Discussion Paper Series

No.68

Contrasts in Vital Rates: Madras and Punjab in the Colonial Period

Osamu Saito and Mihoko Takahama
with Ryuichi Kaneko

January 2005

Hitotsubashi University Research Unit for Statistical Analysis in Social Sciences
A 21st-Century COE Program

Institute of Economic Research
Hitotsubashi University
Kunitachi, Tokyo, 186-8603 Japan
http://hi-stat.ier.hit-u.ac.jp/

Contrasts in Vital Rates: Madras and Punjab in the Colonial Period[*]

Osamu Saito and Mihoko Takahama[¶]

with

Ryuichi Kaneko[§]

Abstract It is well known that there have been persistent differences in demographic rates between northern and southern areas in post-independence India: in the north marital fertility is higher, infant mortality higher and life expectancy shorter than in the south. As Tim Dyson has shown for infant mortality, this probably has pre-independence origins. In this paper the post-WWII contrasts in demographic performances between north and south India will be traced back to the colonial period. By choosing Madras and Punjab, by selecting districts whose registration statistics are reasonably usable in each province (Madras: Coimbatore, Salem, North Arcot, South Arcot, and Tilnelvelli; Punjab: Gurdaspur, Jallundur, Amritsar, Hoshiarpur, Ferozepore, and Ambala, Karnal and Rohtak), and then by adopting W. Brass's relational Gompertz fertility model, logit life-table system and growth balance method, as exemplified by Dyson's seminal work on Berar, we estimate annual series of e_0 and TFR for both provinces. The series clearly show that even in the colonial period both fertility and mortality were higher in the north than in the south, which will have wider implications in historical contexts.

Introduction

This paper reports some of our first estimation results of an effort to reconstruct the history of population in two contrasting regions of the Indian sub-continent, Madras in the south and Punjab in the north. For this purpose, two tasks are to be done: to set out long-run series of estimated vital rates and to provide corresponding series of population statistics, i.e. population totals and their age compositions. It is well known that in the post-war southern provinces life expectancy at birth tends to be higher, infant mortality lower and the fertility transition smoother, whereas both mortality and fertility levels remain high in the north, and that the boundary lies along the line from the Chota Nagpur Plateau to the Satpura Range (Dyson and Moore 1983). One of our objectives is to see if such demographic contrasts can be traced back into the past as suggested by Tim Dyson in relation to infant and child mortality (Dyson 1997). For this, we need series of reliable estimates of vital rates for the colonial period. Most of previous efforts were made on a ten-year inter-censal basis. Ideally, however, such series should be annual so that we can reach a better understanding of

[*] Research, on which this paper is based, was funded by a three-year grant from the Japan Society for the Promotion of Science.
[¶] Both at the Institute of economic Research, Hitotsubashi University.
[§] National Institute of Population and Social Security Research.

short-term mortality crises, such as famines and epidemics, and their effects on the area's longer-run levels of mortality, on the one hand, and on changes in fertility, on the other. As is well known, vital registration was introduced in the late nineteenth century, which provide us with annual data series. And there is a pioneering work by Tim Dyson that exhibited how to utilise the registration data in the colonial period (Dyson 1989c, 1989d, 1991). However, not much has been done in exploring the use of such vital registration data with a couple of notable exceptions such as Monica Das Gupta's and Jose Antonio Ortega Osona's pieces (Dyson and Das Gupta 1997, Ortega Osona 2001). All these suggest that the registration data are reasonably usable for estimation, and that in most cases, it is important to work not with province-level but with district-level data since the degree of under-registration varied considerably across districts in any province.

So far four districts of the Berar area in the central and one district in the north, Ludhiana, have been examined by Dyson and Das Gupta to estimate both mortality and fertility measures (e_0 and TFR). Hence we would like to look at the south first. Then we will turn to a contrasting region where social, cultural and geographical circumstances surrounding the demographic sphere were almost diagonally different from the south, i.e. to districts in the north. In the following two sections, data and estimation methods will be briefly discussed, while the results will be presented in Section 3. Since mortality and fertility measures did not entirely move separately, we shall turn in Section 4 to a detailed examination of the interrelationships between the time-series of estimated e_0 and TFRs in each area. In the final section, implications of the findings will be discussed in relation to the issues concerning time trends in both mortality and fertility during India's pre-transition period. Such issues include whether or not mortality worsened in the late nineteenth and early twentieth centuries (there is some disagreement between MacAlpin 1985 and Visaria and Visaria 1983, on the one hand, and Davis 1951, ch.5, and Mari Bhat 1989, on the other; see also Dyson 1989b), and whether or not a 'pre-decline rise' in marital fertility, i.e. an increase in fertility before the onset of fertility decline in the mid-twentieth century, took place during the colonial period (Dyson and Murphy 1985).

1. Data: Source, Quality Evaluation and District Selection

The gist of Tim Dyson's approach in his pioneering work on Berar is to utilize annual series of vital registration records, together with information from census reports made in ten-year intervals. The vital statistics are taken from the Reports on the Sanitary Administration. The death registration started earlier than the births and marriage ones, aimed to control the epidemics, pandemics and hygiene environment, in particular among the people in the army, the prison, and later also in the society at large. Such registration data were not available on a national basis but is available on a regional basis; e.g. Central Provinces of Berar, Madras, Bombay, Bengal, North-Western Province, Punjab, Assam, Bihar and Coorg from 1867 onwards.

Province Selection: Madras and Punjab

There are several reasons to choose the provinces of Madras and Punjab. The availability of materials, data continuity and quality of data are obvious points to check. For these reasons princely states and areas under the so-called zamindar system should not be chosen. Moreover, it is interesting to examine two contrasting areas, one from the south and the other from the north.

Each local government attempted to improve the quality of registration data by issuing acts and regulations on the registration of vital events, by introducing penalty charges, and by taking surveys on under-registration when necessary. Some provinces enacted and amend the acts and regulations more frequently than others. These legislative efforts cannot be expected to result immediately in improvements in the accuracy of data, yet it is likely that completeness improved eventually. The registration reports were published annually, from 1864 in Madras and from 1867 onwards in Punjab. The earliest reported data on mortality for Madras was on death rates of the European army in 1858 and crude death rates in 1866 for Punjab, while on the number of births it was for 1869 in Madras and 1870 in Punjab. Unfortunately, those early reports provided merely the total numbers of events for the whole area, no break-down was made by district, age and sex. Thus we will focus on the period after 1881.[1]

Even within that period, there must have been some sort of under-registration. However, according to the post-Independence reports of *Vital Statistics of India*, in which the results of a survey of under-registration in birth and death records, the rates of under-registration for Madras and Punjab in 1961 were reasonably low: 9.6% and 13.7% for Madras's births and deaths, and 9.1% and 4.1% for Punjab's. These percentages were substantially lower than the figures for all India, i.e. 28.1% and 31.3% respectively.[2]

District Selection

Madras was one of the most rigorously administered provinces in the colonial period while Punjab was probably a little better than the 'average' provinces on this point. In fact, a close look at the Madras Presidency's registration data suggests that province-level aggregates may be reasonably utilised for estimation purposes. Thus, while there is no point using whole Punjab data, we are going to make separate estimates—as far as Madras is concerned—on both province-wide and select district data. What we have to do next, therefore, is to select districts whose quality of data is particularly good. This is because the coverage of vital registration in early years seems to have varied substantially across districts within each province.

In Madras, we focus on districts in present-day Tamil Nadu: Coimbatore, Salem, North Arcot, South Arcot and Tirunelveli are chosen as districts whose data were of particularly good quality. One criterion for this selection is the sex ratio of a district population and another are geographical consistency through time and district-level registration coverage. Of those chiefly Tamil speaking

---

1 The sources are: *Annual Administration Reports of the Sanitary Commission for Madras* for 1876-1920, *Annual Reports of the Director of Public Health, Madras* for 1921-1948, *Sanitary Administration Reports of Punjab* for 1867-1936, and *Annual Reports on the Sanitary Administration of Punjab* for 1937-1946.

2 *Vital Statistics of India 1961*, p.42 (XLII), Table 21(A). The 1961 tables are derived from the 1941-50 data. The figures for 1966 were somewhat higher than the 1961 ones, but the pattern remained the same: 13.5% and 13.6% in Madras, and 8.8% and 11.4% in Punjab, as against 47.5% and 41.5% for all India. *Vital Statistics of India 1966*, Statement 3, p.viii.

district populations, the less distorted the sex ratio of a recorded population, the less frequent the border change, and the smaller the affected area the better. Indeed, recorded sex ratios at birth in Madras, 1869-1948, are around 1.05 with a coefficient of variation, 0.0084, which implies that most of the observations fall in the normal range of sex ratios, 1.03-1.07. From 1897 to 1900, a village-level inspection was made by District Medical and Sanitary Officers. According to tables published the proportion of 'towns and villages inspected and reports received' varied considerably, which may be interpreted as showing varying rates of under-registration across the districts.[3] The district of Madras is not included in the list for heavy town-ward migration could be a source of inaccuracy.

The task of selecting districts is rather difficult for Punjab. First, the sex ratio seems to have been more skewed than in Madras. The average level of recorded sex ratios for 1885-1946 was higher for Punjab and its coefficient of variation greater (1.104 and 0.018 respectively). Second, migration was probably more frequent in Punjab than in Madras. In the period before 1920 especially, a number of development projects undertaken in this region made a substantial proportion of the population on the move. Moreover, princely states and municipalities were intertwined with districts under British rule and district border changes took place more often than in Madras. Judging from subsequent lists of census districts and maps from 1868 up to the present, these border changes were particularly numerous in the nineteenth century and the period immediately after independence. The partition of the nation not only divided Punjab geographically and politically, but also altered the religious and demographic composition of each of the divided halves drastically. Muslim population had occupied more than 50% of the population of most of the districts in today's Indian Punjab and Haryana in both 1931 and 1941, but the proportion became 2%.[4] However, it is worth noting here that there were only a few border changes between 1920 and 1941.

Another way to check the completeness of death registration is to employ the Growth Balance Method. This method, developed by William Brass, is applicable to a stable or at least quasi-stable population, from which indices of completeness of registration for mortality estimation, and corresponding correction factors can be calculated (UN 1983, pp.139-146). When applied to both Madras and Punjab data, it turns out that the method is applicable to the former but not to the latter. While for the Madras the average completeness of registration from 1891 to 1947 is 66.4% for males and 74.1% for females respectively (especially for the 1904-1945 period it goes up to 72.3% and 80.2%), the calculation for Punjab suggests an unfeasible range of 3.6 to 230 %. This implies that the Punjab population cannot be considered even a quasi-stable population, and that migration was very frequent.

---

[3] *Annual Reports of the Sanitary Commission*, from 1897 to 1900, include 'Statements showing the Number of Towns and Villages inspected by the District Medical and Sanitary Officers', according to which the percentage covered varied considerably from district to district. The highest average over the four-year period was 95.2 % for Tinnevelly and the lowest 19.5 % for Chingleput, with the mean percentage being 59.1%.

[4] To be exact, Gurgaon could be an exception that the proportion of Muslim population was approximately 33% in 1931 and 1941, it decreased to about 17%, whilst most of other districts demonstrate less than 1%.

For Punjab districts, therefore, a check may be made with respect to the population aged one. This is to compare the census's age-one population with a hypothetical age-one population calculated from the number of registered births by applying a life table function p_0 (probability of survival) for each district.[5] According to the results of this calculation for all districts of present-day Himachal Pradesh, Punjab and Haryana for 1891-1947, the male and female populations estimated from registration data are larger than the corresponding census populations by 24% and 19% respectively. The differences are not negligible, but they are not particularly bad either. A close look at annual figures suggests that the period from 1903 to 1928 are reasonably good. Also suggestive is a district break-down. In present-day Himachal Pradesh, Simla and Kangra have very low discrepancy ratios, while Haryana's Gurgaon and Delhi exhibit show exceptionally high ratios. The latter two, therefore, should be rejected for this reason. Even for Simla and Kangra, however, their annual fluctuations turne out to have been too great, probably due to their small population size and location in the mountainous area, so that we cannot take them in either. Other districts are generally regarded as usable. Finally, by taking all the other information such as border changes into account, eight out of the remaining twelve districts of present-day Indian Punjab and Haryana, i.e. Gurdaspur, Jallundur, Amritsar, Hoshiarpur, and Ferozepore, *plus* Ambala, Karnal and Rohtak, are chosen for estimation. Note that Ludhiana was not selected against those criteria.

2. Data Processing and Estimation Methods Employed

The estimation methods employed in this article are Brass's indirect techniques (UN 1983). The essential data for that type of estimation are the age-, sex- and district-specific data. From the census reports, such population data are generally available. However, the classification of age groups did not remain constant throughout the period and at district level the grouping tended larger than at province level. All the data used here are standardized on the basis of single or five-year age groups by using provincial age-group distributions and the last age group is lumped together for 60 years old and over. Concerning inter-censal populations, simple interpolation is applied assuming that the population of each sex-age group grew at the same inter-censal rate.[6] The numbers of deaths by age, sex and district are available from the registration reports. In the death statistics, however, since the grouping of age 20 and upwards was not on the five-year basis, the figures are allocated according to the age structure of deaths for each sex obtained by polynominal estimation. The number of births is available by sex, but not by the age of mother. The allocation of births is made according to the assumed age structure derived from the general standard of Gompertz fertility model.

---

[5] One-year-old population from vital registration at *x* year: $P_{(x)}$ = {[$N_{(x\text{-}2)}$ * $p_{0\,(x\text{-}2)}$ * (305/365)] * $p_{0(x\text{-}1)}$ + [$N_{(x\text{-}1)}$ * $p_{0(x\text{-}1)}$ * (60-365)]} * $p_{0(x)}$, where $N_{(x\text{-a})}$ is the births of *a* year prior to *x* year; $p_{0(x\text{-}a)}$ is the probability of survive of *a* year prior to *x* year.

[6] This could cause a bias in the estimated population totals if a mortality crisis occurred in between. In order to assure ourselves that such a bias was not serious, a check was made for such a period, i.e. 1911-21, during which was the outbreak of the Spanish Flu. By estimating excess influenza deaths based on monthly 'fever' death patterns derived from cause-of-death data for 1900-20, the number of excess deaths was subtracted from each interpolated population total from 1918 on. However, the results from this adjustment showed that the difference, for example, with Madras's male life expectancy at birth without influenza adjustment was marginal: -0.12 years for 1918 and 0.05 years for 1919.

There remains one hitherto overlooked source of inaccuracy, however. Mari Bhat has demonstrated that there is a persistent tendency for South Indian adults to misreport their ages upward, hence that the proportions of older age groups in census reports are likely to be inflated (Mari Bhat 1995). Such an upward bias in age reporting cannot be removed by conventional methods of correction, and will overstate the level of any life expectancy estimates derived from Indian data. Since age exaggeration seems greater among males than females, sex differentials in life expectancy are also likely to be biased, although it is not unlikely that such an upward bias does not vary greatly across regions. In other words, it is regional comparisons that can be comparatively robust.[7]

Life expectancy at birth

For the application of Brass's Logit Life-Table System,

$$STD\left(l_x^s\right) = \frac{\sum_{k=t}^{t+a} Logit(l_x^k)}{a+1} = \frac{\sum_{k=t}^{t+a} \left[0.5 \ln \frac{(1-l_x^k)}{l_x^k} \right]}{a+1}$$

Note: t denotes the start year, $t+a$ the end year, and l_x^k the survived population of age at x in year k.

an appropriate standard is to be chosen. Two approaches are tried: one employs model life tables and the other attempts to construct an original standard which would represent the mortality pattern of a region. After trials and errors with Coale and Demeny model life tables (i.e. West level 10 for males and level 9 for females, Madras, level 7 for males and level 6 for females, Punjab respectively), it turns out that life tables obtained from each region's mortality experiences exhibit a better fit. For Madras two periods are selected, i.e. 1904-1945 and 1924-1939, while for Punjab the 1921-1937 period is used. For these calculations, data are taken from a slightly larger group of districts for each province: eight districts for Madras and eleven districts (five from present-day Haryana and six from Indian Punjab) for Punjab. The results are set out in Appendix table 1.

Total fertility rate

In order to estimate the TFRs age-specific female populations in the reproductive period and the number of births by the age of mother are required. Unfortunately the latter is not available from the reports. Thus, an assumption is made that the age pattern of births followed the distribution of a general standard used in Brass's Gompertz Model, and the cumulative age specific fertility rate is targeted to fit the standard. To estimate α and β, the group average method is used instead of the least square method.

3. Results

The resultant annual series of e_0 and TFR for Madras and Punjab are reported in Appendix table 2.

7 We would like to thank Dr P.N. Mari Bhat for drawing our attention to this problem of age misreporting in South Asia.

Their decade averages are set out in Tables 1 and 2 and their annual series in Figures 1 and 2, with Berar included for comparison. Before going over the estimated results for both Madras and Punjab, however, it is worth having a quick look at two separate estimates for Madras. In Tables 1 and 2 as well as Figures 1 and 2, the e_0 and TFR series for all twelve districts in present-day Tamil Nadu are compared with the series for five select districts. From these it is apparent that the levels of e_0 estimates in the twelve-district series are substantially lower than those in the five-district select series, and that the gap widened over time. Differences for TFR are less apparent, but the gap in the late 1920s and early 30s is not small. The reason why there are such wide differences is not entirely clear. It is likely that this could partially be explained by migration effects since the five districts were inland and distanced from the province's urban centre. Also likely is that the select group of districts picked up areas comparatively unaffected by famines. It is not unlikely either that the inclusion of districts, whose data are considered less reliable than the select group's, especially that of the urban district of Madras led to the underenumeration of total deaths and births. Whichever the real reason, the select-district series of longer life expectancy, as we will see below, highlights the characteristic features of the southern demographic regime.

From these tables and graphs, it is possible to make several observations. Firstly, there did exist north-south contrasts. Decade averages in Tables 1 and 2 show that in the southern province of Madras, the general level of life expectancy derived from the five-district sample, close to 40 years even in the late eighteenth and early nineteenth centuries, was substantially higher than in Berar and Punjab, and that of TFR, in the range of 3.5-4.3 during the same period, was lower than in those two provinces located north of the Chota Nagpur-Satpura line (geographically Berar is right in central India, but this province should probably be regarded as belonging to the northern demographic regime). This conclusion holds even if an alternative, twelve-district set of Madras estimates (e_0 substantially lower and TFR somewhat higher than the five-district estimates) is compared with Berar and Punjab, although their differences with the two northern provinces are curtailed. In the colonial past too, therefore, both mortality and natural fertility were higher in the north than in the south.

Secondly, there are some noticeable features with respect to gender differences in life expectancy at birth. According to Table 1, females' life expectancy was lower than males' in the northern province of Punjab throughout the period in question. In the all Madras and Berar series, in contrast, the female advantage was evident over the same period. In the select Madras series the female level was higher for the period before 1920, but since then the male level tended to exceed the female one. From these overall observations, on the face of it, it seems difficult to draw a clear north-south demarcation. However, it should be remembered that the aforementioned tendency for males to exaggerate their ages more than for females makes the interpretation of those results rather difficult. Moreover, a closer look at excess female mortality in all the annual series reveals a sharp north-south divide. Figures 3 and 4 show scatter diagrams with respect to the level of life expectancy (expressed as the average of male and female values) and the male-female difference in life expectancy for the five-district sample of Madras and Punjab. Scatters in Figure 3 come closer to the right (with the exception of the Flu year of 1918) and those in Figure 4 to the left, indicating the clear regional difference in the level of e_0. More interesting, however, is that the relationship between the two in the Madras graph is upward-sloping, especially in the area where life expectancy was comparatively low, whereas it is downwardly sloped in the case of Punjab. This finding suggests that by regressing the male-female difference in e_0 in a given year on the average of male and female life expectancies in the same year, it is probably possible to determine whether or not a mortality crisis was associated with excess female mortality *regardless* of the general levels of both male and female life expectancies. The summary results of this exercise, reported in Table 3, clearly show that in both Berar and Punjab such an association existed. The regression coefficients for the two provinces take negative values, i.e. the lower the e_0 level the greater the male-female difference in e_0. In contrast, the sign of the coefficient is positive for both cases of Madras: males' advantage over females was associated with a higher level of life expectancy. Although it is not immediately apparent why Madras males extended their life expectancy more than females in the period after 1920 when mortality conditions were improving, the contrast with the northern provinces of Berar and Punjab is unambiguously clear.

Thirdly, fluctuations in e_0 were extremely wild in the northern provinces of Berar and Punjab until 1920. As widely recognised, most, if not all, of the sharp downward spikes were mortality crises triggered by famine, but what characterises Berar's and Punjab's graphs of e_0 is that most of such mortality crises were followed by equally sharp upward spikes. On the other hand, the Madras curve for e_0 was neither jerky nor spiky. Short-term drops in e_0 during the first three decades were much less dramatic than in the north. The only exception was the 1918 one, a mortality crisis caused by the influenza pandemic, suggesting that the impact of famines was generally much less serious in Madras than in Berar and Punjab.[8] After about 1920, the attenuation of mortality fluctuations became apparent. For some reason that tendency was less clear in Berar, but the fluctuation of e_0 became clearly attenuated in both Berar and Punjab.

Finally, long-term trends in the total fertility rate are, on the face of it, less clear-cut. While there is neither an upward nor a downward trend for Berar, its lowness in the levels observed for the 1940s in both Madras and Punjab is a little puzzling (though the existence of missing years makes it difficult to determine the trend over the period). As far as Madras and Punjab are concerned, however, despite the wide gap in TFR between the two provinces, the overall tendency was unmistakably on the increase. In Punjab the TFR level in the 1880s was below 6 but it came to close to 7 in the 1930s, while in the select group of Madras districts the increase was from 3.5 to 5 over the same period. Since there is no evidence that there occurred a significant change in nuptiality during this period,[9] this finding about TFR may be taken to imply that a 'pre-decline rise' in marital fertility was on the way during the late colonial period.

4. Mortality-fertility correlations

It is well known that during famine years peaks in the death rate were followed by a drop in the birth rate (see Dyson and Ó Gráda 2002a). On the face of it, this suggests that the drop in fertility was caused solely by excess famine mortality. However, Tim Dyson's detailed analysis of late

---

[8] A close look at monthly statistics of deaths from the 1918 influenza reveals that both the timing of outbreak and pattern of lingering effects varied across provinces and districts, reflecting army camp location, and differences in density and mobility of the population. All these must have had differential impacts on the local population.

[9] During this period, a legislative effort was made to curb child marriage. But the 1929 Act of Child Marriage Restraint is said to have been ineffective.

nineteenth-century Indian famines showed that the actual processes were far more complicated (Dyson 1991, Maharatna 1996). It was conceptions that responded to crop failure first, well before the number of deaths started increasing, and this initial decline in conceptions was compounded by conception-reducing effects of excess famine mortality observed almost one full year after the initial harvest failure. The conception-reducing effects of high mortality must have included not only those caused by famine stress, but by delayed marriage and widowhood as well. Take the 1899-1900 famine, for example. The failure of the monsoon in 1899 caused a steep rise in food prices and a reduction in conceptions during the latter half of the year. At that time the death rate remained normal. However, with the resumption of the monsoon in 1900 the death rate suddenly started rising, while the conceptions had still been declining. Thus the mortality rate peaked in 1900, which coincided with the minimum occurrence of conceptions during the famine years. As birth occurs nine months after conception, it means that it was from mid-1900 on that the birth rate started declining, with the largest drop in births in the following calendar year. It is this process that produced a pattern of a lagged reduction in fertility during the famine period.

All this leads us to expect that the one-year lagged response of TFR to a fluctuation in e_0 was universal. However, the effects of famine on fertility may have stayed longer depending on how serious the fertility-reducing effect of a particular famine could be, while it is widely observed that there was a short-term rebound in the birth rate some time after the famine (Dyson and Ó Gráda 2002b). It is interesting, therefore, to conduct a multiple regression analysis in order to examine how an estimated TFR was correlated with e_0 in the previous year, i.e. t-1, and in t-2, … t-n, for Madras, Berar and Punjab respectively. By setting n at 5, we will regress TFR on e_0 in t-1, i.e. $e_0(t\text{-}1)$ and $e_0(t\text{-}2)…e_0(t\text{-}5)$ for each of the four cases. It is expected that in t-1, the regression coefficient of $e_0(t\text{-}1)$ would take a positive sign, while in the case of $e_0(t\text{-}2)…e_0(t\text{-}5)$, the sign of coefficient could turn to a negative value if the rebound effect would exceed a prolonged fertility-reducing effect of famine.

Two alternative sets of regression will be conducted on male and female life expectancy, respectively, for the period 1890-1940 within which there is no missing year in any of the data series concerned. The results of such multiple regression exercises are set out in Table 4. Before taking a close look at the estimated coefficients of $e_0(t\text{-}n)$, it is worth noting, first, that the level of the 'constant', which measures a TFR component unaffected by changing $e_0(t\text{-}n)$, was high in the north. The level was over five in both Berar and Punjab whereas in the south it was either very low or returned as statistically insignificant.[10] This sharp contrast is not inconsistent with the supposition that *natural* fertility was comparatively high in the north even in the colonial period. Second, the choice of male or female life expectancy seems to have little effect on the performance of regressions. Again, this is not inconsistent with the suggestion that the direct impact of crop failure had more to do with the reduction in conceptions than the death of parents that occurred later when the monsoon returned. Third, the overall fitness for the 12-district series of Madras is very weak. Although it is difficult to know exactly what the cause for this poor result was, it is not unlikely that the inclusion of a district where the frequency of migration was high disturbed the relationships between observed mortality and fertility measures. The examination of the regression

[10] Its negative sign looks a little odd, but that fact should not be given much significance. What is really important with the Berar and Punjab results is their high levels.

results below will therefore focus on those derived from the select series of Madras.

Turning to the second row in each panel of Table 4, it is clear that the coefficients of $e_0(t\text{-}1)$, all positive, are estimated as statistically significant in the six columns concerned (although the level of significance varies from case to case). The estimated coefficients fall within a range of 0.035-0.075, in which Madras was on the higher and Berar and Punjab on the lower side. This on the face of it may seem inconsistent with Table 2 above, where the fluctuations in TFR were much greater in Berar and Punjab. However, given the observed gap in the level of e_0 between north and south, a ten-point drop in e_0, not uncommon in late-nineteenth-century Punjab, would resulted in a 0.5 decline in the level of next year's TFR, while a three-point drop in e_0, a magnitude observed for Madras in the same period, would mean just a 0.2 decline in next year's TFR, suggesting much milder fluctuations of TFR in Madras. At any rate it is worth reiterating that the fertility-reducing effect of famine was felt, with a one-year time lag, across the sub-continent.

As for the effects of $e_0(t\text{-}2)\ldots e_0(t\text{-}5)$, however, there emerge a little more pronounced differences between Madras, on the one hand, and Berar and Punjab, on the other. Given the likelihood that they would reflect a net effect of prolonged reduction in conceptions and a rebound of fertility, it is interesting to note that in Madras none of $e_0(t\text{-}2)\ldots e_0(t\text{-}5)$ had a statistically significant relation with TFR, while in Berar and Punjab, the only case in which the coefficient is estimated significantly is a negative effect was discernible for $e_0(t\text{-}5)$. This latter negative coefficient implies that in year t-5 the fertility rebound outweighed any prolonged negative effect of famine, suggesting that in the northern provinces there was an inherent tendency to keep fertility high. It must have been one factor explaining why there were so many post-famine upward spikes on the TFR curve in both Berar and Punjab.

5. Implications

The foregoing results are inevitably tentative. However, some of the findings may be suggestive for general interpretations of the population history of modern India.

Firstly, it is demonstrated that we can trace the north-south demographic divide back to the colonial past. Both fertility and mortality rates were comparatively lower in Madras than in the northern provinces of Berar and Punjab. More marked was the degree of mortality fluctuations in earlier years, which was much greater in the latter provinces. Undoubtedly the demographic impact of famines was harder in the north than in the south. Furthermore, there was a clear tendency for excess female mortality to increase in times of such mortality crisis in Berar and Punjab. This latter finding about gender differences, which are regarded as reflecting social norms concerning son preference and prejudice against daughters, suggests that it was in the northern societies where such norms had been embedded from historic periods, and that it was in years of mortality crisis when the effect of those gender-biased practices was felt particularly strongly. In the north, the severer the crisis the greater the excess female mortality.

Secondly, there was a clear indication of worsening mortality in the first half of the period in question in both central and northern India. Having looked at annual estimates of life expectancy during the first decade of the twentieth century in particular, one may notice that it was the worst decade in the history of mortality of the two provinces since 1881. The worsening trend was particularly pronounced in both Berar and Punjab. Even in Madras, where mortality was generally on the increase and its levels lower than in northern provinces, life expectancy tended to decline until 1908. This finding casts doubt upon some of the previous mortality estimates for all India in the pre-1920 period. Most of those estimates indicated that the 1901-11 period was a peak in the series of life expectancy at birth before 1921. A region-specific table for life expectancy reported in Leela and Pravin Vissaria does show some regional variations. In the north, life expectancy was lower for both sexes than in any other periods; however, their suggested overall pattern for the whole country was for life expectancy to increase from 1891-1901 to 1901-1911 (Vissaria and Vissaria 1983). Our estimates for the northern, central and southern provinces strongly suggest that it did not: life expectancy at birth must have worsened during the 1891-1911 period in many parts of the Indian sub-continent as Mari Bhat and Dyson suggested (Mari Bhat 1989, Dyson 1989b).

Thirdly, our estimates have shown that mortality situations improved in the period after 1920 in both Madras and Punjab. Mortality rates declined although, if the aforementioned inherent tendency for adults to misreport their ages upward improved even in the colonial period, the observed degree of improvement in life expectancy at birth may have been somewhat overstated). More certain is that its fluctuation became less volatile in the 1920s and 30s compared with the pre-1920 period. It is demonstrated that mortality crises in late nineteenth- and early twentieth-century Madras were much less serious than in the northern provinces, but even there occurred an attenuation of mortality fluctuations. This confirms what the previous estimates (such as Ortega Osona 2001) suggested.

Finally, over the entire period in question, our estimates of TFR exhibited an increasing, rather than decreasing trend. This may be taken to imply that there was a ‘pre-transition rise in fertility’ during the pre-World War II period in both Madras and Punjab. Our regression analysis of the relationships between the annual series of life expectancy at birth and the total fertility rate has suggested that such changes in fertility were conditioned by mortality situations. Famine mortality reduced the next year’s fertility. Despite the observed regional differences in the magnitude of mortality fluctuations, its impact was felt right across the areas examined. By implication, therefore, the reduction in the number of severe mortality crises or the attenuation of mortality fluctuation, or both, must have a positive effect on the level of fertility in both northern and southern regions. Indeed, all this was what actually happened in the period after 1920 in the Indian sub-continent generally, suggesting that mortality decline was a component of the ‘pre-decline rise’ in fertility in the Indian case.

References

Davis, K. (1951). *The Population of India and Pakistan*. New Jersey: Princeton University Press.

Dyson, T., ed. (1989a). *India's Historical Demography: Studies in Famine, Disease and Society*. London: Curzon Press.

Dyson, T. (1989b). 'Indian historical demography: developments and prospects', in Dyson (1989a).

Dyson, T. (1989c). 'The Historical Demography of Berar 1881-1980', in Dyson (1989a).

Dyson, T. (1989d). 'The population history of Berar since 1881 and its potential wider significance', *Indian Economic and Social History Review*, vol.26, pp.167-201.

Dyson, T. (1991). 'On the demography of South Asian famines. Parts I-II', *Population Studies*, Vol.45, pp.5-25, 279-297.

Dyson, T. (1997). 'Infant and child mortality in the Indian subcontinent', in A. Bideau, B. Desjardins, and H.P. Brignoli, eds., *Infant and Child Mortality in the Past*. Oxford: Oxford University Press.

Dyson, T. and M. Das Gupta (2001) 'Demographic trends in Ludhiana district, Punjab, 1881-1981: an exploration of vital registration data in colonial India', in Liu (2001).

Dyson, T. and M. Moore (1983). 'On kinship structure, female authority, and demographic behavior in India', *Population and Development Review*, vol.9, pp.35-60.

Dyson, T. and M. Murphy (1985). 'The onset of fertility transition', *Population and Development Review*, vol.11, pp.399-440.

Dyson, T. and C. Ó Gráda (2002a). Famine Demography: Perspectives from the Past and Present. Oxford: Oxford University Press.

Dyson, T. and C. Ó Gráda (2002b). 'Introduction', in Dyson and Ó Gráda (2002a).

Liu, T.-J., et al., eds. (2001). *Asian Population History*. Oxford: Oxford University Press.

McAlpin, M.B. (1985). 'Famines, epidemics, and population growth: the case of India', in R.I. Rotberg and T.K. Rabb, eds., *Hunger and History: The Impact of Changing Food Production and Consumption Patterns on Society*. Cambridge: Cambridge University Press.

Maharatna, A. (1996). *The Demography of Famine: An Indian Historical Perspective*. New Delhi: Oxford University Press.

Mari Bhat, P.N. (1989). 'Mortality and fertility in India, 1881-1961: a reassessment', in Dyson (1989a).

Mari Bhat, P.N. (1995). 'Age misreporting and its impact on adult mortality estimates in South Asia', *Demography India*, vol.24, pp.59-80.

Ortega Osona, J.A. (2001) 'The attenuation of mortality fluctuations in British Punjab and Bengal, 1870-1947', in Liu (2001).

United Nations (1983), *Manual X, Indirect Techniques for Demographic Estimation*, New York: United Nations.

Vissaria, L. and P. Vissaria (1983). 'Population (1757-1947)', in D. Kumar, ed., *The Cambridge Economic History of India*, vol.2: *c.1757-c.1970*. Cambridge: Cambridge University Press.

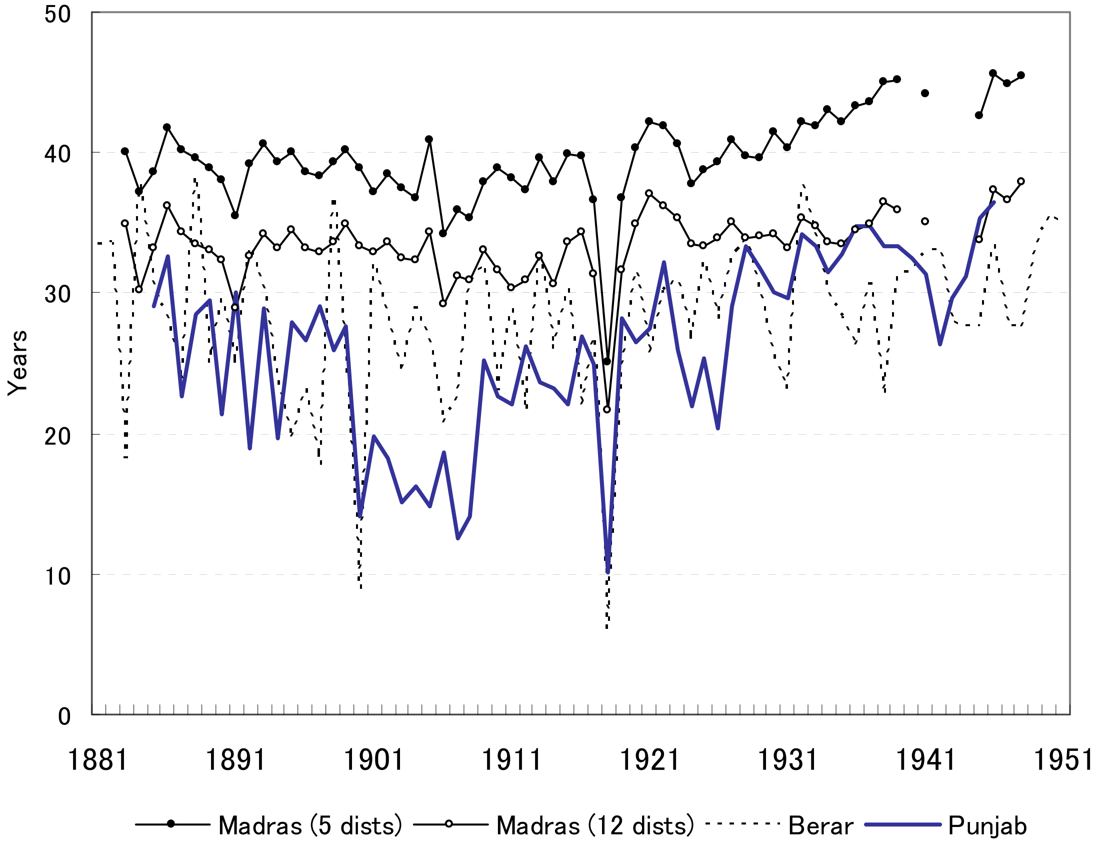
Table 1 Life Expectancy at Birth: Decade Averages

		1881-1890	1891-1900	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950
Madras								
5 dists	M	38.8*	38.5	36.9	36.9	40.6	43.6¶	44.6**
	F	39.8*	39.5	37.7	37.3	39.8	42.3¶	44.4**
12 dists	M	32.8*	32.5	31.5	30.8	34.4	34.7	36.0**
	F	34.1*	33.7	32.7	31.6	34.8	34.7	36.2**
Berar	M	29.5	23.8	26.4	24.0	28.5	29.0	30.2
	F	30.1	25.0	27.6	26.2	30.7	30.2	31.2
Punjab	M	27.7‡	25.9	19.2	24.4	28.2	33.8¶	33.8§
	F	26.9‡	23.9	16.3	22.4	27.3	32.3¶	29.6§

Source: Appendix table 2, and Dyson (1989c).

* Average for 1883-1890. ¶ Average for 1931-1939. ** Average for 1941 and 1945-1948.
‡ Average for 1885-1890. § Average for 1941-46.

Figure 1 Annual Life Expectancies at Birth for Madras, Berar and Punjab



Source: Appendix table 2, and Dyson (1989c). Both sexes are combined.

Table 2 **Total Fertility Rates: Decade Averages**

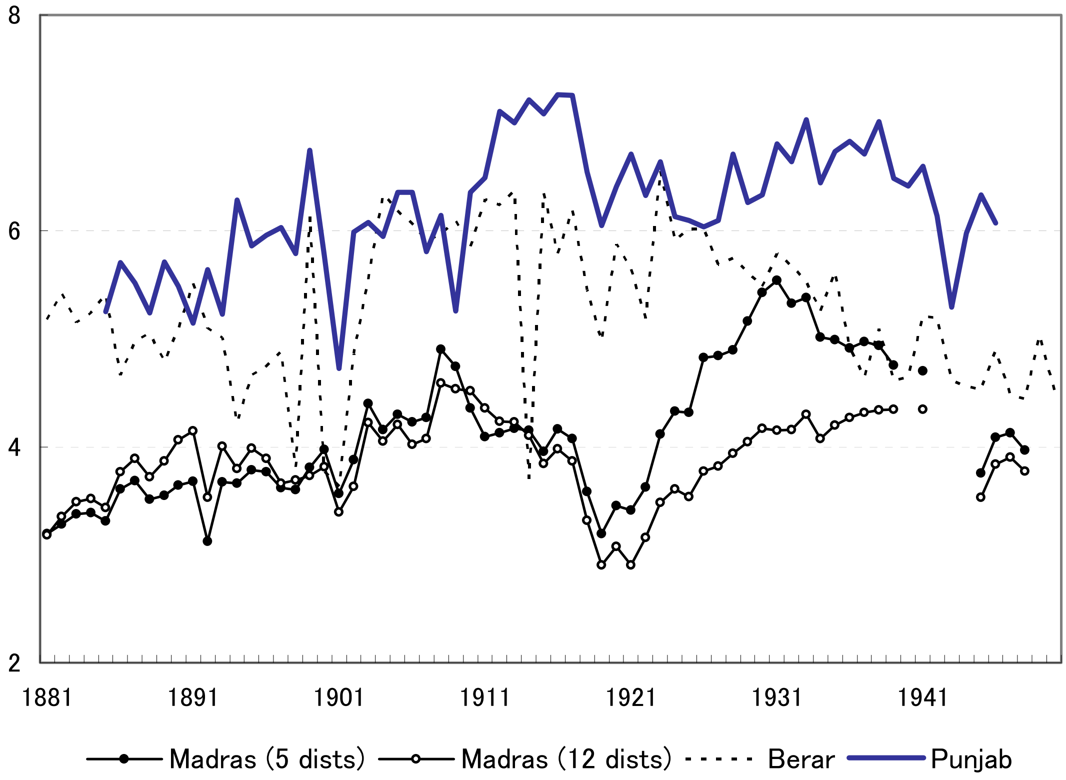
	1881-1890	1891-1900	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950
Madras							
5 dists	3.46	3.67	4.28	3.90	4.50	5.09¶	4.13**
12 dists	3.63	3.83	4.12	3.79	3.64	4.24¶	3.88**
Berar	5.10	4.78	5.64	5.72	5.79	5.18	4.67
Punjab	5.49*	5.85	5.90	6.84	6.33	6.71¶	6.07‡

Source: Appendix table 2, and Dyson (1989c).

* Average for 1885-1890. ¶Average for 1931-1939. ** Average for 1941 and 1945-1948.
‡ Average for 1941-46.

Madras: Coimbatore, Salem, North Arcot, South Arcot, and Tilnelvelli
Berar: Amraoti, Akola, Buldana and Yetmal
Punjab: Gurdaspur, Jallundur, Amritsar, Hoshiarpur, Ferozepore, Ambala, Karnal and Rohtak

Figure 2 Annual Total Fertility Rates for Madras, Berar and Punjab

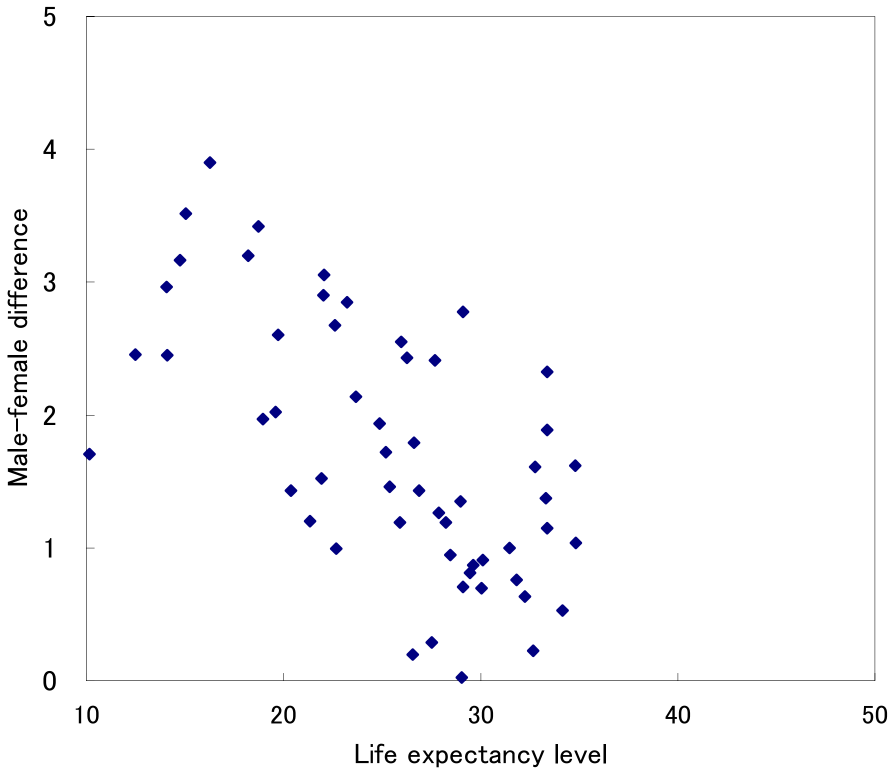


Source: Appendix table 2, and Dyson (1989c).

Fifure 3 Life expectancy level and the male-female difference: Madras, 1885-1939

Source: Appendix table 2.

Fifure 4　Life expectancy level and the male-female difference: Punjab, 1885-1939



Source: Appendix table 2.

Table 3. Excess female mortality and the level of life expectancy in Madras, Berar and Punjab

	Effect of life expectancy level on its male-female difference (regression coefficient)	Controlled for:	R^2 (adjusted)
Madras			
5 districts	+0.23	1918	0.283
12 districts	+0.13	1918	0.169
Berar	-0.07	—	0.216
Punjab	-0.09	—	0.380

Source: Appendix table 2 and Dyson (1989c).

Note: The male-female difference in life expectancy is regressed on the average of male and female life expectancies for the period 1885-1939 (N=55). Since scatter diagrams show that 1918 is an outlier in both cases of Madras, the regressions are controlled for these outlier years in the Madras equations. All the regression coefficients shown are statistically significant at the 1 % level.

Table 4. Relationships between TFR and life expectancy in Madras, Berar and Punjab

A. Male life expectancy

	Madras 5 dists (1)	Madras 12 dists (2)	Berar (3)	Punjab (4)
Constant	-2.81¶	1.56	5.36*	5.79*
	(-2.12)	(1.19)	(5.12)	(13.3)
e_0 (t-1)	0.075*	0.027	0.036¶	0.050*
	(2.79)	(1.02)	(1.95)	(3.20)
e_0 (t-2)	0.012	-0.015	-0.002	0.005
	(0.39)	(-0.49)	(-0.09)	(0.33)
e_0 (t-3)	0.043	0.027	0.003	0.000
	(1.41)	(0.89)	(0.20)	(0.01)
e_0 (t-4)	0.035	0.014	-0.004	-0.008
	(1.16)	(0.48)	(-0.24)	(-0.53)
e_0 (t-5)	0.016	0.018	-0.030§	-0.028§
	(0.58)	(0.68)	(-1.71)	(-1.76)
R^2 (adjusted)	0.364	0.00	0.031	0.182

A. Female life expectancy

	Madras 5 dists (5)	Madras 12 dists (6)	Berar (7)	Punjab (8)
Constant	-1.79	1.12	5.02*	5.92*
	(-0.81)	(0.69)	(4.76)	(16.7)
e_0 (t-1)	0.069¶	0.032	0.035¶	0.048*
	(2.10)	(1.18)	(2.08)	(3.22)
e_0 (t-2)	0.009	-0.009	0.000	0.002
	(0.24)	(-0.30)	(0.01)	(0.16)
e_0 (t-3)	0.038	0.027	0.007	0.000
	(1.03)	(0.93)	(0.40)	(0.03)
e_0 (t-4)	0.030	0.016	0.000	-0.007
	(0.83)	(0.54)	(0.02)	(-0.49)
e_0 (t-5)	0.009	0.018	-0.027	-0.028§
	(0.25)	(0.67)	(-1.63)	(-1.89)
R^2 (adjusted)	0.090	0.00	0.031	0.184

Source: Appendix table 2 and Dyson (1989c).

Note: The period considered is the same for all the four regressions: TFR from 1890 to 1939 and e_0 for the corresponding years (N=50). * statistically significant at the 1 % level, ¶ at the 5 % level, and § at the 10 % level.

Appendix table 1. Original Standards (l_x)

	Madras				Punjab	
	Reference period of data:					
	1924-39		1904-45		1921-37	
i	Male	Female	Male	Female	Male	Female
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	0.8273	0.8273	0.8188	0.8188	0.8138	0.8225
5	0.7263	0.7317	0.7161	0.7209	0.6808	0.6955
10	0.6977	0.7040	0.6839	0.6899	0.6439	0.6558
15	0.6831	0.6892	0.6641	0.6699	0.6139	0.6200
20	0.6579	0.6553	0.6355	0.6317	0.5780	0.5753
25	0.6329	0.6239	0.6067	0.5975	0.5492	0.5402
30	0.6089	0.5942	0.5792	0.5652	0.5217	0.5071
35	0.5787	0.5636	0.5467	0.5330	0.4896	0.4690
40	0.5499	0.5348	0.5160	0.5026	0.4594	0.4338
45	0.5094	0.5011	0.4742	0.4681	0.4142	0.3877
50	0.4719	0.4696	0.4358	0.4361	0.3735	0.3465
55	0.4159	0.4201	0.3807	0.3876	0.3188	0.2908
60+	0.3666	0.3759	0.3325	0.3445	0.2721	0.2442

Source: See text.

Appendix table 2. Estimated series of TFR and e_0 for Madras, 1881-1948, and Punjab, 1885-1946

A. Madras

Year	5 districts			12 districts		
	TFR	e_0		TFR	e_0	
		Male	Female		Male	Female
1881	3.19	—	—	3.18	—	—
1882	3.28	—	—	3.35	—	—
1883	3.38	39.59	40.36	3.49	34.35	35.37
1884	3.39	36.55	37.69	3.52	29.63	30.91
1885	3.31	38.02	39.18	3.43	32.49	33.91
1886	3.61	41.42	42.16	3.77	35.61	36.61
1887	3.68	39.71	40.73	3.89	33.73	34.96
1888	3.51	39.10	40.23	3.72	32.83	34.16
1889	3.55	38.37	39.54	3.87	32.33	33.76
1890	3.64	37.50	38.48	4.06	31.81	32.89
1891	3.68	34.79	36.02	4.15	28.44	29.52
1892	3.12	38.50	39.74	3.53	31.89	33.25
1893	3.67	40.18	41.12	4.00	33.61	34.64
1894	3.66	38.74	39.79	3.79	32.65	33.73
1895	3.79	39.54	40.59	3.98	33.92	35.11
1896	3.77	38.04	39.12	3.89	32.64	33.69
1897	3.62	37.74	38.88	3.66	32.19	33.52
1898	3.60	38.75	39.87	3.69	32.94	34.38
1899	3.81	39.79	40.45	3.73	34.44	35.41
1900	3.98	38.51	39.38	3.82	32.62	33.92
1901	3.56	36.64	37.76	3.39	32.23	33.48
1902	3.88	38.13	38.71	3.63	33.06	34.08
1903	4.40	37.35	37.71	4.22	31.92	32.93
1904	4.16	36.40	37.13	4.05	31.73	32.86
1905	4.30	40.54	41.20	4.21	33.77	34.83
1906	4.23	33.66	34.59	4.02	28.52	29.79
1907	4.27	35.54	36.28	4.07	30.59	31.75
1908	4.90	34.73	35.90	4.59	30.19	31.67
1909	4.74	37.53	38.33	4.53	32.30	33.68
1910	4.36	38.65	39.12	4.52	31.09	32.18
1911	4.09	37.86	38.41	4.36	29.81	30.91

1912	4.13	37.00	37.68	4.24	30.38	31.46
1913	4.17	39.48	39.64	4.23	32.17	33.04
1914	4.15	37.59	38.07	4.10	30.21	31.08
1915	3.96	39.79	39.96	3.85	32.99	34.30
1916	4.16	39.63	39.89	3.98	33.83	34.76
1917	4.08	36.43	36.71	3.87	30.95	31.69
1918	3.58	25.15	24.91	3.32	21.71	21.68
1919	3.19	36.40	37.02	2.90	31.13	32.00
1920	3.45	40.07	40.53	3.08	34.55	35.35
1921	3.41	41.94	42.37	2.91	36.49	37.47
1922	3.62	41.93	41.96	3.16	35.87	36.52
1923	4.12	40.86	40.33	3.49	35.16	35.42
1924	4.33	37.78	37.66	3.61	33.07	33.88
1925	4.32	38.85	38.56	3.54	32.99	33.81
1926	4.82	39.67	38.88	3.77	33.77	34.01
1927	4.84	41.35	40.28	3.82	34.83	35.29
1928	4.90	40.45	39.09	3.94	33.92	34.01
1929	5.16	40.45	38.75	4.05	34.02	33.95
1930	5.43	42.29	40.52	4.17	34.32	34.06
1931	5.54	41.47	39.13	4.15	33.40	32.97
1932	5.33	42.89	41.32	4.16	35.38	35.33
1933	5.38	42.78	40.94	4.30	34.92	34.49
1934	5.01	43.67	42.27	4.07	33.63	33.65
1935	4.99	42.94	41.40	4.20	33.60	33.45
1936	4.91	43.82	42.72	4.27	34.46	34.57
1937	4.97	44.06	43.19	4.32	34.90	34.95
1938	4.94	45.31	44.70	4.34	36.38	36.68
1939	4.76	45.33	44.96	4.34	35.89	36.04
1940	—	—	—	—	—	—
1941	4.70	44.39	44.07	4.35	34.90	35.09
1942	—	—	—	—	—	—
1943	—	—	—	—	—	—
1944	—	—	—	—	—	—
1945	3.75	42.63	42.43	3.53	33.71	33.77
1946	4.09	45.58	45.54	3.84	37.15	37.57
1947	4.13	45.18	44.69	3.91	36.66	36.58
1948	3.97	45.46	45.47	3.77	37.78	37.98

B. Punjab

Year	TFR	e_0	
		Male	Female
1885	5.25	29.45	28.74
1886	5.71	32.78	32.56
1887	5.52	23.17	22.17
1888	5.24	28.92	27.98
1889	5.71	29.87	29.06
1890	5.49	21.95	20.75
1891	5.15	30.55	29.65
1892	5.64	19.96	17.98
1893	5.23	29.65	28.30
1894	6.28	20.61	18.59
1895	5.86	28.52	27.26
1896	5.96	27.52	25.73
1897	6.03	30.49	27.71
1898	5.79	27.23	24.69
1899	6.75	28.88	26.47
1900	5.77	15.54	12.58
1901	4.72	21.05	18.44
1902	5.99	19.83	16.63
1903	6.08	16.82	13.30
1904	5.95	18.22	14.32
1905	6.36	16.34	13.18
1906	6.35	20.43	17.01
1907	5.81	13.70	11.25
1908	6.15	15.32	12.87
1909	5.26	26.05	24.33
1910	6.36	23.94	21.27
1911	6.49	23.58	20.52
1912	7.11	27.47	25.04
1913	7.00	24.73	22.60
1914	7.22	24.65	21.81
1915	7.08	23.48	20.58
1916	7.26	27.59	26.16
1917	7.26	25.85	23.91
1918	6.55	11.02	9.31
1919	6.05	28.82	27.63
1920	6.41	26.65	26.46
1921	6.71	27.68	27.39
1922	6.33	32.56	31.92
1923	6.64	26.50	25.31
1924	6.13	22.70	21.18
1925	6.10	26.12	24.66

1926	6.04	21.09	19.66
1927	6.10	29.06	29.04
1928	6.71	33.95	32.80
1929	6.26	32.21	31.45
1930	6.33	30.39	29.69
1931	6.80	30.07	29.20
1932	6.64	34.41	33.88
1933	7.03	34.01	32.64
1934	6.45	31.98	30.98
1935	6.73	33.58	31.97
1936	6.83	35.34	34.30
1937	6.71	35.62	34.00
1938	7.01	34.32	32.44
1939	6.49	34.56	32.23
1940	6.41	34.16	30.91
1941	6.60	33.13	29.59
1942	6.14	28.64	23.98
1943	5.29	31.53	27.71
1944	5.98	33.01	29.36
1945	6.34	37.75	33.02
1946	6.07	38.80	34.11

Source: See text.