# THE EGYPTIAN BIRTH RATE AND ITS SEX RATIO

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## INTRODUCTION

It is important to establish the birth rate of a country as accurately as possible, and especially in Egypt where the birth rate is high. Although birth registration has been in force in Egypt since 1917, it is known that the registered births are somewhat below the total births. The annual live birth rate for the 48 years 1917 to 1964 varied between 37.6 per thousand (in 1942) and 45.4 (in 1930), with a median of 42.6. The registered birth rate has declined somewhat since 1964, and was only 36.8 per thousand in 1969, the lowest figure ever recorded. At the observed rate of decline.,the 1972 birth rate would be about 34.2, and the whole demographic transition might be over by about 1990. The figures, however, are not accurate and the decline in recent years may owe a good deal to the crisis since 1967. It is therefore opportune to make a careful appraisal of the Egyptian birth rate. Because there was a national census in 1960, most of our study is confined to that year.

There is no doubt that births in Egypt were substantially under-registered in 1960. The official rates (see *Vital Statistics, 1960* Volume II p. 58) were : urban, 47.5 per thousand ; rural areas with Health Bureaus, 43.7 ; other rural areas, 40.0. The combined rate was 42.9. However, this was based upon the provisionally estimated mid-year population of 25.951,800 Following the census of September 1960, in which 26,085,000 was the final estimated total population, including nomadic Bedouins *(Statistical Abstract of the U. A. R., 1951/52—1908/69,* p. 16) the estimate of the mid-year population was reduced to 25,832,000 (p. 10 of the same work), and consequently the birth rate was re-estimated at 43.1 (p. 19), although the number of registered births remained at 1,113,888.

Khodary, aided by Al-Hennawy and Issa, estimated the birth rate of Egypt in 1960 from first assuming a stable population with the mortality pattern of the Princeton South model life tables, and then adjusting his results to allow for declining mortality. The eventual birth rate was 45.44 per thousand *(Demographic Measures and Population Growth in Arab Countries,* Cairo 1970, p. 267). The average registered birth rate of 1958—62 was 42.44 (using *Statistical Abstract of the U. A. R. 1951/52 — 1968/69,* p. 19), so that one might say that Khodary's method found that birth registration about 1960 was incomplete by 3.00 per thousand, or 6.6 per cent. Zachariah, using the registered births for 1960—65 and Khodary's estimate for 1965, found 5 per cent underregistration of births in 1965 *(Demographic Measures and Population Growth in Arab Countries,* p. 298).

The present study seeks to make another estimate of the birth rate in Egypt in 1960. The weaknesses of the stable population methods—which are based on the United Nations Manual IV (New York, 1967) *Methods of Estimating Basic Demographic Measures from Incomplete Data* are chiefly two in this context : they must rely on a set of model life tables that may be rather inappropriate (the mortality pattern not being known in detail ; and they tell us nothing about regional variation. The assumptions about stability or quasi-stability, which are often discussed critically, are less serious, because enough is known about Egypt's demographic history in the twentieth century to justify the assumptions fairly well. At the same time, the unknown extent of mis-statement of age or of omission of young children also makes the method of stable popultions hazardous.

For these reasons, an entirelydifferent approach is tried here. with a view to seeing how well it appears to work in practice. Wider applications can be envisaged if the approach should seem satisfactory.

## METHOD OF THE PRESENT STUDY

The essential element in the method is the sex-ratio at birth. It has been used already in correcting underrecorded birth data in *The Demography of the the British Peerage.* (Supplement to *Population Studies,* November 1964). There, however, merely a rough attempt to correct underrecorded births in a highly unusual population was made, and no extensions to more conventional population seemed likely.

The sex-ratio at birth is not, of course, invariable. It varies with the ages of the parents. The father's age matters for the genetic reason of the determination of sex at conception. The mother's age

matters because while abortions and stillbirths are mor likely to be male, they are also more likely to occur to older mothers. In both cases, the sex-ratio of males to females falls with advancing age. As parents' ages are highly correlated, it is not easy (or always necessary) to distinguish between the effects in the statistics.

The sex-ratio also depends somewhat upon the ethnic group and the standard of living (strictly speaking, presumably, upon the ethnic group of the father and the standard of living of the mother). But these differences are small, and Egypt is, in any event, fairly homogeneous in both respects.

Nevertheless, the reported sex-ratio of births in Egypt is highly variable. The lowest male to female ratios are found in the large cities and in urban areas generally. The rural areas have higher reported ratios, and those without a Health Bureau have very high sex-ratios indeed. This is clearly caused by underreporting of female births.

While we may assume that the true sex-ratio of births is the same everywhere, it is not safe to assume that the true birth rate is everywhere the same. Some degree of limitation of births may well exist in parts of Egypt, and a difference between urban and rural birth rates would not be surprising. However, we are entitled to assume that the existence of a Health Bureau is not related to the true rate of births, and that the higher reported birth rates of the rural Health Bureaus merely reflect a stimulus towards registration of births.

The model that we propose, to account for the levels of reported births, is as follows :

In a given area, a certain proportion, x, of all births is not registered because of such general causes as ignorance of the law, distance from a registration centre, and forgetfulness. This affects births of each sex equally. Of the remaining births, the proportions of males and females are the same as in the actual births. Amongst these remaining female births, however, a further proportion, y, are not registered because of a special disinclination to make much effort for a daughter rather than a son. If the true male and female births are M and F respectively, the corresponding reported births are therefore M (1-x) and F (1-x) (1-y).

We can assume that M/F is constant for all areas. We should be careful, however, not to consider very small areas separately, because random variations might make the true sex-ratio for a given year very

different from the general average. If we group governorates together, this difficulty will be minimized.

In order to proced with the analysis, some relation between x and y needs to be postulated. Now, if we imagine that the true values of x and y are somehow known for a large number of areas and plotted against Cartesian axes, we should expect that x and y would be corrlated in some way. They are both types of under-registration, and can hardly be wholly independent. In particular, it would be surprising if low values of x, which imply nearly complete registration in general, were not usually associated with low values of y. There are, after all, many instances in which the assumption $x = y = o$ is implicitly made.

On the other hand, as x increases it would be surprising if y were not also to increase. The special lack of concern about registering female births seems likely to be related to a general tendency towards non-registration of any births. Without probing deeper into the matter, the assumption seems plausible that $y = ax$ for a given area, where a is a constant.

The special feature of Egyptian vital statistics that makes this model-building worthwhile is that for two parts of the same area (rural Lower Egypt, for example), we have two sets of birth data, with two reported birth rates for each sex. If the male and female birth rates for one area are m and f respectively.

$m(1-x)$ = reported male birth rate, $m_1$ ;

$f(1-x)(1-ax)$ = reported female birth rate, $f_1$ ;

and $m/f$ = the known sex-ratio of births, R, say.

Hence $ax = 1-f_1R/m_1$ (1)

For the second set of data, we have reported birth rates $m_2$ and $f_2$, and x will be different. Take the appropriate value as hx, where h is an index that will show the effect of the Health Bureaus. We shall assume, however, that a is the same as before, since it merely chooses a value of y related to the new value of x.

For the second set af data,

$m(1-hx) = m_2$

$f(1-hx)(1-ahx) = f_2$

and we find $ahx = 1-f_2R/m_2$ (2)

Dividing (2) by (1), $h = \{ (m_2 - f_2 R)\ m_1\} / \{(m_1 - f_1 R)m_2\}$

It is now a straightforward matter to solve the equations, although the algebra is fairly heavy.

## CALCULATION OF RESULTS

This now enables us to estimate the true birth rates for any part of Egypt, provided we have a value of R to work from. As a simplification, we shall regard the five urban governorates as being completely registered. The sex-ratio of their births (129,320 to 124,743) is taken as the national Egyptian figure, which comes to 103.669 males per 100 females. From what we know of other countries, this is a highly possible figure, bearing in mind that stillbirths (which are largely male) are rather high in Egypt. The urban governorates account for about 20% of the whole population so that this estimate of R is not liable to much random error.

We now take the rest of Egypt essentially in two parts, Lower Egypt and Upper Egypt. The four sparsely populated Frontier Governorates can be treated separately later.

(1) *Lower Egypt :*

Take the rural areas first. (pp. 58—59 of *Vital Statistics)*

| | Population | Male Births | Female Births |
|---|---|---|---|
| With Health Bureaus | 1,597,00 | 36,963 | 34,432 |
| Without Health Bureaus | 7,558,500 | 171,724 | 151,607 |

We calculate the following reported birth rates per thousand population and sex-ratios per 100 female births :

| | Male Rate | Female Rate | Sex Ratio | Combined Birth Rate |
|---|---|---|---|---|
| Health Bureau areas | 23.1453 | 21.5604 | 107.351 | 44.7057 |
| Other Localities | 22.7193 | 20.0578 | 113.269 | 42.7771 |

Taking the Other Localities as the first population, we have $ax = 0.0847552$, and taking the rural areas with Health Bureaus as the second population, we similarly get $ahx = 0.0342985$, from which $h = 0.4046772$.

The equation for x, via the male birth rate is

$13.9513\,x = 0.4260$, so that

$x = 0.0305348$

The value already found for ax then yields

$a = 2.77569$.

The true birth rates, m and f, are

$m = 23.4349$, $f = 22.6055$, and the total

birth rate is therefore 46.0404.

This implies 421,523 births in the rural areas of Lower Egypt in 1960, of which only 394,726 were registered. The remaining 26,797 births were not registered.

We now turn to urban areas of Lower Egypt. The data are : Population 2,037,600.

Registered Male births 48,797. Annual birth rate per thousand 23.9483.

Registered female births 46.441. Annual birth rate per thousand 22.7920.

Registered sex-ratio at birth 105.073.

It is reasonable to expect that R is the same as before, but not that m, f, or x are unchanged. In order to solve the equations that can be written down, we shall assume that a is the same as for the rural areas. This means simply that, while the true birth rate and the general tendency not to register a birth may be different in rural and urban areas, the special lack of concern about registering female births is of the same *type* in urban as in rural areas. The relationship between the rates of special female birth underregistration and of general birth underregistration is, in fact, assumed to be idential throughout Lower Egypt.

The basic equations for urban areas are :

$m(1-x) = 23.9483$, $f(1-x)(1-ax) = 22.7920$, and $m/f = 1.03669$,

Whence $1-ax = 22.7920 \times 1.03669 \quad 23.9483$ or $ax = 0.0133639$ Since $a = 2.77569$ previously, we therefore find $x = 0.00481462$ Hence $m = 24.0642$, $f = 23.2125$, and the total birth rate $= 47.2767$.

The true births are thus 96.331, of which 1,093 are not registered.

(2) *Upper Egypt :*

The same methods apply again. The rural data are :

| | Estimated Population | Births Male | Female | Sex-ratio |
|---|---|---|---|---|
| With Health Bureaus | 1,209,400 | 27,305 | 23,969 | 113.9180 |
| Without Health Bureaus | 6,478,400 | 135,329 | 103,611 | 130.6126 |

| Birth rates : | Male | Female | Combined |
|---|---|---|---|
| Health Bureau areas | 22.5773 | 19.8189 | 42.3962 |
| Other Localities | 20.8893 | 15.9933 | 36.8826 |

$ax = 0.2062877$
$ahx = 0.0899684$
So $h = 0.4361307$

Notice that this is quite close to the value of h previously found for Lower Egypt, which implies that the influence of Health Bureaus is similar in Upper and Lower Egypt. It would have been disturbing if this had not emerged from the analysis

Continuing the calculation, we find

$13.4668\ x = 1.6880$, so that

$x = 0.1253450$ and
$a = 1.64576$

Hence the general rate of rural under-registration of births is much higher (over 12 per cent) in the absence of a Health Bureau in Upper Egypt than in Lower Egypt (3 per cent), but the coefficient of special female underregistration is lower (1.6 as against 2.8).

Finally, for rural Upper Egypt,

$m = 25.8128$, $f = 24.8993$, and the combined birth rate is 50.7121. The total births are therefore 389,864, of which 99.650 are unregistered.

The urban areas of Upper Egypt have the following official statistics :

Population 1,514,600

| | | | |
|---|---|---|---|
| Registered male births | 37,334. | Rate, | 24.6494 per thousand. |
| Registered female births | 34,489. | Rate, | 22.7710 per thousand. |

Registered sex-ratio at birth 108.249.

We find ax = 0.0423106, and because we assume now a = 1.64576, we get x = 0.0257089.

Once again, the urban areas are much more completely registered than the rural areas. This, in a way, helps to justify our continuing assumption that the five urban governorates have complete birth registration and consequently that their registered sex-ratio at birth is correct.

For the urban areas of Upper Egypt, finally,

m= 25.2998, f = 24.4044, and so the true combined birth rate comes to 49.7042. The urban births are 75.282, of which 3,459 are unregistered.

(3) *Frontier Governorates :*

There were no Health Bureaus in the Frontier Governorates, which are wholly rural. The best way to estimate their true births would seem to be to apply the average rural birth rate for the rest of Egypt (as estimated) to their population of 227,500. It is not a large number, so that any error will be relatively small in Egypt as a whole.

The figures we have found are :

| | Population | Rural Births | Rate |
|---|---|---|---|
| Lower Egypt | 9,155,500 | 421,523 | 46.0404 |
| Upper Egypt | 7,687,800 | 389,864 | 50.7121 |
| Total | 16,843,300 | 811,387 | 48.1727 |

The estimated births in the Frontier Governorates are therefore 10,959, of which 5,578 would be male and 5,381 female. Registered births in these areas are only 4,171 and 3,653 respectively. This incidentally, implies values of x = 0.2522410 and a = 0.3652346. A larger value of x combined with a smaller value of a is what we had naticed before.

(4) *The whole of Egypt :*

The sex-ratio is, of course, assumed to be 103.669 male births per 100 female births all over Egypt. The estimates of the vital rates are now as follows :

| | Population | Births Total | Births Unregistered | Birth Rate |
|---|---|---|---|---|
| Urban governorates | 5,328,800 | 254,063 | 0 | 47.68 |
| Lower Egypt | 11,193,100 | 517,854 | 27,890 | 46.27 |
| Upper Egypt | 9,202,400 | 465,146 | 103,109 | 50.54 |
| Frontier governorates | 227,500 | 10,959 | 3,135 | 48.17 |
| Total | 25,951,800 | 1,248,022 | 134,134 | 48.09 |

The estimated rate of underregistration of births for the whole of Egypt is therefore 10.7 per cent, which is considerably above the figures of 6.6 or 5 per cent previously found by other methods. (see page 116).

We can note that twin birth (registered) are rarer in Upper than in Lower Egypt. This should mean that mothers are generally somewhat younger in Upper Egypt, and consequently we might expect a higher birth rate. Similarly, in the Health Bureau areas, 39.40% of live births in Lower Egypt were the first, second, or third births of that particular mother, whereas in Upper Egypt the corresponding figure was only 35.47%.

These two considerations lend some likelihood to our estimated result that the true birth rate is higher in Upper Egypt even though the registered birth rate is lower there.

## EXTENSIONS

We might try to separate the urban governorates, and see if further refinement is possible in reaching a true sex-ratio for Egypt, but in fact the urban areas in the other governorates seem so well registered that little further work is likely to be profitable. For these governorates, the true births are 171,613, of which only 4,552 are unregistered, or 2.7 per cent.

In rural areas, the true births are 822,346, of which 129,582 (15.8 per cent) are unregistered.

Yet the birth rates are remarkably similar :

| | |
|---|---|
| Urban Governorates | 47.68 |
| Other urban areas | 48.31 |
| Rural areas | 48.17 |

It would also be possible, using statistics on age at marriage, to estimate different sex-ratios in the different parts of Egypt. Higher sex-ratios, as well as higher birth rates, would be expected where marriage is earlier. This might apply to Upper Egypt, and the result would be to reduce the level of estimated births in Upper Egypt somewhat. The calculation is, however, hazardous, as it requires a knowledge of marriage over a considerable period and not just in 1960, whose brides contribute very little to the births of 1960.

*Infant Mortality :*

A more promising extension is to infant mortality (deaths under 1 year). The data for Egypt are very detailed, especially in 1960, and show strong indications of underregistration, especially in the neonatal period (under 1 month). A great deal of addition of parts of table VII of *Vital Statistics, 1960 Volume* II has to be done, but eventually we have the following data on registered infant deaths by sex :

| | Neonatal | | Postneonatal | |
|---|---|---|---|---|
| | M. | F. | M. | F. |
| Urban Governorates | 4,341 | 3,514 | 13,963 | 15,113 |
| Lower Egypt Urban | 1,551 | 1,208 | 3,978 | 4,417 |
| Lower Egypt Rural (H. B.) | 1,080 | 837 | 3,064 | 3,479 |
| Lower Egypt other | 1,734 | 1,288 | 11,750 | 12,109 |
| Upper Egypt Urban | 1,404 | 1,109 | 4,467 | 4,877 |
| Upper Egypt Rural (H. B.) | 1,003 | 655 | 3,302 | 3,069 |
| Upper Egypt other | 1,061 | 676 | 8,564 | 7,305 |
| Frontier Governorates | 117 | 116 | 297 | 308 |
| Total | 12,291 | 9,403 | 49,385 | 50,677 |

The ratio of male to female deaths is $> 1$ for neonatal but $< 1$ for postneonatal, except in the rural parts of Upper Egypt. This suggests that the distinction between the two types of infant mortality is particularly important.

The estimated births are :

| | Males | Females |
|---|---|---|
| Urban Governorates | 129,320 | 124,743 |
| Lower Egypt Urban | 49,033 | 47,298 |
| Lower Egypt RHB | 37,426 | 36,101 |
| Lower Egypt Other | 177,133 | 170,864 |
| Upper Egypt Urban | 38,319 | 36,963 |
| Upper Egypt RHB | 31,218 | 30,113 |
| Upper Egypt Other | 167,226 | 161,308 |
| Frontier Governorates | 5,578 | 5,381 |
| Total | 635,253 | 612,771 |

The total is larger by 2 than before, owing to rounding.

Strictly speaking, to calculate infant mortality rates one should divide the infant deaths by the *related* live births, that is to say, the births of a slightly earlier period than that of the deaths. It the birth

rate varies a great deal, this is an important point. In Egypt, however, there is not much variation in the birth rate from year to year, and we can presumably treat the births of 1960 and the infant deaths of 1960 as being sufficiently related in the proper way to give reasonably good estimates of infant mortality. This is almost always what is done in the official statistics for Egypt.

The first step is to find the registered infant mortality rates by sex, separated into neoatal and postneonatal components, for each of the groups of areas, using the estimates of births already made. The figpres are (per 100 live births).

| | Neonatal | | Postneonatal | |
|---|---|---|---|---|
| | Males | Females | Males | Females |
| Urban Governorates | 33.568 | 28.170 | 107.972 | 121.153 |
| Lower Egypt Urban Areas | 31.632 | 25.540 | 81.129 | 93.387 |
| Lower Egypt Rural with Health Bureaus | 28.857 | 23.185 | 81.868 | 96.369 |
| Lower Egypt Other Localities | 9.789 | 7.538 | 66.334 | 70.869 |
| Upper Egypt Urban Areas | 36.640 | 30.003 | 116.574 | 131.943 |
| Upper Egypt Rural with H. B. | 32.129 | 21.751 | 105.772 | 101.916 |
| Lower Egypt Other Localities | 6.345 | 4.191 | 51.212 | 45.286 |
| Frontier Governorates | 20.975 | 21.557 | 53.245 | 57.238 |
| Total | 19.348 | 15.345 | 77.741 | 82.701 |

These figures are, of course, presumably too low because of underregistration of infant deaths. We treat neonatal and postneonatal infant mortality separately. The Urban Governorates must be assumed fully registered, at least provisionally. As we have assumed that their birth registration is complete, there is no simple basis for assessing possible underregistration of infant deaths.

As before, the critical step is with the difference between rural areas with or without Health Bureaus. No difference in the true levels of infant mortality is anticipated, so that we can apply the same mathematical model to account for the figures as we used for the birth. This implies that, if m and f are the true rates of male and female infant mortality, whereas $m_1$ $f_1$ are the observed rates for the

areas without Health Bureaus, $m_1 = m\ (1\text{-}x)$ and $f_1 = f\ (1\text{-}x)\ (1\text{-}ax)$, where x and a are constants, and similar equations apply to the areas with Health Bureaus, with x replaced by hx.

In the birth registration model, we had an additonal equation given m/f, the sex-ratio at birth, which was assumed the same all over Egypt. The sex-ratio of infant deaths is not likely to be constant, however. It very probably depends upon the level of mortality, and may also be different in urban areas from its value in rural areas. It depends on the causes and ages of death, which certainly need not be even approximately uniform throughout the country. In the absence of this additional equation, some alternative method of solving the system of equations is needed.

Now, for Lower Egypt (and equally for Upper Egypt), we have already found values of x, a, and h in connection with underregistration of births. If any one of these could be assumed the same for the underregistration of infant deaths, the equations could be solved. But a constant x is not satisfactory, for it implies that births and infant deaths are underregistered to the same extent fundamentally. This would be true enough if those people who never register any vital event accounted for the great majority of non-registration, but such an idea seems rather improbable. A constant a would imply that the special tendency not to register a girl's birth is very similar to the tendency not to register a girl's death, in terms of the level of non-registration current in the area. This also, seems to have no particular likely basis in reality.

The remaining possibility, a constant value for h, is more encouraging. It implies that the effect of a Health Bureau in reducing the extent of non-registration is the same for infant deaths as it was for births, in that it reduces the number of events unregistered by the same proportion. In other words, if a Health Bureau makes 60% of the peasants register a birth who would not have done so without the Health Bureau, it also makes 60% of them register an infant death.

*Calculations* (1) *Neonatal :*

We can now begin the calculations. Lower Egypt comes first, and the rural areas are the critical ones. For neonatal deaths, the equations are :

$$m\ (1\text{-}x) = 9.789,\ f\ (1\text{-}x)\ (1\text{-}ax) = 7.538,$$
$$m\ (1\text{-}hx) = 28.857,\ f\ (1\text{-}hx)\ (1\text{-}ahx) = 23.185,$$

and h = 0.4046772 from the birth calculations.

Whence x = 0.7659180, and ax = 0.06790352, so a = 0.08865638, m = 41.819, f = 34.548.

For the urban areas,, as we did for the births, we can use the value of a we have just found. This leaves indeterminate equations, however. Now, obviously the urban areas are more fully registered than the rural areas.

It seems reasonable to continue our proportional method of allotting values to x. We have :

| | Birth data | Infant Death data |
|---|---|---|
| Urban Areas | 0.00481462 | x |
| Rural (Health Bureaus) | 0.0305348h. | 0.7659180h. |
| Other Localities | 0.0305348 | 0.7659180 |

If we take x as (0.00481462 x 0.7659180) $\div$ 0.0305348, we shall at least be consistent. We find x = 0.1207673.

As, for urban areas,

m (1-x) = 31.632 and f (1-x) (1-ax) = 25.540,

we get m = 35.977, f = 29.362.

For Upper Egypt, rural areas, we have h = 0.4361307 from the birth analysis, m (1-x) = 6.345, m (1-hx) = 32.129,

f (1-x) (1-ax) = 4.191, and f (1-hx) (1-ahx) = 21.751.

So x = 0.8780070, ax = 0.04234724, and so a = 0.04823110,

m = 52.011, f = 35.874.

For the Frontier Governorates, no similar method can be applied. Registration is probably poor, and might simply be taken as at the average level for the other rural areas without Health Bureaus. An unweighted average of Lower and Upper Egypt gives m = 108.674, f = 126.737. These values, however, seem extremely large.

*Calculations* (2) *Postneonatal.*

The methods have now been fully explained. We therefore merely give the results.

*Lower Egypt.* (Rural)

x = 0.2823124. m = 92.427.
ax = 0.1460297. f = 115.632.
a = 0.5172628.

*Lower Egypt.* (Urban)

x = 0.04451403. m = 84.909.
ax = 0.02302545. f = 100.041.
a = 0.5172628.

*Upper Egypt.* (Rural)

x = 0.6539075. m = 147.972.
ax = 0.1371551. f = 151.649.
a = 0.2097470.

*Upper Egypt.* (Urban)

x = 0.1341198. m = 134.631.
ax = 0.02813122. f = 156.791.
a = 0.2097470.

*Frontier Governorates* m = 100.105. f = 125.363.

## SUMMARY OF RESULTS

we now have the following estimated infant mortality rates For Egypt :

| | Meonatal | | Postneonatal | | Total | |
|---|---|---|---|---|---|---|
| | M. | F. | M. | F. | M. | F. |
| Urban Govs. | 33.568 | 28.170 | 107.972 | 121.153 | 141.540 | 149.323 |
| Lower Egypt Urban | 35.977 | 29.362 | 84.909 | 100.041 | 120.886 | 129.403 |
| Lower Egypt Rural | 41.819 | 34.548 | 92.427 | 115.632 | 134.246 | 150.180 |
| Upper Egypt Urban | 44.687 | 36.913 | 134.631 | 156.791 | 179.318 | 193.704 |
| Upper Egypt Rural | 52.011 | 35.874 | 147.972 | 151.649 | 199.983 | 187.523 |
| Frontier Govs. | 108.674 | 126.737 | 100.105 | 125.363 | 208.779 | 252.100 |

Urban areas generally fare better than rural, but this is mainly because of the lower neonatal mortality rates that they enjoy.

Reverting to the original births, the corresponding figures for estimated infant deaths in 1960 are :

| | Meonatal | | Postneonatal | |
|---|---|---|---|---|
| | Males | Females | Males | Females |
| Urban Governorates | 4,341 | 3,514 | 13,963 | 15.113 |
| Lower Egypt Urban | 1,764 | 1,389 | 4,163 | 4,732 |
| Lower Egypt Rural | 8,978 | 7,151 | 19,831 | 23,934 |
| Upper Egypt Urban | 1,712 | 1,364 | 5,159 | 5,795 |
| Upper Egypt Rural | 10,321 | 6,867 | 29,364 | 29,029 |
| Frontier Governorates | 606 | 682 | 558 | 675 |
| Total | 27.717 | 20,967 | 73,038 | 79,278 |
| % registered | 44.8 | 44.8 | 67.6 | 63.9 |
| Estimated mortality | 43.631 | 34.217 | 114.975 | 129.376 |

The male infant mortality rate is 158.606, and the female is 163.593. The combined rate for both sexes is 161.055 per thousand live births.

## DISCUSSION

The results, except for the neonatal deaths in the Frontier Governorates, seem quite probable. In all, we have estimated that in 1960 there were 201,000 infant deaths, whereas only 121,756 were registered, giving as excess of 79,244. The total of registered deaths in Egypt at all ages was only 437,822 in 1960, so that we would raise it to 517,066 for missed infant deaths alone. This in turn would imply that deaths were underregistered by at least 15.3 per cent.

A good deal of further work is needed to test the model to the full. The Urban Governorates are surely not complete in their neonatal death registration, for instance. One might test whether $y = ax$ is the best function to use, by trying other possibilities. We could subdivide the governorates further, and subdivide infant mortality further. The season of the year and the causes of infant deaths might similarly be studied.

Yet, after a certain point, such refinement must be in vain. The model can only be an approximation at best. Its purpose is to let us investigate the patterns of the birth rate, infant mortality, and registration completeness in a general way, and it will not carry us into great detail.

## SUMMARY

A model for underregistration of births in Egypt is developed, based upon the assumption of a constant true sex-ratio at birth. It shows that the highest birth rates are found in Upper Egypt, but the regional differences are quite small.

The model is then extended to a study of infant mortality. More than half the neonatal deaths (under 1 month of age) are found to be unregistered, and about a third of the postneonatal infant mortality is also not registered.

The estimated infant mortality rate for Egypt in 1960 is 161 per thousand live births, whereas the officially published figure was only 109. Upper Egypt had particularly high infant mortality after the first month of life.