Variation in Disability-Free Life Expectancy over a Decadal Aspect of Life in India

Sunita Sajwan
Research Scholar, Department of Statistics, NEHU, Shillong

Abstract **- Background: The present research paper describes about variation in disability-free life expectancy (DFLE) over a decadal characteristic of life using SRS and Indian Censuses 2001 and 2011.**
Methodology: Secondary data are utilized for the computation of DFLE within this paper based on SRS and Indian Censuses 2001 and 2011. Sullivan Technique is applied for the estimation of DFLE.
Objective: Aim of present research paper is to estimate DFLE of Indians based on Censuses 2001 and 2011. Statistical tests are also applied together with comparison.
Result: Census 2011 data exhibit higher growth rates of DFLEs than that of Census 2001. These observations show about significant differences in disability prevalence. Population in Census 2011 have longer life expectancies and also DFLE than that of population in Census 2001.
Conclusion: This study discusses about estimates of DFLE for Censuses 2001 and 2011 in India with their differentials. The inequalities in DFLEs are present. The result has an important implication to reduce inequalities between Indian Censuses 2001 and 2011 together with health component expectation. These findings will help to implement various policies by the policy makers. Estimates of DFLEs are statistically significant due to being all p-values lesser than $\alpha = 0.05$. All p-values are less than a common α level of 0.05.

Index Terms **- Disability-Free Life Expectancy; Life Table Technique; Statistical Tests, Sullivan Technique.**

1.INTRODUCTION

Life Expectancy (LE) is defined as the number of years on an average a person can expect to survive after attaining a certain age, x. LE is composed of average number of years a person is expected to survive in different states of health until occurrence of mortality on prevailing the current rate of mortality. The length of time remaining in different states of health combines information on both, mortality and morbidity. LE is generally constructed by two ways: Cohort Life Expectancy and Period Life Expectancy. LE describes number of years a person can be expected to survive the alive, whereas the Disability-free life expectancy (DFLE) represents the average number of years an individual expecting to survive free from disability, if current mortality and disability pattern is continued. Sanders (1964) have first time presented the concept of health indicators combining information related to mortality and morbidity. Sullivan (1971) then developed a technique to estimate the DFLE, which became popular among academicians. Health expectancy indices combine mortality and morbidity into a single composite indicator, which is very attractive device to monitor long-term trend for the evolution of health for addressing the expansion of morbidity in population. Sullivan technique thus utilizes the information related to prevalence of health states among India population. The observed age-specific prevalence of health states of a population in a given geographical area and at a given point of time is utilized for computation of DFLE in the Sullivan technique. The years of life survived in the various health states at each age are computed using a period life table cohort. Mathers and Robine (1997) discussed problems related to the validity of the Sullivan method first time raised by Bebbington, Brouard and Robine in 1989. Brouard and Robine (1992) argued in similar manner while incidence of disability is a flow to compute a pure period proportion of disabled people, not depending on the past flows. This could be used to compute pure period indicator of DFLE. Rogers, Rogers and Belanger (1990) advocated that the Sullivan method generates biased estimate of active LE in the direction of increased dependency (Sajwan and Singh, 2020). For constructing any planning and policy to calculate the DFLE, it is very important to understand the trend of healthy and DFLE persons. Government and international agencies have started setting up goal for

disability-free life along with total life and monitoring variation in disability-free life. Crimmins et al. (2016) examined variations in American persons (men and women) of all ages from 1970 to 2010. They concluded that a steady increase in both, DFLE and disabled LE over 40 years and average increase in DFLE observed more than the average increase in disabled life at age 65 years.

This paper discusses about variation in DFLE based on different factors using Sullivan technique. Statistical tests are also applied together with comparison.

2. PREVALENCE OF DISABILITY

Disability rate is increasing globally due to increasing the population and growing chronic disorder of health, variation in lifestyle and food habits etcetera. Constitution of WHO defined 'Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'. WHO states that over a billion of people (about 15% of the world's population) have some forms of disability. Article 25 of the UN Convention on the 'Rights of Persons with Disabilities' reinforces the right of persons with disability to attain the highest standard of health-care without discrimination on the basis of disability.

'Rights of Persons with Disability Act 2016'gives effect to the UN Convention on rights of persons with disabilities and for matters connected herewith or incidental thereto whereas the aforesaid Convention lays down the following principles for empowerment of persons with disabilities: (i) Respect for inherent dignity, individual autonomy including the freedom to make one's choices and independence of person (ii) Non-discrimination (iii) Full and effective participation and inclusion in society (iv) Respect for difference and acceptance of persons with disabilities as part of human diversity and humanity (v) Equality of opportunity (vi) Accessibility (vii) Equality between men and women (viii) Respect for the evolving capacities of children with disabilities and respect for the right of children with disabilities to preserve their identities and whereas India is a signatory to the said Convention (Right of Persons with Disability Act 2016).

Table 1 illustrates group-wise population and disabled population based on Indian Censuses 2001 and 2011 with their percentages in different age-group. A trend has been emerged that number of disable persons (Fig. 1) with their percentages is increasing among different age-group over a decade during various age-group (Fig. 2).

Table 1: Percentage of Disable Persons to Census Population

	Census 2001			Census 2011		
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Age-group	Total Population	Disable Population	Disable Population per Total Population (in %)	Total Population	Disable population	Disable population per Total population (in %)
0-4	11,04,47,164	11,99,872	1.09	11,28,06,778	12,91,332	1.14
5-9	12,83,16,790	20,57,043	1.60	12,69,28,126	19,55,539	1.54
10-19	22,50,62,748	44,75,281	1.99	25,32,35,661	46,16,050	1.82
20-29	17,31,86,525	32,71,049	1.89	21,28,38,187	41,89,839	1.97
30-39	14,48,48,129	28,47,944	1.97	17,37,35,635	36,35,722	2.09
40-49	10,31,47,273	23,70,987	2.30	13,47,56,439	31,15,651	2.31
50-59	6,42,40,906	18,38,417	2.86	8,82,15,309	24,92,429	2.83
60-69	4,73,23,734	19,18,586	4.05	6,41,18,690	26,57,679	4.14
70-79	2,12,59,869	12,32,462	5.80	2,84,41,345	17,69,370	6.22
80+	1,07,77,190	6,95,128	6.45	1,57,78,807	10,86,946	6.89
Total	1,02,86,10,328	2,19,06,769	2.13	1,21,08,54,977	2,68,10,557	2.21

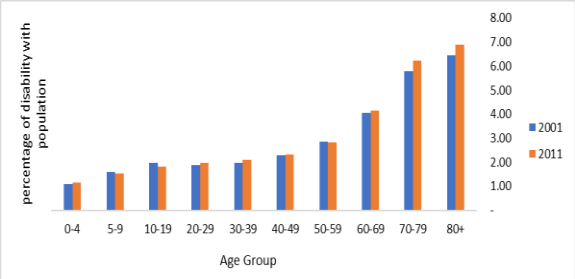

Fig. 1

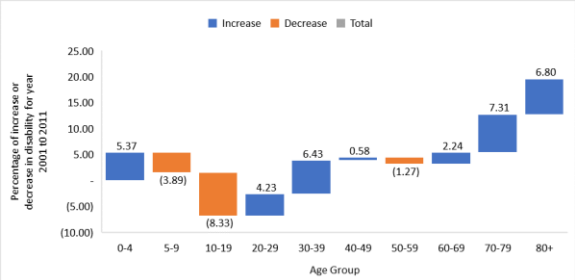

Fig. 2

3. METHODOLOGY WITH COMPUTATION OF LIFE EXPECTANCY OF DISABLE PERSONS USING SULLIVAN METHOD

Sanders (1964) proposed a concept of health expectancy as health indicators. Sullivan (1971) published the first example within a report of the US Department of Health Education and Welfare containing preliminary estimate of DFLE employing his own method devised, which is applicable for any state of health definition. In short, it is called as the 'Sullivan Health Expectancy (SHE)'. SHE reflects the current health of a real population adjusted for mortality levels and it is independent of age structure of the population. Sullivan technique became now-a-day popular technique to estimate DFLE. SHE provides a technique of comparing the health states of an entire population at two time points or of two different populations at the same time point, despite any differences in age composition (provided that the age intervals are not too large) and it also discusses about expectation of survival for several future years in healthy state of life at particular age of a person. Data on age-specific prevalence (in proportion) of the population in both, healthy and unhealthy states together with age-specific mortality information from a period LT are essential to compute SHE. Its computation is not possible if above information are not available. Quinquennial data on healthy and unhealthy states of human beings are preferred for its computation since it is not very sensitive to size of age-group. Emphasis should be given on chronic disease like cardiovascular disease due to originating ample human suffering, which creates significant threats to economies for concern counties and contributing towards health inequalities within population on the globe (WHO, 2002). Fries in 1908 discussed comparison of morbidity (appearance of ill-health) hypothesis assuming the fixed length of life and chronic disease together with related disability can be possible to postponed to older ages.

Application of a period LT and disability prevalence (a fundamental factor of population dynamics) is needed to compute DFLE by Sullivan technique. DFLE is computed combining data on mortality prevalence from a period LT and on disability prevalence from a cross-sectional disability survey.

There are two situations available in this discussion and they are called disability-free and with disability. LT functions are defined as:

Let l_x = No. of persons surviving to exact age x

L^x = Total No. of years lived in the age interval (x, x+5)

π^x = Observed prevalence of disability in the age interval (x, x+5)

$DFLE^x$ = Disability-Free Life Expectancy at age x

DLE^x = Life Expectancy with Disability at age x

Jagger, Oyen and Robin (2014) defined $DFLE^x$ and DLE^x using Sullivan technique as

$$DFLE^x = \frac{\sum_{i=x}^{w} L_i\,(DF)}{l_x} \quad \ldots (1)$$

$$DLE^x = \frac{\sum_{i=x}^{w} L_i\,(D)}{l_x} \quad \ldots (2)$$

where $L^i(DF)$ and $L^i(D)$ are number of persons survived from age x onwards in the state of disability-free and with disability up to w, the last age interval respectively.

Table 2: Disability-Free Life Expectancy of India, 2001

Age Group	Total life expectancy	Proportion of age group with disability	Disability free life expectancy
x-x+n	e_x	πx	*DFLEx*
0-9	63.88	0.013641	62.23
10-19	60.05	0.019885	58.37
20-29	50.87	0.018887	49.36
30-39	42.03	0.019662	40.67
40-49	33.25	0.022986	32.05
50-59	24.76	0.028618	23.74
60-69	17.39	0.040542	16.54
70-79	11.62	0.057971	10.94
80+	7.38	0.059164	6.94

Table 3: Disability-Free Life Expectancy of India, 2011

Age Group	Total life expectancy	Proportion of age group with disability	Disability free life expectancy
x-$x+n$	e_x	πx	$DFLEx$
0-9	68.60	0.013544	66.67
10-19	62.72	0.018228	60.80
20-29	53.29	0.019686	51.54
30-39	44.12	0.020927	42.53
40-49	35.10	0.023121	33.69
50-59	26.55	0.028254	25.31
60-69	18.83	0.041449	17.75
70-79	12.87	0.062211	11.96
80+	9.54	0.084078	8.74

Table 4. Statistical Test, Confidence Intervals and Standard Error Estimate

Age Group	2011				2001				p-value Pr(Z>|z|)
	Disability free life expectancy	Standard Error of Estimator	Confidential Interval at 95%		Disability free life expectancy	Standard Error of Estimator	Confidential Interval at 95%		
	DFLEx	S(DFLE$_x$)	Not less than	Not higher then	*DFLEx*	S(DFLE$_x$)	Not less than	Not higher then	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
0-9	66.67	0.223803	66.23	67.11	62.23	0.226971	61.79	62.68	<0.05
10-19	60.80	0.228904	60.36	61.25	58.37	0.241438	57.89	58.84	<0.05
20-29	51.54	0.222541	51.10	51.98	49.36	0.235842	48.90	49.82	<0.05
30-39	42.53	0.215749	42.11	42.96	40.67	0.229469	40.22	41.12	<0.05
40-49	33.69	0.207729	33.29	34.10	32.05	0.221787	31.61	32.48	<0.05
50-59	25.31	0.199493	24.92	25.70	23.74	0.211246	23.32	24.15	<0.05
60-69	17.75	0.190885	17.38	18.13	16.54	0.200242	16.14	16.93	<0.05
70-79	11.96	0.203015	11.56	12.35	10.94	0.210514	10.53	11.35	<0.05
80+	8.74	0.271794	8.21	9.27	6.94	0.252478	6.45	7.44	<0.05

There is a significant decline in the decadal population growth from 2001 to 2011 since independence. The population growth during 2001-2011 was 17.70%, it was found 22.67% during 1991-2001. Thus, a decline trend in decadal population growth has been observed. Confidence intervals are computed for Censuses 2011 and 2001 separately, which are depicted in columns 4 and 5 for 2011 and in columns 8 and 9 for 2001 in Table 4. Z-statistics are computed, and their differences are statistically tested. Now, p-values are level of significance for a two-tailed test for differences in their estimates of DFLE for Censuses 2001 and 2011. p-values have been calculated to cross-check the significance at $\alpha = 0.05$ and found that all the Z statistics are significant at level 0.05.

4. CONCLUSION

This study discusses about estimates of DFLE for Censuses 2001 and 2011 in India with their differentials. The inequalities in DFLEs are present. The result has an important implication to reduce inequalities between Indian Censuses 2001 and 2011 together with health component expectation. These findings will help to implement various policies for the policy makers. All p-values are less than a common α level of 0.05. Thus, they are statistically significance.

REFERENCES

[1] Brouard, N. and Robin , J.M (1992) ; "A method for calculation of health expectancy applied to longitudinal surveys of the elderly in France'' Health expectancy London: HMSO, pp.87-97
[2] Crimmins, E. M., Zhang, MS and Saio, S. (2016), "Trends over 4 Decades in Disability- Free Life Expectancy in the United States", American Journal of Public Health Association, Vol. 106 (7), pp. 1287-1293.
[3] Jagger, C., H. V. Oyen and J. M. Robin (2014), "Health Expectancy Calculation by the Sullivan Method: A Practical Guide", 4th Edition, Technical Report, European Health and Life Expectancy, Newcastle University.
[4] Mathers, C. D. and Robine, J. M. (1997), "How Good is Sullivan's Method for Monitoring Changes in Population Health Expectancy, Journal of Epidemiology and Community Health", Vol. 51 (1), pp. 80-86.
[5] Rogers, R. G. Rogers, A. and Belanger, A. (1990), "Longer Life but Worse Health Measurement and Dynamic", Gerontologist, Vol. 30 (5), pp. 640-649
[6] Sajwan, S. and Singh, R. (2020), "Disability-Free Life Expectancy in Urban and Rural Areas of India using Sullivan Technique", International Advanced Research Journal in science, Engineering and Technology, Vol. 7 (7), pp. 69-75.
[7] Sanders, B. S. (1964), "Measuring Community Health Levels", American Journal of Public Health, Vol. 54 (7), pp. 1063-1070
[8] Sullivan, D. F. (1971), "A Single Index of Mortality and Morbidity", HSMHA Health Reports, Vol. 86 (4), pp. 347 - 354.
[9] The Gazette of India (27 December 2016), 'Right of Persons with Disability Act 2016', No. 49 0f 2016, pp. 1-35.
[10] World Health Organization (2002), 'World Report of Disability', Department of Gender and Women's Health, WHO, Geneva.