Annexure I

Clarification to the Examiner’s comments

This annexure provides detailed clarification to the observation and comments raised by both the examiners. To fulfill the rules and regulation of the institute, this annexure is appended in the thesis. Specific observation and comments of the examiners and the corresponding clarification made by the candidate are as follows-

Examiner 1

The Thesis entitled, “Age Pattern of Mortality in India”, submitted by Ms. Ranjana Kesarwani, under the guidance of Dr. K. M. Ponnappalli, International Institute for Population Sciences (Deemed University), is one of the relevant topic of enquiry in the context of Demographic and Epidemiological transition in India. I appreciate both the student and the supervising teacher for selecting such a nice topic and studied in various dimensions covering all techniques and to describe the changing age structure in a systematic manner.

Mortality is one of components of Population Change-hence it is very vital to study the mortality to explain the changes in the structure of the population. The Thesis comprises of Seven chapters. The first two chapters deals with the introduction, review of relevant studies, setting of the problem, purpose and scope of the study and evaluation of the basic data. The Chapter 3 and 4 described the levels and trends of the age patterns of mortality at national and sub-national level, changing pattern and variation of mortality across sex and place of residence. In chapter 5 & 6, developed a model for India and States and further construct the district level life tables. The last chapter discussed the summary, conclusion, limitation and policy recommendation based on the study.
In chapter one and two, the candidate attempted nicely to review the significant studies of age pattern of mortality. It was categorized in to a heading as analytical approach (Mathematical), Empirical approach and Relational approach and discuss its merits and limitations. This is followed by some Age pattern of Mortality in India also. The review concludes that, it is often difficult to choose suitable model for India and States. Hence, the present study highlights the differentials in the age pattern of mortality at sub-state level by means of developing life table at district level and will be helpful in achieving the policy and planning needs of the authorities.

The main objective of the study is the systematic analysis of the age patterns of mortality in India by means of developing Model life tables. The main sources of data for study were taken from the Census of India Publications and SRS. Some estimates based on the census data were taken for the analysis. Usual life table techniques, decomposition approach, the index of relative difference for comparison of age pattern of mortality and regression model are the important methodology used for the study.

In chapter three, the candidate described the Levels, Trends and Patterns of mortality in India and states over the last forty years (1971-2010) in details. The chapter conclude that there is an overall decline in mortality in India and states, but it is not uniform in all states. The gap between rural/urban and male/female mortality is reducing almost in each states. But it is mentioned that the contribution of infant and child mortality in changing mortality pattern is very high than the other ages death rates.
The application of Model life tables to Indian mortality pattern was examined in chapter four. I appreciate the candidate for reviewing all the available model life tables for the purpose. In order to compare the age pattern of mortality rates the index of relative differences (IRD) was also utilized. The analysis conclude that no single model is explaining the whole age pattern of India as well as states and not give god fitting for the entire age range. Some models are concentrating only the initial age mortality (U. N. model), some are focusing over childhood and middle age mortality (WHO model). The chapter commented that there is a need to develop such a model which will be able to explain the entire range pattern of mortality for each states.

In Chapter Five, the candidate attempted to develop a mortality model explaining the whole age pattern for India and major states. The models generated based on all India data were not giving better fit for all states. Due to the heterogeneity in the socio-economic, health and diverse geographic features, generation of states specific model are more convincing. Thus the study attempted to develop the regression based state specific model and evaluated the applicability of the model. The study succeed in the generation of regression based model life table using the Indian data with satisfactory results. Since district wise ASDR not available, life table were constructed using the information on estimated district level infant mortality. As the reduction of infant and child mortality due to infectious disease were not reached up to the desired level, and the increase in non-communicable disease is observed among adults, in this section life expectancy at age 15 was considered in order to explaining the variation in young adult mortality.

Finally, the study concludes that selecting a pattern from the existing models is difficult, hence it necessitate a model explaining the complete mortality age pattern of India. Thus the study developed life tables for India and states based on the regression model using only one significant
key variable infant mortality rate. The candidate argues that regression based model life table gives an acceptable results for India as well states. Thus it is suggested that the state specific model is appropriate rather than the all India model.

**Comment 1:** In Chapter three it is mentioned that contribution of infant and child mortality in changing mortality pattern is very higher than other ages death rate. But it can be seen that in Kerala changes in old age mortality (70+) is contributing more in the overall changes in mortality and life expectancy from late 1990s. Similar, trends can be seen for the states Punjab and Haryana after 2000. This has to be considered for the study on age pattern of mortality.

**Response:** From the decomposition analysis, it is obvious that, in general contribution of lower age mortality in overall mortality rate is high. However, if we look into the state specific decomposition results, we noticed that during 1971-81, older mortality contribution was much higher than the lower age groups, but in next three decades, situation reversed. However, only for state Kerala and Punjab, in period 1991-2010, old age mortality contribution is too high relative to young age. For Punjab, we did not find any specific reason. In Kerala, there is high elderly population and relatively lower population of young people due to heavy migration to Gulf countries leading to high mortality contribution of elderly. Thus, it is to state that the issue raised by the examiner is well answered through decomposition analysis and corroborate with the ideas expressed by the examiner.

**Comment 2:** The demographic, socio-economic and health situation of India and even its states are not same, it varies from region to region. So it is not possible to develop a uniform model for India and states.
Response: The researcher agrees with examiner and the same is observed in the thesis too. India is the second most populous country in the world after China. The population of Indian states can be compared to the population of many countries in the world. So, it is quite obvious that for most of the states, demographic and socio-economic and health situation are different. For instance, Uttar Pradesh is having high birth and death rate than Kerala, indicating different health condition. This informs that we can not have uniform model for each states and hence requires different model to represents the mortality pattern for every states.

Comment 3: The regression based model life table were constructed using life expectancy at birth and infant mortality rate. The IMR is estimate using indirect estimate techniques, which in refers some assumption in addition to that it depends on data quality. Hence efforts should be taken to improve the data quality as well as to develop a methodology without any assumption.

Response: The researcher agrees on including the data quality checks in study, but because of heavy volume of work done in the thesis, we could not include it. Moreover, the quality of any data can be accessed through coverage, completeness and incidence of missing-ness in terms of non-reporting, unavailability and wrong entry. Study by Mahapatra (2010), came up with the fact that the incidence of under-registration of births and deaths were within the tolerable range up to 10%. In addition, representative characters of SRS data allows for reliable estimation of vital data for the country and major states. Therefore, study assumes that Sample Registration system (SRS) based ASDRs of major States and India of the single years 1970 to 2010 reported by the Registrar General of India are good enough to construct model life tables. This has been well documented in the data quality section of chapter 2 as well as limitation section of chapter 7 of the thesis. The researcher fully agrees with the examiner that there is a need to develop a methodology without
any assumptions, but in reality it is very hard to find problem free data and hence to develop any methodology without assumption.

**Comment 4:** The life expectancy and IMR are the indicators of health status of a society, but today one should know that living longer does not mean that the person is healthy, because people living longer at the cost of illness. Hence it is better to consider Healthy life expectancy rather than the overall life expectancy.

**Response:** Researcher thanks to the examiner for suggestion on including the healthy life expectancy instead of overall life expectancy and agrees on his/her raised point. The thesis is mainly intended to come up with the district level life table with the use of available estimates, however as stated in the thesis, only IMR and U5MR rate are available at district level; ASDRs are not available. So, the researcher exploited IMR only. Moreover, according to United Nations, for use of healthy life expectancy, one should need data on age-specific death rates for a particular calendar period together with severity-adjusted health state prevalences by age, which is not available at district level. So, the researcher restricted this work with use of life expectancy only which has been indirectly estimated using infant mortality rate (IMR).

**Comment 5:** The influence of communicable disease are still high among children and non-communicable illness are in increases among adults. So the present study considered the young adult mortality (at age 15) and old age mortality (60+). But these rates based on life table constructed using IMR. Then how far the estimates on young adult mortality are reliable.

**Response:** Researcher recognizes the examiner’s point. As stated in the previous reply too, only IMR and U5MR rate are available at district level, so the thesis used the available information of
IMR to estimate other age mortality. However, as per researcher’s understanding, there is no way to come up with complete life table without knowledge of full mortality pattern. Researcher agrees that IMR status for a district will be reflected in adult and old age mortality, but in practical, mortality at each age is reflected from the health behavior, life style, disease, social and physical environment, etc. and would not be same for all ages. This issue has already been outlined in the limitation of the study.

Comment 6: The differentials in life expectancy estimates at state and district level is because of various socio-economic and health aspects of the population. Without a detailed study on these aspects it is not proper to reach a conclusion in that direction and which is beyond the scope of this study.

Response: At district level, IMR and U5MR are available by sex and place of residence only; these two are not available by other socio-economic characteristics (e.g. Education, income, caste, religion, etc.) and health aspects at the district level. Therefore, it is not possible to carry out the detailed analysis on the basis of suggested directions.

Comment 7: As national Census are conducting only once in 10 years, and estimating parameters based census data always involves some assumptions and as SRS is also not reliable as mentioned in the thesis, it is a high time to take measures to strengthen the CRS at state and district level, if possible at sub district level. It is necessary for local level policy and planning purpose.

Response: Researcher is fully concordant with the examiner. In India, despite the implementation of decentralization, it is very tough to get a direct estimate at the district level. One has to rely on the decennial information from the census that too employing indirect approach to estimate the
district indicators. Indirect estimation always incorporates some assumption; thus, there is a necessity to improve and regularize the administrative data system at small area and at the same time, efforts should be made to strengthen the civil registration system (CRS).

**Observation:** Overall the study is done in a systematic manner with research vigor. Hence this study is an asset to the literature on age pattern of mortality in India. By taking into the above observations and the candidate effort and dedication to the research work, I recommend that the Thesis submitted by Ms. Ranjana Kesarwani, be accepted for the award of Ph.D. degree by International Institute for Population Sciences (Deemed University), Mumbai, India.

**Response:** Thanks to the examiner on his/her appreciation about this thesis.

**Examiner 2**

**Observations and Comments:** Examining age patterns of Mortality in India is motivated by two considerations (a) how is the evolving age pattern of mortality linked with the changing age structure of the population and (b) differential share of gain in life expectancy by different ages of the population. Apart from these two primary considerations characteristic differentials in mortality has assumed significance in the wake of aggregate improvement in longevity. This particular work can be placed with this juncture and can be considered among the few that deals with the literature on mortality estimation techniques. While reading the thesis one feels that exhaustive use of existing information on mortality with an objective of figuring out some model pattern to which the experience of mortality transition in India qualifies. The Thesis comprises of four core chapters apart from the introductory chapters detailing on the motivation for the work.
along with data and methods. While discussing on levels, trends and patterns of mortality in India the focus has been on early age mortality like IMR and CMR and life expectancy at birth. These parameter does not enable a comparison of pattern across states and over time but in a limited way given that they are computed rates of the phenomenon of survival. The realistic pattern comparison of survival should ideally have been made in a distributional perspective. Given that life tables are used as inputs, the cumulative distribution of survivors in the life table population could have been compared over time to indicate proportions surviving at least a certain years of life. In the chapter examining the changing age pattern of mortality, it is argued that the same is carried out based on corresponding life tables rather that the observed age-specific death rates. This may sound appropriate but than in a continuously changing survivorship scene, the derived pattern from a life table is a derivative that does not link to reality. However, the verification of age patterns of mortality based on life tables could depict changes that are comparable. Again comparing them with the existing model life table pattern and discover mismatch is but expected primarily because the evolving survivorship pattern is undoubtedly different form the expected trajectory with which model life tables were made. Rather than contrasting this age pattern of mortality with the same observed in model life table, an ideal exercise should have been to compare states to comment on the pattern as a response to the differentials pace of demographic transition across states. Because of the mismatch with the existing model life tables, there is an attempt made at constructing new model life table suiting to Indian mortality transition. The regression-based model life tables generated for India seems to be more appropriate for Indian mortality transition. However, such an exercise stands critical scrutiny given that it is validation that has inputs from itself. The candidate goes on to computation of district-level model life tables that will enable generating information at district level. For this state specific groups are considered which will represent the
mortality pattern in general and the same regression-based method generates a life table suiting to the transitional pattern of mortality of a specific group. This obsessive exercise towards obtaining fitting model life tables for all varying transitional situation of mortality sound little bizarre in the sense that model life tables are approximate expositions to reflect pattern at the best. Given the availability of district level early age mortality, it would be a rewarding exercise to derive adult and old age mortality conditioned by the age structure of the population. There are numerous ways in which age specific pattern of mortality could be modeled to obtain the same conditioned on early age mortality. This thesis is driven single mindedly towards having model life table to most disaggregated level that would be fitting to the emerging transition.

A thesis intended to understand age-pattern of mortality need not necessarily be limited to an inspection of model life table. This could very well have engaged in verification of period and cohort variant in reading age pattern of mortality. Apart from period-cohort segregation a decomposition exercise would have been interesting to know which segment of the population share the most from the gains in survival indicated by incremental life expectancy. To be fair, the candidate has not maintained balance between numbers and word in the thesis. Although the numeric calculations are needed for exposition they are not to be presented in such detail as has been done in the thesis. A work of this kind looses appreciation in the absence of sufficiently pronounced motivation for each exercise undertaken along with inadequate interpretation of the results.

Despite these critical observations, I find the quantum of work satisfactory. It undoubtedly involves critical understanding of methods and appreciation of the literature. The work has made appropriate use of available information and attempted an exposition of the mortality transition in
India. Considering the exercise as comprehensive, exhaustive and holistic in content, I have no hesitation in awarding the degree of doctor of philosophy in population studies to the candidate.

**Response:** Thanks to the Examiner’s critical observation, positive feedback and appreciation.

I would like to express thanks to both the examiners for their critical comments, observations and appreciation about the thesis.

Date: Ranjana Kesarwani

Place: (Ph.D. Candidate)
**Introduction:** The age-pattern of mortality has drawn considerable attention in the applied field of demography and public health. Ideally, death should appear at last stage of life when all natural vitality of a human is lost. Under these circumstances, death would tend to mass in the terminal ages of life with only few elisions of early expiries of life at lower ages. Moreover, due to the physical and socio-economic diversity of the country, the health and development scenario has never been uniform. The regional heterogeneity in health condition of states appeared both in inter as well as the intra-district variation and leads the different mortality condition among districts. However, to understand the district level differentials in mortality, very less information are available. In India, districts are the basic unit of administration and all development and planning process. It leads the growing demand of district level indicators of health, development and education, etc.

**Objectives:** The objectives are: first is to explore the age patterns of mortality in Indian life tables and their differentials across residence, gender and major states; second is to test the applicability of model life tables to Indian mortality pattern across gender and major states over the period 1970-2010; next to develop a model for India and states; and last is to derive a model based life tables by sex for districts of India for Census year 2001.

**Data:** For most part of the analysis for this thesis, data have been used from census 2001 publication and Sample registration system (1970-2010).

**Methodology:** Ranges of statistical techniques and software packages have been used. To reconstruct the life tables, starting from 1970-75 to 2006-10, MortPak software has been utilized which uses Greville’s method. United Nation’s (1985) decomposition method have been used for analyzing the mortality change in India and major states by sex. However, models giving the best results for Indian mortality data identified with the help of three error measures say mean error, mean absolute error and mean square error. In addition, to compare the complete mortality age pattern, a single index has been derived out from a set of mortality rates, named as Index of relative difference. Linear regression method have been exploited to get the full life table using only the infant mortality rate as initial input.

**Findings:** The research demonstrate the decline in all age mortality over time for all states and India, but the rate of decline found different for all states. Gap between rural and urban mortality and male and female is reducing almost in each state of India over the period. Result signifies that the contribution of infant and child mortality in changing mortality pattern is very high than other ages death rates. The empirical analysis done in the thesis suggests that, no single model is explaining the whole age pattern of India as well as states as these models do not utilize mortality pattern over the entire range. Some models are concentrating only the initial age mortality (e.g. United Nations); some are focusing over childhood and middle age mortality (e.g. WHO model). Therefore, the applied model is giving approximate fit to some specific ages, not able to explain the mortality of entire ages. Moreover, as the knowledge of current mortality pattern is required for health policy, population projection, etc.; but the each state are exhibiting the different pattern, it may be due to a different level of health and development situations so the study concludes that there is a need to develop such a model which will be able to explain the entire mortality age pattern for each state. Dissertation also developed the state as well as India based regression model using only one significant key variable that is infant mortality rate. The study found that regression-based model life table is yielding acceptable results for India as well as states. Furthermore, thesis tried to improve the mortality database at district level for India using the only information on infant mortality rate. Examination for district variation reveals that life expectancy at birth (LEB) is highest for district Udupi of state Karnataka followed by Mahe of Pondicherry. However, for male highest LEB is observed in Pune and for female in Udupi. The study observed significant variation in life expectancy values across gender and district as well.