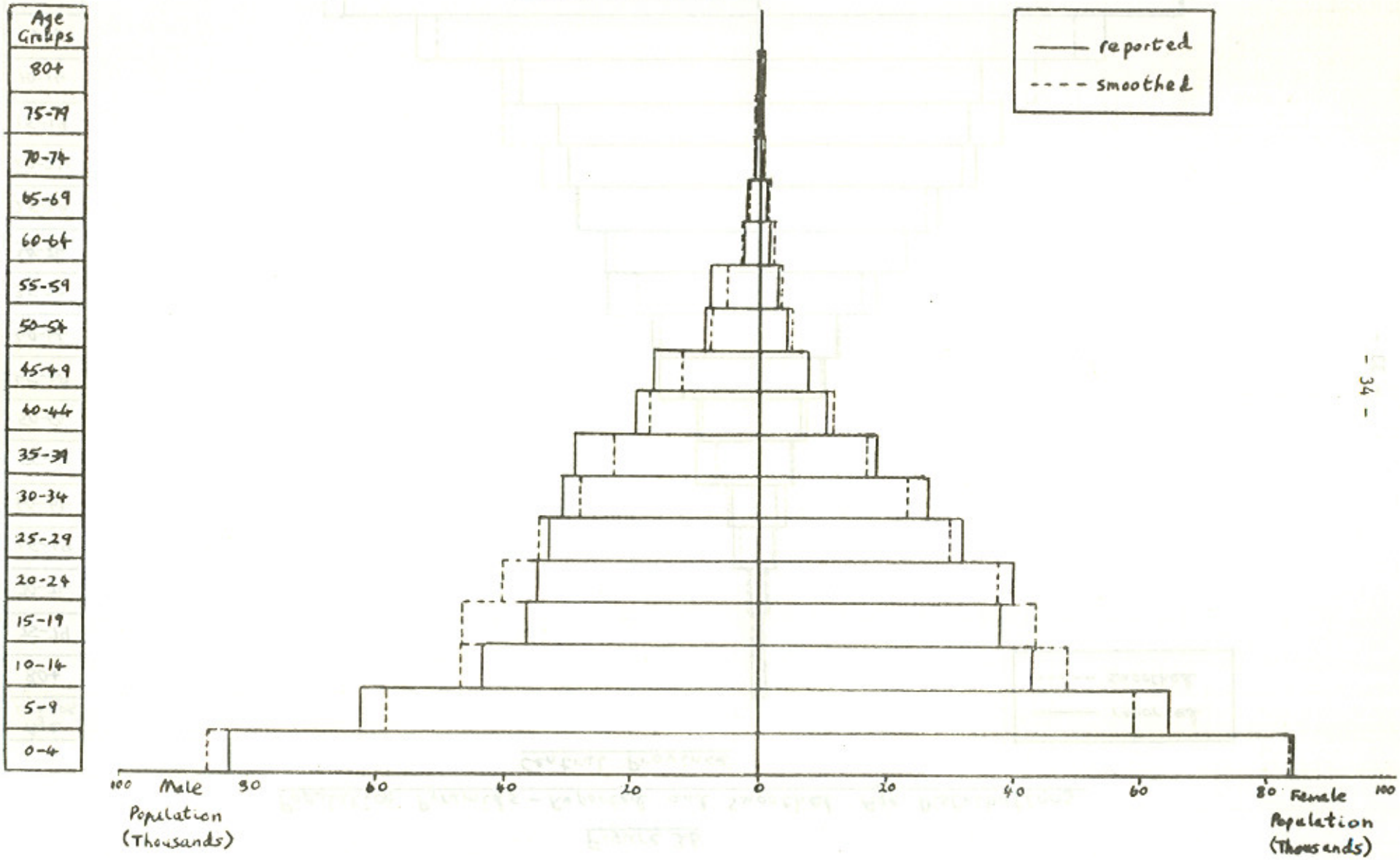


Figure 3.8

Population Pyramids – Reported and Smoothed Age Distributions

Eastern Province

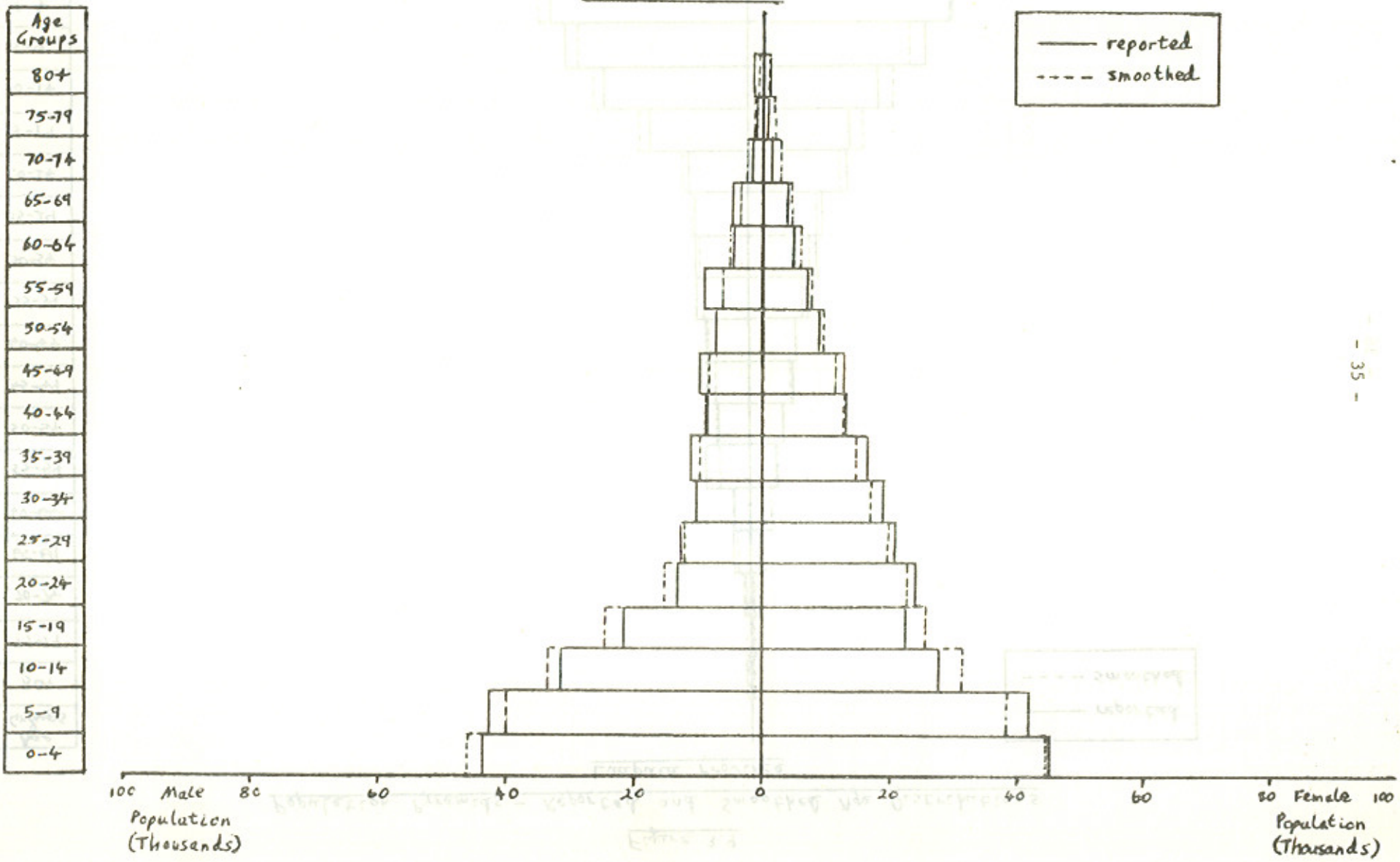


Figure 3.9

Population Pyramids - Reported and Smoothed Age Distributions

Luapula Province

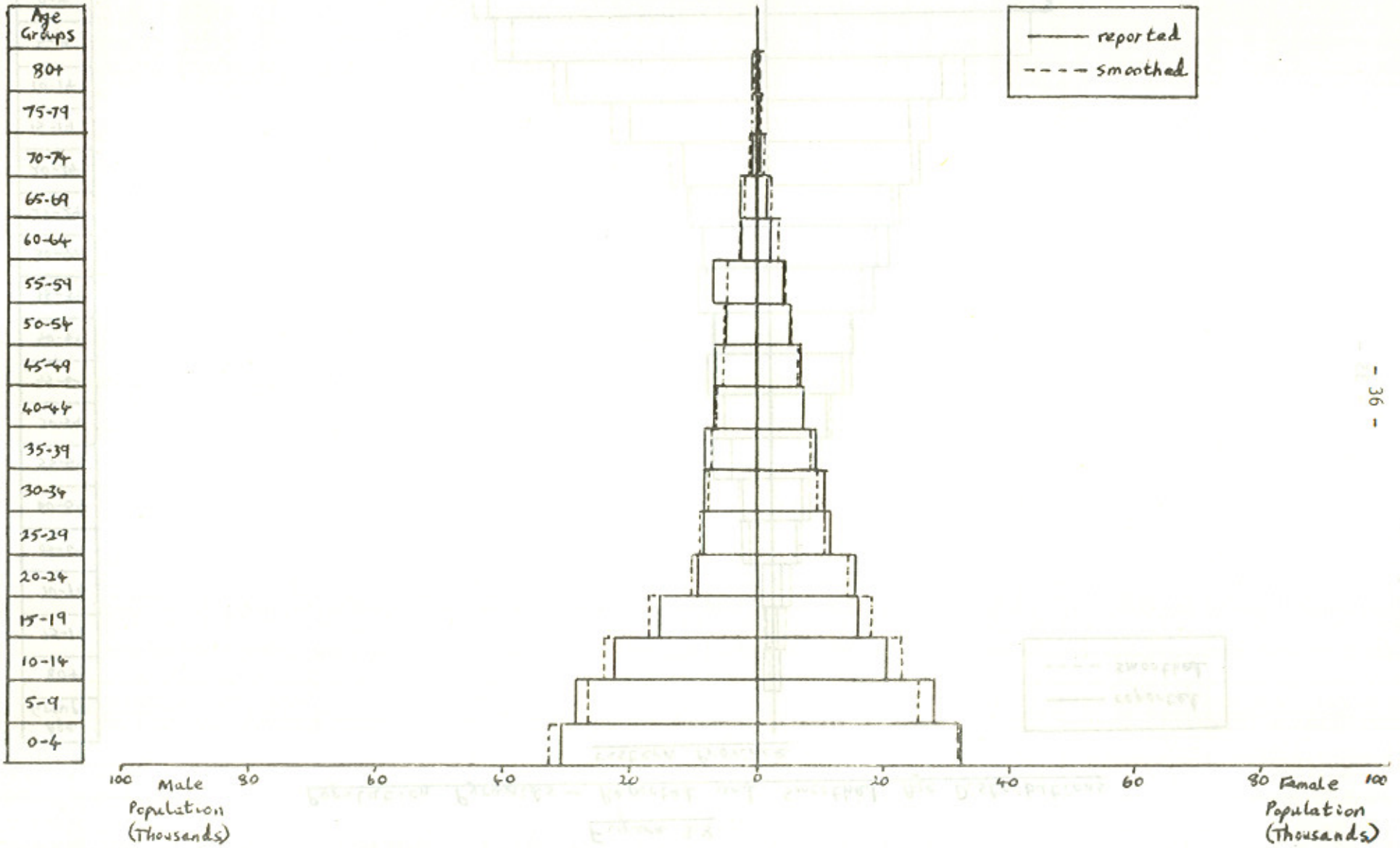


Figure 3.10

Population Pyramids - Reported and Smoothed Age Distributions

Northern Province

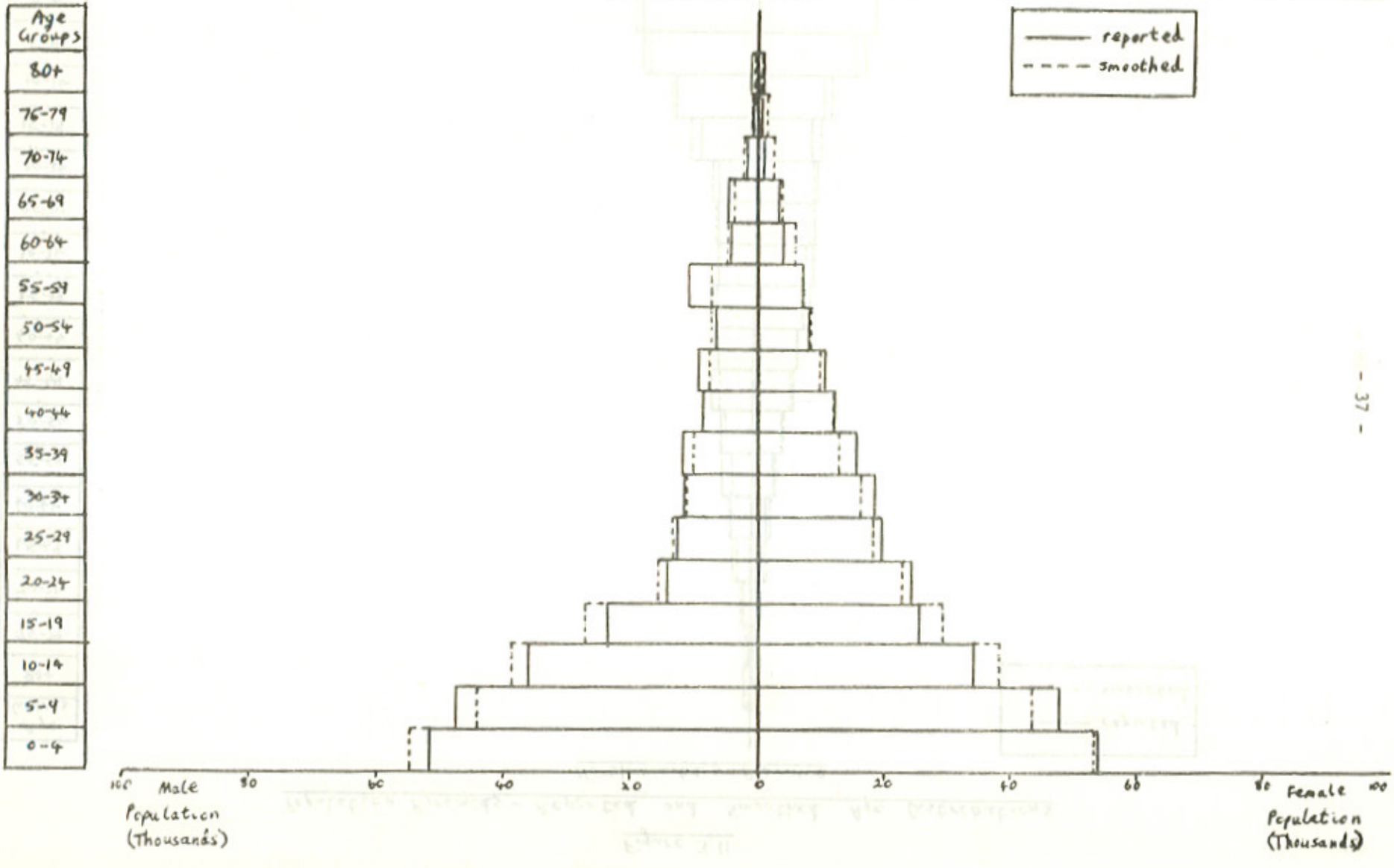


Figure 3.11

Population Pyramids - Reported and Smoothed Age Distributions

North-Western Province

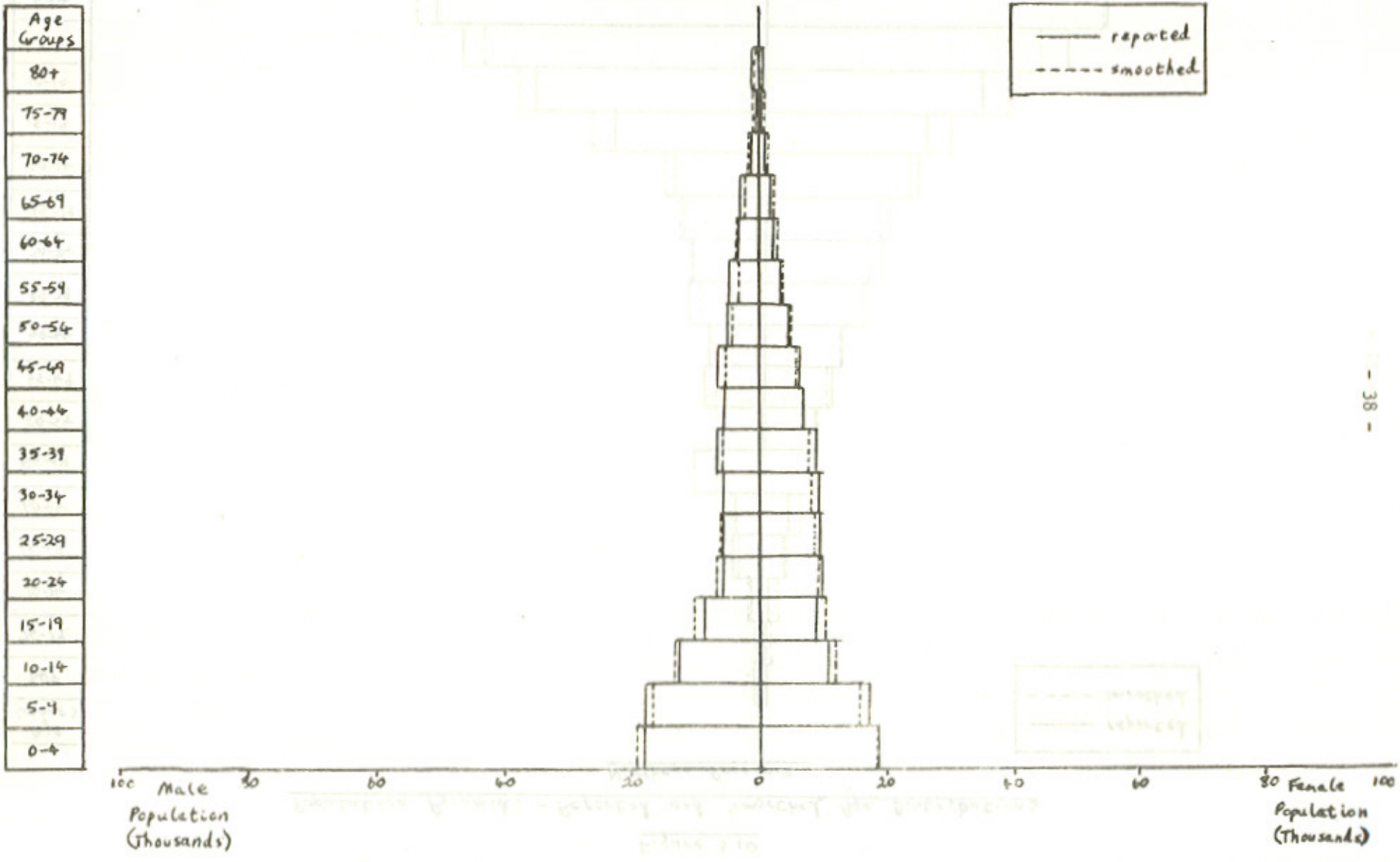


Figure 3.12

Population Pyramids - Reported and Smoothed Age Distributions

Southern Province

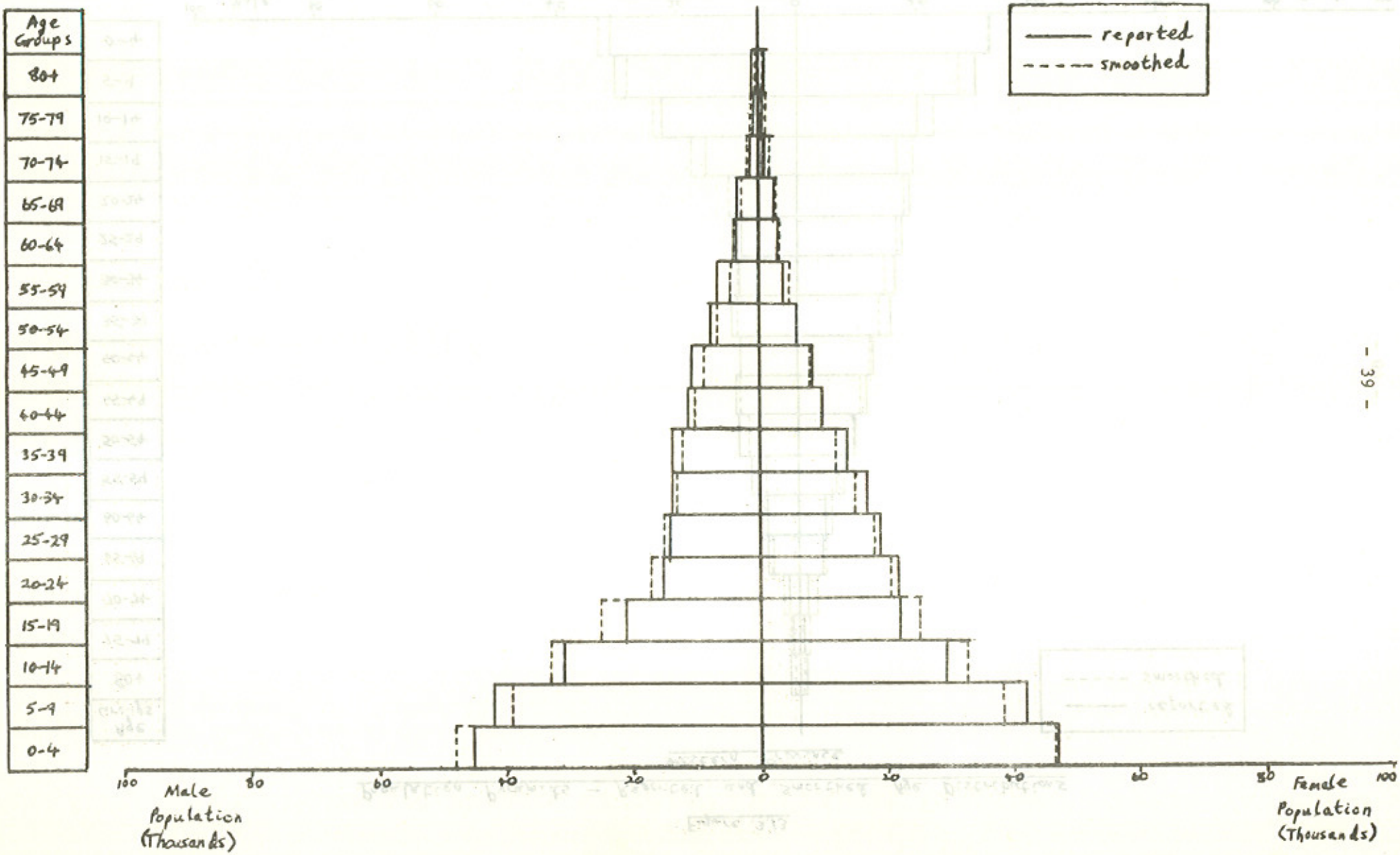
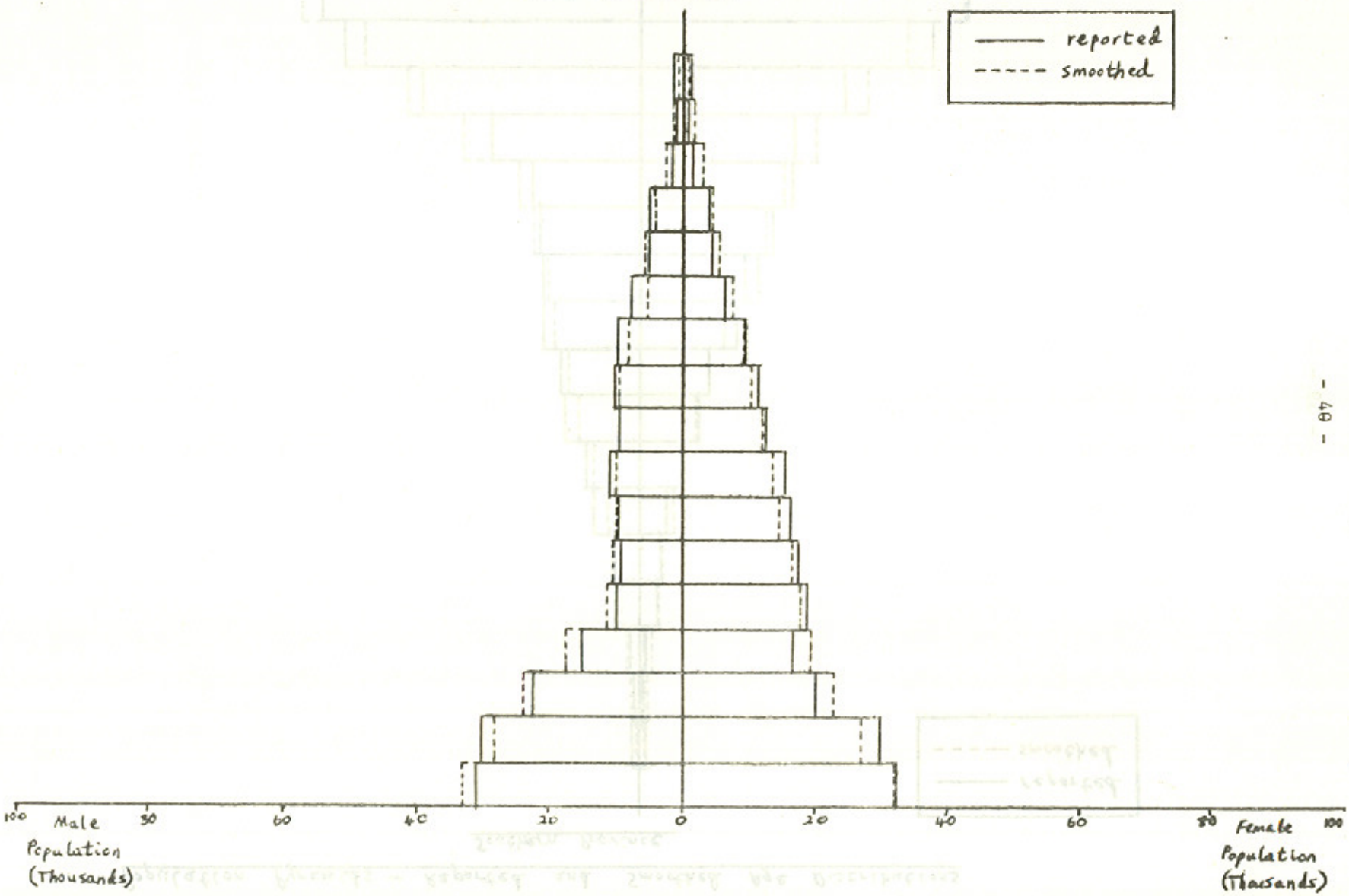


Figure 3.13

Population Pyramids – Reported and Smoothed Age Distributions

Western Province



CHAPTER 4

CONCLUSIONS

4.1 Conclusions

From the model stable population chosen, estimates of various fertility and mortality characteristics were obtained. These are given in Table 4.1. The smoothed age distributions obtained for the whole country and for individual provinces are those given im Chapter 3.

Table 4.1

Final Estimates of Various Measures of Fertility and Mortality

Expectation of life at birth (females)	45.0
Expectation of life at birth (male)	41.8
Crude birth rate (per 1000)	47.7
Crude death rate (per 1000)	19.7
Natural increase rate (per 100)	2.80
General fertility rate (per 1000 women aged 15 to 44)	233.7
General fertility rate (per 1000 women aged 15 to 49)	215.9
Gross reproduction rate (mean age 29.7)	3.44
Total fertility	7.05
Infant mortality rate (per 1000 live births)	141

REFERENCES

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