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Original Research Article

Potential gain in life expectancy by gender after elimination of a specific cause of death in urban India

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ABSTRACT

Background: Life expectancy is a statistical measure to depict average life span a person is expected to live at a given age under given age-specific mortality rates. Cause-elimination life table measures potential gain in life expectancy after elimination of a specific disease. The present study aims to estimate potential gain in life expectancy by gender in urban India after complete and partial elimination of ten leading causes of deaths using secondary data of medical certification of cause of death (MCCD) for the year 2015.
Methods: Life table method was used for estimating potential gain after eliminating diseases to the tune of 25%, 50%, 75% and 100%.
Results: Maximum gain in life expectancy at birth estimated from complete elimination of diseases of the circulatory system (11.1 years in males versus 13.1 years in females); followed by certain infectious and parasitic diseases (2.2 versus 2.1 years); diseases of the respiratory system (2.2 versus 2.1); injury, poisoning and certain other consequences of external causes (1.1 versus 0.7); neoplasms (0.9 versus 1.0); endocrine, nutritional and metabolic diseases (0.8 versus 0.9); diseases of the digestive system (0.8 versus 0.4); diseases of the genitourinary system (0.6 versus 0.6); diseases of the nervous system (0.4 versus 0.4); and diseases of blood & blood forming organs and certain disorders involving the immune mechanism (0.2 versus 0.3 years).
Conclusions: Elimination of the circulatory diseases resulted into maximum gain in life expectancy. These findings may have implications in setting up health goals, allocating resources and launching tailor-made health programmes.

Keywords: Complete, Elimination, Gender difference, Life expectancy, MCCD, Partial, Potential gain

INTRODUCTION

Life expectancy is a statistical measure to depict average life span a person is expected to live at a given age under given age-specific mortality rates.[1] It is convenient, representative and comprehensive indicator to judge social and economic status and quality of life of a country or region; more intuitive than mortality rates; easy to interpret in terms of expectation of life and is most commonly used by policy-makers to set out national strategies for health.[2-3]

Life expectancy in women was higher than in men in mid-2000 and women live longer in nearly all countries of the world probably due to social and economic transformation benefitting women more than men.[4] It is worthy to mention that in India in 1970-75, the urban life expectancy at birth for female (59.2 years) was slightly more than for male (58.8 years) and the same trend is continuing till now. In 2012-16, the female life expectancy (73.5 years) is also higher than that of male (70.9 years) by about three years.[5]

Information on cause of death plays an important role in mortality analysis. The pattern of death by cause reflects the health status of the population and in turn provides a rational basis for health planning. Though the medically certified cause of death data from complete civil registration system is the 'gold standard' for such statistics, these are generally not available in over two-thirds of all countries.[6]

Potential gain in life expectancy (PGLE) by eliminating a disease means that on average people will live more than they would in the presence of that disease. PGLE represents the added years of life expectancy the population would receive if the deaths from a particular cause were reduced or eliminated as a competing risk of death.[7-10]

PGLE is a reasonable way to explain the impact of a certain disease on life expectancy because it can reflect the loss of life expectancy caused by a certain disease and provide a numerical indicator of survival if the disease is eliminated. In addition, this indicator is not affected by the age structure of the population, facilitating comparisons between diseases.[11]

The study aims to estimate potential gain in life expectancy by gender in urban India after complete and partial elimination of ten leading causes of deaths- certain infectious and parasitic diseases; neoplasms; diseases of blood and blood forming organs and certain disorders involving the immune mechanism; endocrine, nutritional and metabolic diseases; diseases of the nervous system; diseases of the circulatory system; diseases of the respiratory system; diseases of the digestive system; diseases of the genitourinary system; and injury, poisoning and certain other consequences of external causes.

METHODS

The present study used the secondary data of medical certification of cause of death (MCCD) for the year 2015.[12] The MCCD under civil registration system covers mostly those deaths, which occur in medical institutions located in urban areas. It has been operational in the country but with varying levels of coverage across the states/union territories. The necessary data was collected in the prescribed forms (form 4 for hospital deaths and form 4A for non-institutional deaths) by the medical professionals attending to the deceased at the time of terminal illness. These forms were to be sent to concerned registrars of births and deaths for onward transmission to the Office of Registrar General of India (RGI) for tabulation and consolidation as per the National List of Causes of Death based on Tenth Revision of International Classification of Disease (ICD-10).[13] The detailed information is available elsewhere.[14]

All medically certified deaths occurred during the year 2015 for the period from 1st January to 31st December, 2015 in the hospitals covered under the scheme (whether public or private) mostly from urban areas and all non-institutional deaths which are attended to by the medical practitioners in respect of 33 states/UTs are included in the study. The MCCD-2015 report is based upon 11,83,052 total medically certified deaths (male: 7,36,882 and female: 4,46,170) accounting for 22.0 per cent of total registered deaths in respect of 33 States/UTs who supplied data for the report. [12]

Though this study used the secondary data available in public domain ethical approval from the institutional ethics committee was obtained.

Statistical analysis

In the MCCD report, there were a large number of cases in which age was not stated (1.9%).[12] These cases were adjusted by distributing the deaths under the head "age not stated" in to all the age groups in proportion to total deaths in those age groups. The adjusted deaths were used for constructing the life tables after estimating the age-sex specific death rates in the age groups <1, 1-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-69 and 70+ years for both males and females.

Following steps were carried out to estimate potential gain in life expectancy through life table technique:

1: Construct life table using the Greville method for all causes (e_x):

The values of ${}_nq_x$ (the probability of death between age x and x+n) have been calculated by using the relation between the probability of death (${}_nq_x$) and the observed age specific death rates ${}_nm_x$ by Greville formula:[15]

$$ {}_nq_x = \frac{{}_nm_x}{\frac{1}{n} + {}_nm_x[0.5 + n/12({}_nm_x - \ln C)]} $$

where, ln C=0.09.

Other life table functions namely l_x, L_x, T_x, e^o_x have been calculated in usual manner as mentioned in the standard text books on demography using Microsoft Excel. The ${}_nm_x$ values are all causes of deaths for the year 2015 and the projected urban population for the year 2015.[12,16] Crude birth rate, crude death rate, age-specific death rate and sex ratio at birth of urban population for 2015 have been taken from SRS.[17]

2: Construct cause-eliminated life tables [$e_x^{(-1)}$] after complete (100%) and partial (25%, 50% and 75%) elimination of certain causes of deaths viz. certain infectious and parasitic diseases (A00-A99); neoplasms (C00-D48); diseases of blood and blood forming organs and certain disorders involving the immune mechanism (D50-D89); endocrine, nutritional and metabolic diseases (E00-E89); diseases of the nervous system (G00-G98); diseases of the circulatory system (I00-I99); diseases of

the respiratory system (J00-J98); diseases of the digestive system (K00-K92); diseases of the genitourinary system (N00-N99); and injury, poisoning and certain other consequences of external causes (S00-T98).

3: To estimate potential gain in life expectancy as the difference between cause-eliminated life expectancy [$e_x^{(-1)}$] and life expectancy (e_x).

PGLE = [$e_x^{(-1)}$] − e_x.

RESULTS

Life tables were constructed separately for both male and female for urban India for all causes of deaths. Also, life tables for partial and complete elimination of all causes of death were constructed. As per SRS, urban life expectancy at birth in 2012-16 was 70.9 years for males and 73.5 years for females. As per author calculation, after using all-cause age-specific deaths from MCCD, 2015 life expectancy at birth was 72.4 years for males and 75.3 years for females and after complete elimination of ten examined leading causes of death in case of diseases of the circulatory system 83.4 years for males and 88.3 years for females; followed by certain infectious and parasitic diseases (74.3 versus 77 years); diseases of the respiratory system (74.5 versus 77.1 years); injury, poisoning and certain other consequences of external causes (73.4 versus 75.9 years); neoplasms (73.3 versus 76.2 years); endocrine, nutritional and metabolic diseases (73.2 versus 76.2 years); diseases of the digestive system (73.2 versus 75.7 years); diseases of the genitourinary system (73 versus 75.8 years); diseases of the nervous system (72.8 versus 75.6 years); and diseases of blood and blood forming organs and certain disorders involving the immune mechanism (72.6 versus 75.5 years). It is evident that females are in favourable position than males. It is also interesting to note that if diseases of the circulatory system are completely eliminated, then the life expectancy for a male at birth would be 83.4 years and for female it would be 88.3 years, a gender difference of around 5 years in favour of females.

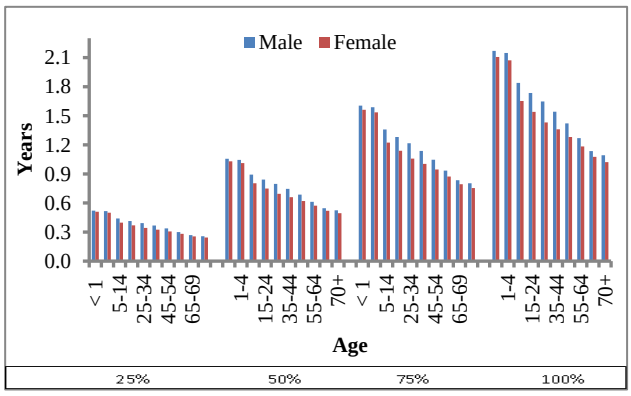

Figure 1: Potential gain in life expectancy after partial and complete elimination of certain infectious and parasitic diseases (MCCD, 2015).

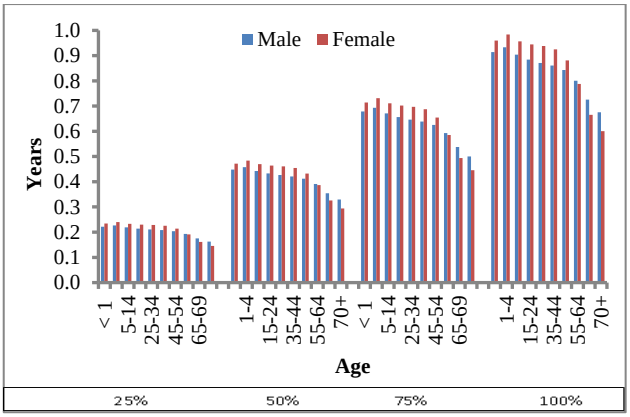

Figure 2: Potential gain in life expectancy after partial and complete elimination of neoplasms (MCCD, 2015).

Figures 1 to 10 show the potential gain in life expectancy by age and sex after complete and partial (25%, 50% and 75%) elimination of mortality of examined ten leading causes of deaths.

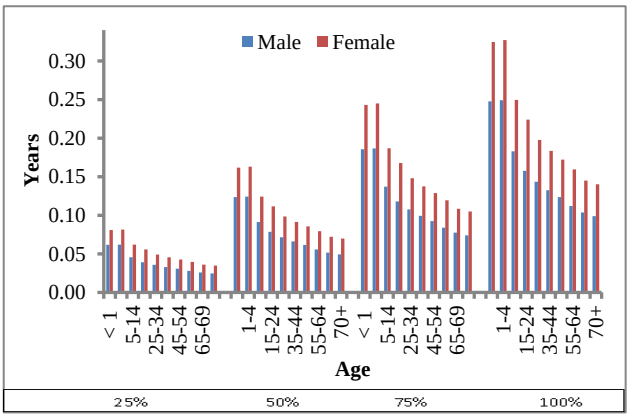

Figure 3: Potential gain in life expectancy after partial and complete elimination of diseases of the blood and blood forming organs (MCCD, 2015).

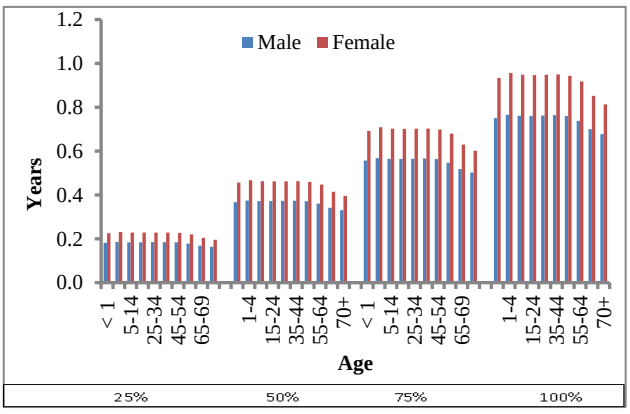

Figure 4: Potential gain in life expectancy after partial and complete elimination of endocrine, nutritional and metabolic diseases (MCCD, 2015).

Partial elimination of 25% of mortality from ten examined leading causes of death resulted into gain in life

expectancy at birth ranging from 0.1 year to 2.1 years in males and females. Similarly, 50% mortality elimination gave gain in life expectancy at birth varying from 0.1 year to 4.7 years. Mortality elimination to the tune of 75% estimated maximum gain in life expectancy at birth for diseases of the circulatory system 7.1 years for males and 8.2 years for males and for other examined diseases from 0.2 years to 1.6 years.

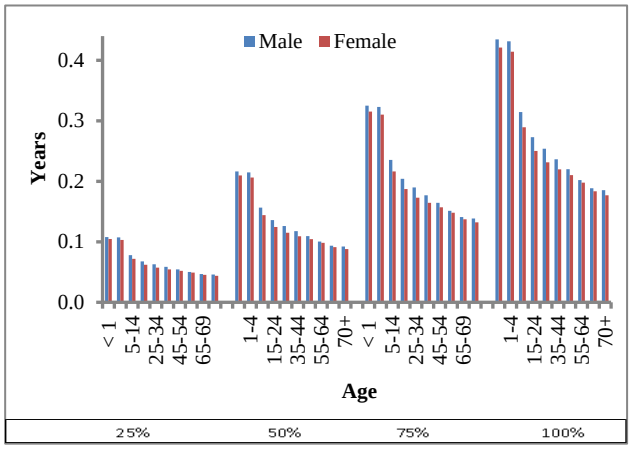

Figure 5: Potential gain in life expectancy after partial and complete elimination of diseases of the nervous system (MCCD, 2015).

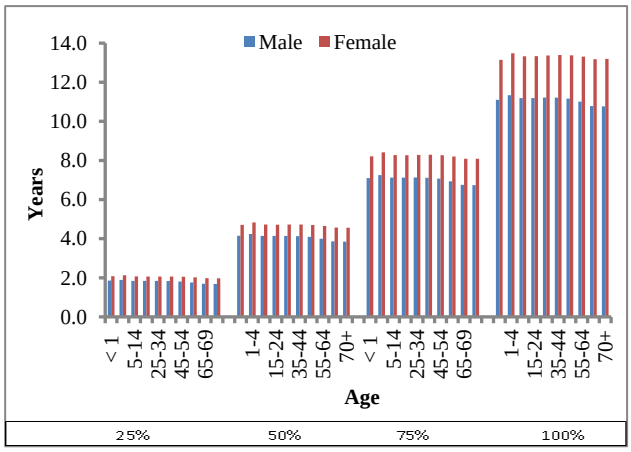

Figure 6: Potential gain in life expectancy after partial and complete elimination of diseases of the circulatory system (MCCD, 2015).

The complete elimination of mortality resulted into maximum gain in life expectancy at birth from diseases of the circulatory system (11.1 years in males versus 13.1 years in females); followed by certain infectious and parasitic diseases (2.2 versus 2.1 years); diseases of the respiratory system (2.2 versus 2.1 years); injury, poisoning and certain other consequences of external causes (1.1 versus 0.7 years); neoplasms (0.9 versus 1.0 years); endocrine, nutritional and metabolic diseases (0.8 versus 0.9 years); diseases of the digestive system (0.8 versus 0.4 years); diseases of the genitourinary system (0.6 versus 0.6 years); diseases of the nervous system (0.4 versus 0.4 years); and diseases of blood and blood forming organs and certain disorders involving the immune mechanism (0.2 versus 0.3 years).

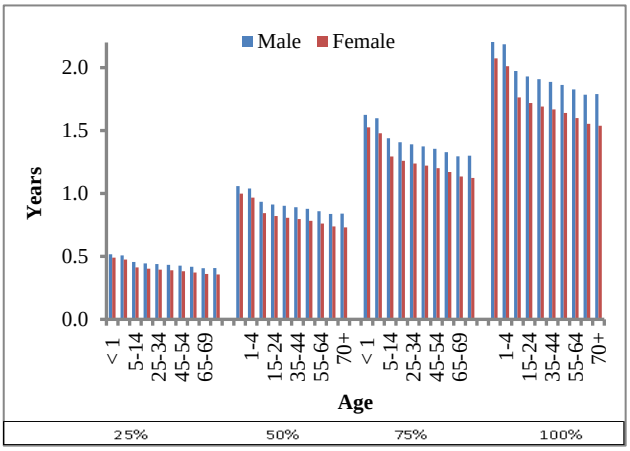

Figure 7: Potential gain in life expectancy after partial and complete elimination of diseases of the respiratory system (MCCD, 2015).

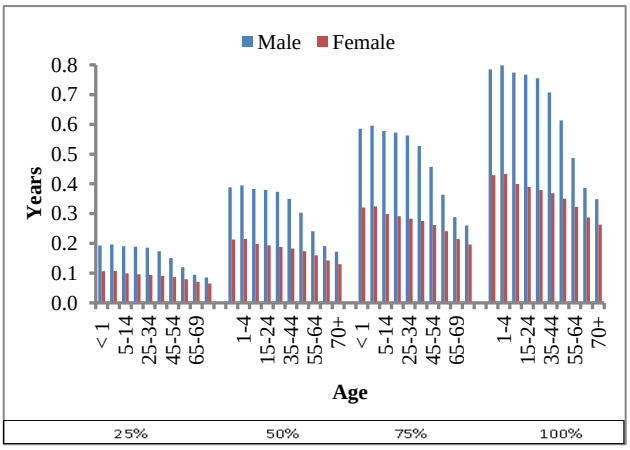

Figure 8: Potential gain in life expectancy after partial and complete elimination of diseases of the digestive system (MCCD, 2015).

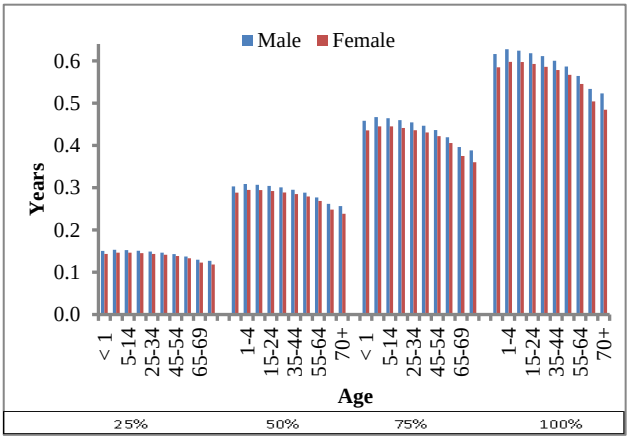

Figure 9: Potential gain in life expectancy after partial and complete elimination of diseases of the genitourinary system (MCCD, 2015).

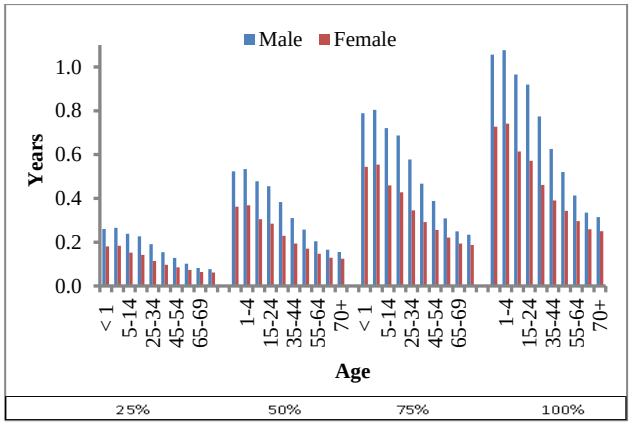

Figure 10: Potential gain in life expectancy after partial and complete elimination of injury, poisoning and certain other consequences of external causes (MCCD, 2015).

It is worth mentioning that males and females both are more burdened with diseases of the circulatory system. Thus, after elimination of circulatory disease, a female at birth could be expected to live 13.1 years longer than the actual life expectancy at birth for females. While a male at birth could be expected to live 11.1 years longer than the actual life expectancy at birth for males. There is a gender difference of 2 years favouring females in the potential gain in life expectancy at birth after complete elimination of the circulatory disease. Complete elimination of no other diseases reported such gender difference of gain in life expectancy.

The impact of neoplasms; diseases of blood and blood forming organs and certain disorders involving the immune mechanism; and endocrine, nutritional and metabolic diseases on the length of life are higher for females than those for males. On the other hand, males would live longer than females, if certain infectious and parasitic diseases; diseases of the respiratory system; diseases of the digestive system; and injury, poisoning and certain other consequences of external causes were eliminated. Elimination of the diseases of the nervous system and diseases of the genitourinary system would have equal impact on the life expectancy of both males and females and there would be no gender difference.

DISCUSSION

The study estimated the gender differences by examining the potential improvements in life expectancy in urban India after complete and partial elimination of ten leading causes of death. The maximum gain in life expectancy at birth was after complete elimination of mortality from diseases of the circulatory system (11.1 years in males versus 13.1 years in females); followed by certain infectious and parasitic diseases (2.2 versus 2.1 years); diseases of the respiratory system (2.2 versus 2.1 years); injury, poisoning and certain other consequences of external causes (1.1 versus 0.7 years); neoplasms (0.9 versus 1.0 years); endocrine, nutritional and metabolic diseases (0.8 versus 0.9 years); diseases of the digestive system (0.8 versus 0.4 years); diseases of the genitourinary system (0.6 versus 0.6 years); diseases of the nervous system (0.4 versus 0.4 years); and diseases of blood and blood forming organs and certain disorders involving the immune mechanism (0.2 versus 0.3 years).

These findings are in line with findings of other studies. Tsai et al found that elimination of cardiovascular disease would add 11.10 years in life expectancy at birth for white males and 12.81 years for white females.[18] The gain in life expectancy was 10.74 years for non-white males and 15.66 years for non-white females in the USA. Jayachandran et al found that the gains in life expectancy at different ages were varied by sex and cause.[19] The maximum gain in life expectancy at birth for males from respiratory disorders (cough) eliminated cause was 3.49 years but for females the cause was fever (3.21 years). Kulkarni et al found that net gain in life expectancy at birth was 11.5 years in males and 15.2 years in females when mortality due to cardiovascular diseases was eliminated in Goa.[20] An ICMR study found that infectious and parasitic diseases were the most common causes of deaths in Assam, Bihar, and Rajasthan.[21] However, diseases of the circulatory system were the most common causes of deaths in Maharashtra and Tamil Nadu.[21]

Six causes of deaths viz. certain infectious and parasitic diseases (11%); diseases of the nervous system (5.3%); diseases of the circulatory system (33.2%); diseases of the respiratory system (9%), diseases of the digestive system (4.4%) and injury, poisoning and certain other consequences of external causes (6.2%) constituted around 60% of the total medical certified deaths in 2015. There were 1183052 medically certified deaths (22%) in 2015, in the total registered deaths of 5374824 in India and this pertains to urban area only.[12] As per census 2011, around 70% (68.84%) population lives in rural areas.[22] If we take into consideration the same percentage of the total medically certified deaths and calculate the number of deaths under these six leading causes of deaths we would have a substantial number of deaths to be averted after eliminating these causes.

Limitation

While the potential gain in life expectancy seems to be a good indicator for measuring the burden of diseases, it has some limitations. According to this indicator life expectancy is extended by elimination of causes of deaths. However, life expectancy is also affected by many other factors, e.g., quality of health care, life style, economy, environment etc. Furthermore, improvement in the coverage of MCCD data is required for further strengthening of the study findings.

CONCLUSION

On the basis of study findings, the most important benefit in terms of gained years would be obtained after implementing the intervention programmes for reducing

mortality from circulatory diseases. It is generally accepted that the main risk factors for circulatory diseases can be influenced by the lifestyle changes with focus on both behavioural and dietary habits. These findings may have implications for practical decision making in setting up health goals, allocating resources and launching tailor-made health programmes. It may be pointed out that hypothesis of complete elimination of certain causes of death is not realistic but it is useful in giving the right weight to other competing risks.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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