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Correction of Age-Specific Migration Data for Mortality Risk : Methodology and Application

1. Introduction

THE need for accurate information on the level of migration rates at regional as well as at country level is well recognised. Multiregional population analysis, projections of subnational populations, study of population distribution over geographic regions, understanding the age-sex pattern of migration and such other exercises need migration rates.

Often migration rates are based on the information collected in a census or a survey, Tiie data obtained from these sources usually relate to, place of birth (FOB), place of last residence (PLR), and duration of residence (DOR) at the place of enumeration, Obviously migrants providing such data are the surviving migrants in the place of enumeration. From the time of migration to the date of enumeration, some of the migrants would have died after coming to the place of enumeration, some would have returned to their place of origin, and some others would have moved to another place during the interval. Also, the ages of the migrants at the time of Census (or survey) enumeration are not the same as their ages at the time of migration.

Heoce, migration rates calculated on the basis of enumeration (at a place other than FOB or PLR) without any adjustment, for mortality, return migration, remigration, and ageing, will be misleading. Corrections for return migration or remigration from census data are difficult but adjustment of the migration data for mortality risk and ageing is possible. The present investiga-

tion, accordingly, suggests a method for the same and illustrates its application to the data from the Indian Census of 1971.

2. Definitions and Assumptions

In this study we are interested in the estimation of out-migration rates. The literature on migration presents an ambivalent position with respect to the definition of migration rates (Haenszel, 1967; Tekse, 1975). Migration rates are not consistently defined and clearly distinguished like fertility or mortality rates. Spiegelman (1955), Hamilton (1965) and the United Nations (1970) have discussed the problem and have attempted to provide clearer definitions.

The calculations of any rate involve the number of events occurring during a given period in the numerator, and the population exposed to the risk (expressed in terms of the number of person-years lived by the population) during the concerned period in the denominator. Generally, the mid-year population is taken as the estimate of the number of person-years lived by a population during a given year. WilSekens (1982) has discussed the merits and demerits of using the initial population as the denominator, while Rees and Willekens (1981) have discussed the use of the person-years lived during the migration period

For the purpose of this study the age specif c migration rate is defined as the ratio of the number of migrants age *X* at the time of migration, during a given year to the mid-year population of age *X* in the sending area.

The assumptions involved in the proposed method are :

(1) Migrants depart uniformly during an interval of time V *(n* will be 5 or 10 years which is the intercensal period) so that together they experience the mortality of the destination area for half the period, on an average.
(2) Among the survivors of migrants in each age group enumerated in the census, the ages at arrival of half of them would have been in the previous age group and of the remaining half in the same age group.
(3) Migrants would experience the general mortality rates in the place of destination.

Similar assumptions are made while incorporating the migration component into the population growth models by Sivamurthy (1982; 18), Willekens^ and and Rogers (1978 : 56), Ramachandran (1980 : 35) among others.

3. Method for Correction of Mortality Risk

Let *Mij (x)* be the number of persons enumerated as aged *x* years, with duration of stay V years, (being the period of migration under consideration) in the *'jth'* area, whose previous place of residence (or birth place) is reported

as the '*i*th' area $P_i^t(x)$ is the population aged X years at time t in the '*i*th' area.

Then, the age-specific out-migration rate from i to j, can be defined as :

$$m_{ij}(x) = \frac{(M_{ij}(x)) \times 1000}{n/2\,(P_i^{t-n}(x) + P_i^t(x))} \qquad (1)$$

The total age specific out-migration rate for any region i, is therefore :

$$m_{i.}(x) = \sum_j m_{ij}(x) = \frac{\left(\sum_j M_{ij}(x)\right) \times 1000}{n/2\,(P_i^{t-n}(x) + P_i^t(x))} \qquad (2)$$

Now, the actual number of migrants from i to j moving during the 'n' years (5 or 10 usually) before the census enumeration would involve D_{ij} *(x),* the number of migrants who moved to j at age x and died in j before the date of enumeration *Rji(x),* the number of migrants who moved to j at age x, but moved back to i and $R_{jk}(x)$, the number of migrants who moved to j from i at age x and moved to some other place K before the date of enumeration, in addition to the surviving migrants who were enumerated as aged x or as aged $x + n$ (depending on their birth days).

Although, it is not possible to correct for *RJI (x)* and R*jk (x)* from census data, we may at least attempt to correct for D*ij (x)* and for the ageing of the population. For the sake of easy understanding, the formulae are presented in five year age groups and consider migrants with duration of stay as five years only. Also, the suffixes i and j are omitted with the explicit understanding that we are dealing with migration from i to *j*.

If we consider the migrants enumerated as aged (0-4) years with duration of stay (0-4) years, they must be the survivors of those who moved into the area *j* when they were aged (0-4) years. On the other hand, the migrants enumerated as aged (5-9) years with duration of stay (0-4) years might have moved into the area. *j* when they were aged (0 4) years, but are now aged (5-9) years, or might have moved when they were aged (5-9) years, and are still in the same age group. Since these two groups forming the enumerated migrants aged (5-9) years are not known separately, it is assumed that half of them would have come in the age group (0-4) years and the other half in the age group (5-9) years. A similar argument is used for alt the five year age groups. The last open ended age interval will involve a slight modified formula which is also based on the same reasoning. Thus, the following formula can easily be derived keeping in mind the assumptions (i) to (iii).

For the first age group (0-4), for instance let M' (0-4) be the actual number of migrants who migrated when they were aged (0-4). Then the number of

survivors at the end of the period, assuming that all of them migrated at exactly the beginning of the period, is :

M'(0-4) • S(O4)

On the other hand if we assume that all of them migrated at exactly the end of the period, the number of survivors will be : simply M' (0-4). Hence, from assumption (i) we have the number of survivors at the end of the period as :

1/2 *{M'* (0-4) + M' (0-4) • *S* (0-4)}.

Among these a portion *'h'* remain in the age group (0-4) and (1 — *h)* will be in the age group (5-9).

Thus we have :

h/2 *M'* (0-4) [1 + *S* (0-4)] = *M* (0-4) (3)

(1 - h) 1/2 M' (0-4) [1 + S (0-4)] = *h' M* (5-9) (4)

where *h'* is the proportion of migrants enumerated in the age group (5-9) who migrated when they were aged (0-4).

Now, from equations (3) and (4) we have

$$M'(0\text{-}4) = \frac{M(0\text{-}4) + h' M(5\text{-}9)}{\frac{1}{2}\{1 + S(0\text{-}4)\}}$$

Since we do not know the value of *h'*, we assume $h' = \frac{1}{2}$ and obtain

$$M'(0\text{-}4) = \frac{M(0\text{-}4) + \frac{1}{2} M(5\ 9)}{\frac{1}{2}\{1 + S(0\text{-}4)\}} \qquad (5)$$

For intermediate age groups it is

$$5 < x < (w - 5)$$

$$M'(x) = M_1(x) + M_2(x)$$

$$= \frac{M(x) + M(x + n)}{(1 + S(x))} \qquad (6)$$

where

$$M_1(x) = \frac{\frac{1}{2} M(x)}{\frac{1}{2}\{1 + S(x)\}} = \frac{M(x)}{\{1 + S(x)\}}$$

$$M_2(x) = \frac{\frac{1}{2} M(x+n)}{\frac{1}{2}\{1 + S(x)\}} = \frac{M(x+n)}{\{1 + S(x)\}}$$

For age group (25-29)

$$M'(25\text{-}29) = M_1(25\text{-}29) + M_2(25\text{-}29)$$

$$= \frac{M(25\text{-}29) + M(30\text{-}34)}{\{1 + S(25\text{-}29)\}}$$

Similarly for the last but one age group $(W - 5)$ it could be shown as

$$M'(w-5) = M_1(w-5) + M_2(w-5)$$

$$= \frac{M(w-5) + M(w)}{\{1 + S(w-5)\}}$$

For the last age group (w) which is open ended age group it is

$$M'(w+) = \frac{M(w+)}{\frac{1}{2}\{1 + S(w)\}} \qquad (7)$$

If the last age is 70+ then

$$M'(70+) = \frac{M(70+)}{\frac{1}{2}\{1 + S(70)\}}$$

For sufficiently large w the error due to this approximation is likely to be small. Where M' *(x)* is the actual estimated number of migrants in age group x from region i to j during the interval of n years.

S(x) is the survival ratio from age x *to* age $x + n$ in region j i.e. *Sj (x).*

One of the limitation of several migration studies is the assumption that the mortality level among the outmigrants and the inmigrants is the same—this assumption is made in the absence of detailed data, which is unlikely though not impossible (Elizaga, 1965; Zachariah, 1964). Zachariah, in his study of internal migration in the Indian subcontinent applied overall survival ratio computed for the country as a whole to the migrant population. He found

that the overall survival ratio may not be applicable to migrants due to following reasons :

1. Migrants have a mortality schedule different from the general population, and
2. migrants have age distribution different from that of the general population.

According to him both these factors are relevant but due to absence of direct information on them the researcher is compelled to assume that no differences exist in mortality of migrants and the general population. However, in this study, for each destination area, age-specific mortality rates have been used instead of overall survival ratio. There are many ways of considering mortality; one may consider the mortality at the destination or at the origin or their average. The differences on account of this may not be large as far as the final results are concerned, if the areas do not have very large differences in mortality.

4. Application of the Method to the Indian Case

For illustrating the application of the method, the inter-zonal migration data from 1971 census of India have been taken. Indian states are grouped into five zones as adopted by the census authorities which were also adopted by Nair (1982 : 3).

Zone	*States or Union Territories*
South	Andhra Pradesh, Karnataka, Kerala and Tamil Nadu
West	Gujarat and Maharashtra
North	Haryana, Punjab, Himachal Pradesh, Rajasthan, Jammu and Kashmir and Delhi
East	Assam, Orissa, Bihar and West Bengal
Central	Uttar Pradesh and Madhya Pradesh.

Information regarding the survival rates, migrants from zone *i to j* during the five years interval before the census which were needed for the application of the method were compiled from various sources; while the detailed migration data by age for the duration 1966-71, have been taken from Nair (1982), The survival rates were calculated from the life tables published by the Registrar General of India (1977). The total mid-period population (i.e., for the point of time 1968.5) was estimated by using the exponential growth rate formula which was distributed by age by assuming the population age distribution observed in the

1971 census for each zone.[1] The data used relates to the total population as the sex-wise distribution was not used by Nair. In the appendix the values of *M(x), S(x)* and *M'(x)* are presented as an example for selected age groups of South zone.

The age-specific out-migration rates without corrections for the mortality risk are presented in Table 1 and those with the mortality correction in Table 2. These are depicted in Figures 1 and 2 respectively. It may be observed that

TABLE 1—AGE-SPECIFIC REGIONAL OUTMIGRATION RATES (PER THOUSAND), INDIA, 1966-71

Age	*South*	*West*	*North*	*East*	*Central*	*India*[a]
0-4	0.43	0.68	0.95	0.23	0.68	0.53
5-9	0.62	0.93	1.39	0.44	1.07	0.82
10-14	0.51	0.77	1.33	0.48	1.12	0.78
15-19	1.11	1.48	2.92	1.09	3.14	1.83
20-24	1.94	2.31	4.83	1.80	5.28	3.05
25-29	1.61	1.89	3.56	1.39	3.81	2.33
30-34	1.15	1 46	2.65	1.12	2.76	1.74
35-39	0.71	0.95	1.89	0.72	1.57	1.07
40-44	0.63	0.89	1.50	0.61	1.29	0.92
45-49	0.50	0.76	1.30	0.44	0.96	0.71
50-54	0.42	0.67	1.09	0.42	0.76	0.62
55-59	0.41	0.63	1.06	0.36	0.73	0.57
60-64	0.37	0.65	0.78	0.26	0.51	0.46
65-69	0.29	0.58	0.56	0,21	0.39	0.36
70 +	0.25	0.63	1.05	0.26	0.56	0.47

SOURCE : P. S. Nair, India's Population : A multiregional Demographic Analysis (The Netherlands : Netherlands Interumversity Demographic Institute, Working Papers of NIDI, Working Paper No. 35,1982) p. 23(a).

[a] These rates are the weighted averages of the rates in the zones. These hold good for in-migrants as well since we consider India as a closed tystem for external migration.

1. Population by Zones were Projected from the year 1961 to 1968.5 using the zonal growth rates between 1961-71. The population figures f re taken from S. B. Mukherjee. *The Age Distribution of Indian Population* (Honolulu : East-West Center, East-West Populatiou Institute, 1976), pp. 69-70.

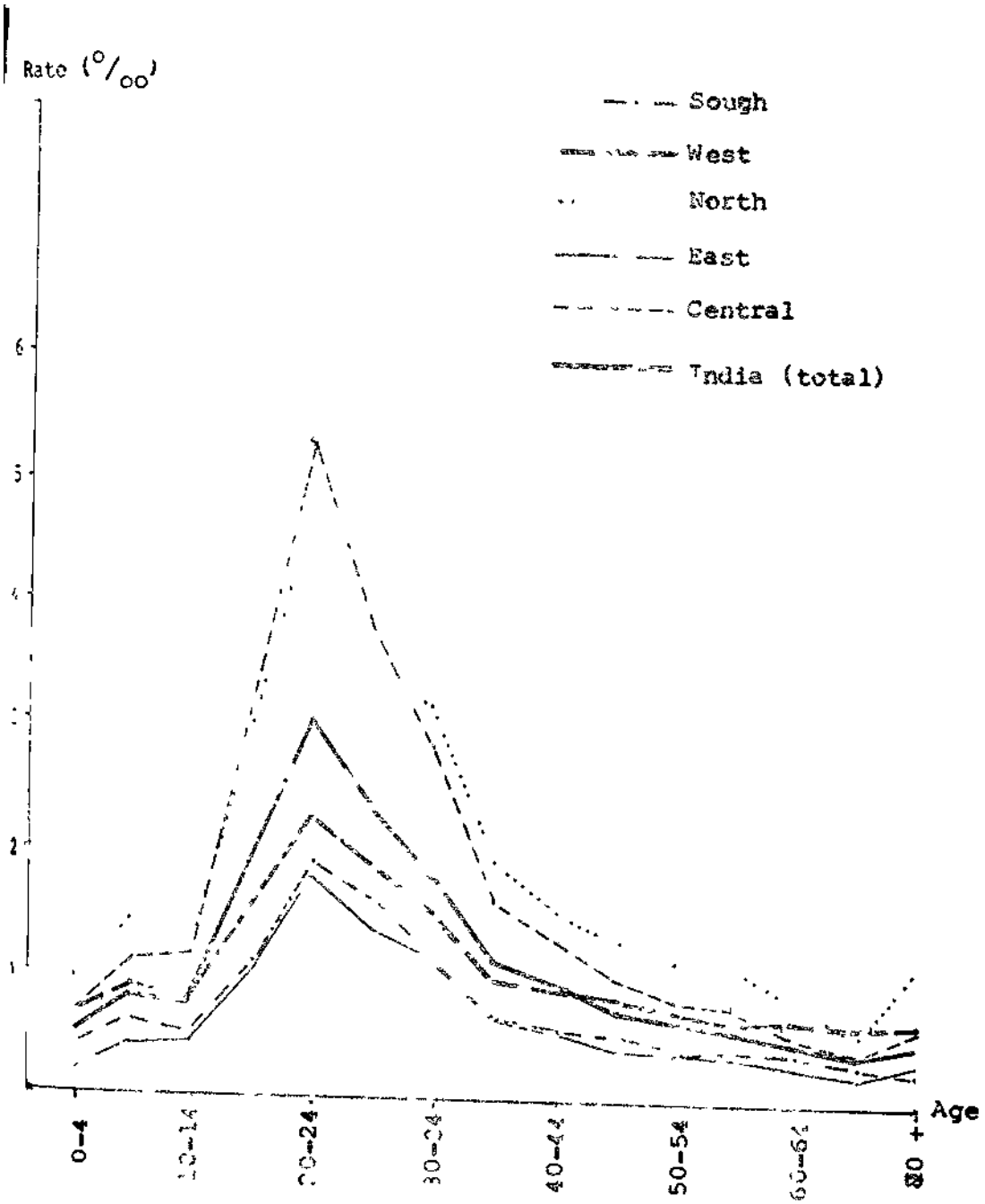

Fig. 1 Age Structure of Regional Outmigrants in India, 1961-1971 (Annual Average)

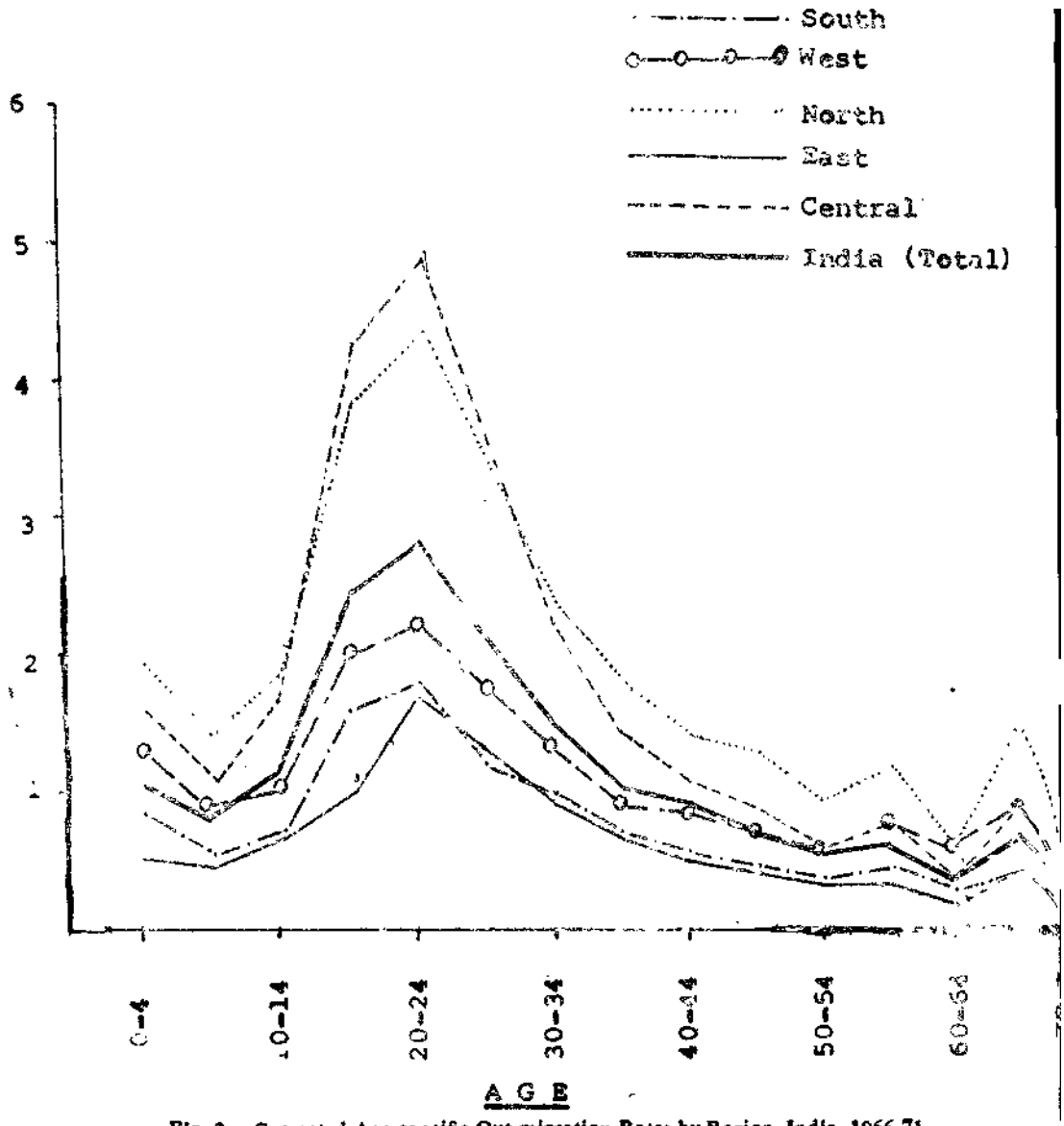

Fig. 2. Corrected Age-specific Out-migration Rates by Region, India, 1966-71.

TABLE 2-CORRECTED REGIONAL AGE SPECIFIC OUTMIGRATION RATES FOR MORTALITY RISK (PER THOUSAND), INDIA, 1966-71

Age	*South*	*West*	*North*	*East*	*Central*	*Total*
0-4	0.81	*1.28*	1.88	0.51	1.32	1.05
5-9	0.57	0.86	1.40	0.45	1.07	0.79
10-14	0.71	0.98	1.82	0.65	1.70	1.10
15-19	1.55	1.96	3.82	0.97	4.29	2.47
20-24	1.81	2.21	4.34	1.72	4.85	2.83
25-29	1.40	1.73	3.20	1.30	3.39	2.09
30-34	1.00	1.28	2.36	0.97	2.23	1.48
35-39	0.69	0.94	1.78	0.68	1.47	1.02
40-44	0.51	0.85	1.40	0.53	1 11	0.82
45-49	0.48	0.74	1.33	0.45	0.92	0.70
50-54	0.38	0.63	0.96	0.36	0.66	0.54
55-59	0.46	0.74	1.18	0.36	0.75	0.62
60-64	0.34	0.58	0.61	0.21	0.41	0.39
65-69	0.42	0.88	1.53	0.40	0.79	0.69
79 +	0.17	0.42	0.69	0.17	0.36	0.31

when the corrections are made, the out-migration rate decreases from age group (0-4) to (5-9) and increase! in the young adult ages, and gradually declines with only a slight increase in the old ages (Figure 2). Such a universal pattern and regularities have been observed in the migration schedules (Rogers *et al,* 1978: 2). Such a pattern is not depicted in Figure 1. The level of out-migration rate is low for children. It increases in the age group (5-9) and remains constant till (10-14). It reaches its peak in the age group (20-24) and decreases gradually. Again it increases in the last open ended age interval, which is not observed in any population. This reveals the importance of correcting the age-specific migration data for mortality risk.

Table 3 presents the summary of the out-migration rates for the zones. They arc 0 88 for South, 1.21 for West, 2 14 for North, 0.76 for East and 1.93 for Central The rate is highest for Northern region. It may be observed that the corrections for mortality risk effect increases in the rates to the extent of 7.82 percent (in Central zone) the 10.00 percent (in West zone).

TABLE 3— OUTMIGRATION RATES FOR REGIONS, 1966-71

Region	*With*	*Without**	*Difference in percentage*
	Correction for mortality		
(1)	(2)	*(3)*	*(4) =(2) - (3)/* (2) x *100*
South	0.88	0.81	8.64
West	1.21	1.10	10.00
North	2.14	1.95	9.74
East	0.76	0.70	8.57
Central	1.93	1.79	7.82
India	1.29	1.19	8.40

*SOURCE : Same as for Table 1.

5. Concluding Remarks

Corrections for mortality risk can be undertaken without much complications, and such corrections would increase even the over all out-migration rates to the extent of about 10 percent. The corrections in certain age groups will be even more. The age pattern of migration is also seen to change to some extent and shows the universal pattern when the interval of observation is wide, the chances of survival of the migrants decrease and hence the extent of underestimation increases. For smaller areal units (e.g., state or district) the difference between the corrected and uncorrected migration rates would be more pronounced not only because of greater number of migrants but also because of greater variations in mortality. Therefore, it may be argued that it would be worthwhile to make such corrections by age before the out-migration rates are used for other purposes like construction of multiregional life tables, projecting regional populations and studying spatial distribution of population of the country.

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APPENDIX

AGE DISTRIBUTION OF OUTMIGRANTS *(M_{ij} (x))* FROM SOUTH, INDIA, 1966-71

Age		*Migration from South to*					
	South	*West*	*North*	*East*	*Central*	*Total*	
0	0	28378	4385	3742	2963	39463	
5	0	39853	5807	7265	5834	58760	
10	0	26821	4868	6165	4823	42677	
15	0	43588	6612	8363	9640	68203	
20	0	73298	8911	12607	14857	109673	
		Survival Ratios *(S_i (x))*					
0	0.94421	0.93350	0.95611	0.89107	0.91858		
5	0 98459	0.56630	0.97412	0.96219	0.95440		
10	0.97801	0.97488	0.97632	0.98030	0.96732		
15	0.96963	0.97661	0.97114	0.98119	0.96698		
20	0.96336	0.97483	0.96705	0.97930	0.96325		
		Estimated number of outmigraats *M'_{ij} (x)*				Estimated mid year population	
0	0	49966	7452	7799	6129	71346	17537493
5	0	33908	5407	6844	5222	51181	18051036
10	0	35652	5808	7336	7352	56141	15829963
15	0	59134	7875	10584	12454	90014	11644588
20	0	65464	7756	12043	11886	97149	10733049