Extended Abstract

Marginal risk progression of non-communicable chronic diseases with varying ages in India: An application of competing risk model

Introduction:

In most of the developing countries, recently, disease pattern is shifting from communicable to non-communicable diseases. Though these diseases are non fatal in nature but are chronic. Epidemiology transition theory [Omran,1971; Olshansky and Atul, 1986] suggest that with modernization and advanced levels of development characterizing improved sanitation and environmental hygiene, advances in field of medicine societies experiences a changing disease burden from acute communicable diseases to chronic non-communicable diseases. These diseases are basically life style disease like diabetes, hypertensions, cancer, renal failure, cardiovascular diseases, heart disease, asthma, arthritis, etc.

India has more than 1.2 billion population with large number of adult and older population which are at the risk of getting chronic diseases and due to fast changing life style, multi-culture environment, increasing pollution, urbanization and acute poverty in India, people are getting these diseases very early in their working ages. According to Special Survey of Deaths (SSD), undertaken in 2001-2003 (Registrar General of India, 2008), non-communicable diseases are the leading causes of death in India, constituting 42% of all deaths. Since the risks of these diseases are generally arise in the age of late 30's or after, so a larger section of working population is bound to suffer with these diseases which definitely affect their productivity. So there is huge economic burden on household as well as on the country because of the chronic diseases.

In developing country like India which is in the stage of reaping the fruits of demographic dividend, the increasing trend of chronic diseases is really a matter of public health concerned. Due to epidemiological transition and increased longevity, the time has come to focus on new health intervention and new health policies and program targeting towards non-communicable diseases. Since India is experiencing the rapid health transition, there is a great mismatch between health care needs and resources available (Reddy, 2003). And this mismatch is widened by an expanded list of health conditions that seeks attention from policy makers and public health action while posting competing claims for clinical care. Evidence based clinical practice and appropriate use of technologies and also the decentralization of the modern medical facilities are the growing demand of the present scenario for early detection and prevention of the chronic diseases.

The present study will justify the above needs and scene by investigating the age at onset of chronic diseases, varying risk of onset of chronic diseases at different ages. In this present study risk of major chronic diseases is studied with the help of survival analysis techniques.

Objectives of the Study:

1. To examine the prevalence and age at onset for selected chronic disease across different socio-demographic subgroups in India.
2. To study the risk of onset of selected chronic diseases in competing risk scenario across different socio-demographic subgroups in India.

Data sources:

The Ministry of Statistics and Programme Implementations, Government of India has conducted a survey to collect data on 'Morbidity and Health Care' between January and June, 2004 in its 60^{th} round of National sample survey Organisation (NSSO 2006). The NSSO 60th round is a multi-stage cluster sample survey covering all 35 states and union territories in India. The survey has covered all major ailments including chronic diseases like heart disease, hypertension, bronchial asthma, disorder of joints and bones, neurological disorder, psychiatric disorder, diabetes mellitus and cancer. The survey had collected the data on curative aspect of the general health care system India and utilization of health care services provided by the public and private sectors from 73868 nationally representative households.

Descriptions of diseases investigated:

The present study will focus on six major non communicable chronic diseases namely cardiovascular diseases which include heart diseases and hypertension, diabetes mellitus, bronchial asthma, disorder of joints and bones, mental illness (includes neurological disorder and psychiatric disorder) and cancer. These diseases are selected on the basis of their significant contribution in health burden and NCDs related morbidity and mortality. This study is totally based on the self reported morbidity but not clinically tested. However there are less chances of over-reporting for these selected diseases because of clear and specific symptoms.

Methodology:

The age on onset of different chronic disease is investigated using basic statistical tools: measures of central tendencies and measure of dispersion. Further box and whisker plot is used to investigate the dispersion and concentration of the age at onset. From the box plot we can have the median age of onset of the specific chronic disease and we can have the information about the maximum, minimum, range, and also the skewness of the age at onset of chronic diseases.

Competing Risks of Chronic Diseases:

Hazard function at any age of a particular chronic disease gives the instantaneous risk of getting affected with that disease but at the same time the person may already be affected with any other chronic diseases by that age. Here the concept of competing risk is coming because for the disease by which the person is affected at age x for the first time, rest of the chronic diseases are like competing risks. Therefore competing risks are events that prevent an event of interest from occurring. Unlike cumulative hazard function, the absolute or marginal risk of onset of a disease in the presence of competing risk is measured in terms of 'cumulative incidence function'.

Cumulative incidence, $F_j(t)$ for a particular cause of failure j is the probability of experiencing this cause of failure until time t, in the presence of all the other possible causes (Bakoyannis et al). So

$$F_j(t) = \Pr(\, T \leq t, C = j\,) = \int_0^t h_j(u) \exp\left\{- \int_0^u \sum_{c=1}^{k} h_c(w)\, dw\right\} du, \text{ j=1,2,3,......,k}$$

A popular model for the cumulative incidence is the proportional hazards model for the subdistribution of a competing risk (Fine & Gray, 1999). This method makes use of the hazard of subdistribution which is a function of the cumulative incidence for the corresponding cause of failure and can be defined as:

$$h_j^{sub}\,(t;x) = \lim_{\Delta t \to 0} \frac{\Pr[(t \leq T < t + \Delta t, C = j \mid T \geq t \cup (T \leq t \cap C \neq j), x]}{\Delta t}$$

$$= \frac{\{dF_j(t;x)/dt\}}{\{1 - F_j(t;x)\}} = - \frac{d\log\{1 - F_j(t;x)\}}{dt}$$

A semiparametric proportional hazard model is assumed for hazard of subdistribution and the cumulative incidence function has the form:

$$F_j(t; x) = 1 - \exp\{-\int_0^t h_j^{sub}\,(u; x)du\,\}$$

$$h_j^{sub}\,(t;x) = h_{j0}^{sub}\,(t) \exp\{\beta_j' x\}$$

Result and Discussion:

Graphical analysis through box plot indicates that the median age at onset of CVD, bronchial asthma, disorder of joints and bones are almost same i.e. around 60 years but the distribution of the age at onset of first three chronic diseases are left skewed where as that of diabetes is symmetric around there median age. Onset age of bronchial asthma is more left skewed than CVD, diabetes and bones and joints disorders. The median age at onset of mental illness and cancer are very less i.e. 43 year and 48 year respectively which are very less in compare with the rest selected chronic diseases. Inter quartile range of age at onset of chronic diseases indicates that diabetes has minimum inter quartile range (52-68 years) whereas mental illness has maximum (25-62 years). The first and third quartiles of age at onset of CVD, bronchial asthma and disorder of joints and bones are lying in the age groups (48-68 years) approximately. It means that 50% of the affected individuals have the onset in this age group alone.

A person is likely to get affected with a particular chronic disease from the time of his/her birth with variable chances which depend upon the various risk factors associated with that person. But in general population, irrespective of the risk factors, it would be a prime interest to investigate the probability of having a particular chronic disease by a specific age. If the interest lies in getting the True risk at various ages, cumulative incidence function will be the better option. The risk of onset of CVD up to age 40 years is negligible after that it started increasing.

Female have double risk of being affected with CVD in India in compare with that of male. If we talk about the marginal risk in terms of cumulative incidence function because of competing risk, it is 5% for male and 10% for female by the age 60 and also 12% for male and 22% for female by the age 90 year. The overall adjusted hazard of CVD in the presence of competing risk is 1.93 times higher in female. True risk of getting CVD in urban people is 1.3 times higher than that of rural people. As we go from lower ladder to higher ladder of economic well being, the adjusted marginal risk starts increasing significantly. By age of 70 year the adjusted marginal risk of bronchial asthma is 4% for female and 6% for male respectively. People are affected more with other chronic disease before being affected with disorder of joints and bones and the risk in female is more than two times than that of male. Hazard in the people who are graduate or higher have significantly 50% less risk of mental illness in compare with illiterate people. Those who are in highest MPCE quintile have 75% more risk than those who are in lowest quintile. By the age 70 year the marginal risk of diabetes if 2% in male and 3% in female and by the age 80 year it is 3% and 4%. Female have 42% higher risk of diabetes than male in the presence of competing risk disease. Risk of diabetes is lowest for the people who are in lowest MPCE quintile and as we move from lower to higher MPC quintile risk increases. By the age 70 the risk of diabetes in lowest quintile is 1% whereas it 8% for highest quintile and by the age 80 it 2% and 12% for lowest and highest quintile respectively. The risk and marginal risk of cancer is very low in compare with other selected chronic disease. Currently married or divorced people have 80% less risk of cancer than unmarried people with 0.1% level of significance.

Conclusion:

In conclusion, this study reveals that the prevalence of cardiovascular diseases is highest among rest chronic diseases. The risk of major chronic diseases starts in the age around 40’s. There is early onset of mental illness in Indian population and diabetes onset is comparatively late. For some chronic diseases like CVD and disorder of joints and bones females are more vulnerable. CVD and diabetes onset is earlier in richer and highly educated people in India.

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