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COVID-19 India – QALY Analysis

QUALITY ADJUSTED LIFE YEARS (QALY) – AN EVALUATION METRIC FOR HEALTHCARE INTERVENTIONS

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Contents

Quality Adjusted Life Years (QALY) – an Evaluation Metric for Healthcare Interventions

Introduction

The quality-adjusted life-year (QALY) is a measure of the value of health outcomes. Since health is a function of length of life and quality of life, the QALY was developed as an attempt to combine the value of these attributes into a single index number. The QALY calculation is simple: the change in utility value induced by the treatment is multiplied by the duration of the treatment effect to provide the number of QALYs gained.
To calculate the QALY, the following formula can be used; this assumes a utility value (quality of life) between 1 = perfect health and 0 = dead.

This results in the following:

- If an individual has perfect health for a period of 1 year, they will be said to have 1 QALY, i.e., 1 year of Life x 1 Utility Value = 1 QALY
- If an individual lives in perfect health but only for half a year, that individual will have 0.5 QALY, i.e., 0.5 Years of Life x 1 Utility Value = 0.5 QALY
- If an individual lives for 1 year in a situation with 0.5 utility (half of perfect health) that individual will have 0.5 QALY, i.e., 1 Year of Life x 0.5 Utility Value = 0.5 QALY

QALY and COVID-19

The COVID-19 pandemic has prompted governments in various countries including those in India to opt for a social lockdown as a strategy of intervention. In this study, we try to obtain the optimal duration of the lockdown.
The duration of the lockdown should be such that the QALY lost due to this intervention is not more than that lost by not adopting the intervention strategy. In order to compute this, we require to estimate the quality of life (Q) enjoyed by individuals during a lockdown relative to days without any social or physical restriction. For this purpose, a questionnaire was floated to individuals asking them to rate their perceived quality of life during the lockdown on four aspects – emotional, economic, social and physical, and to rate the importance of each aspect individually. The weighted average of their response was used to compute the value of Q, which came to be 0.66. In other words, the quality of life experienced during the lockdown was roughly 34% lower. It was assumed that individuals below the age of 23 would not experience a loss in quality of life due to the lockdown since most of them would treat this period as an extended period of holidays. The lockdown would affect mostly the group of employed or homemaking individuals – between ages 23 to 60. This group (p_{emp}) comprises 45.64% of the Indian population (P) of 1.3 billion. Likewise, the senior individuals (aged above 60), i.e., the group most at risk of the disease (p_{sen}) comprises 8.57% of the total population.

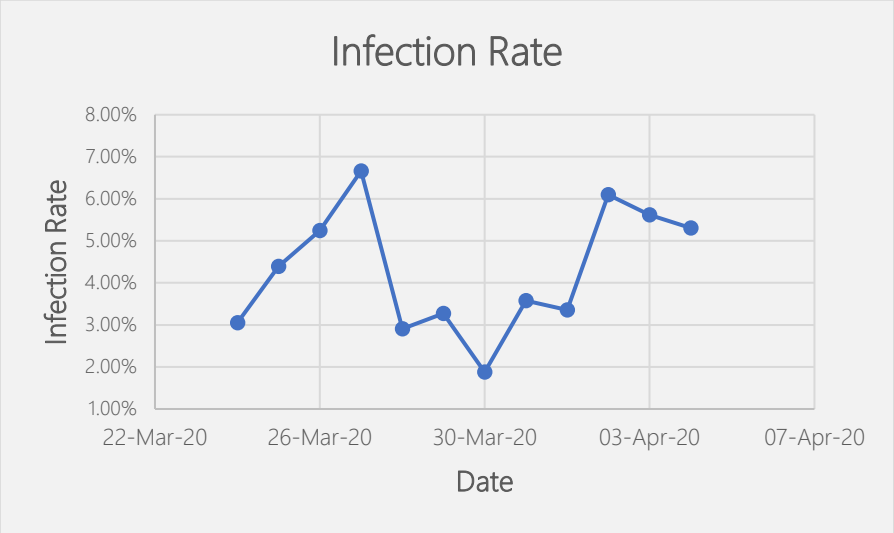
The table below shows the distribution of population by age:

Age Cohort	Share of Population
23-27	4.50%
28-32	8.38%
33-37	7.32%
38-42	7.03%
43-47	5.98%
48-52	5.15%

53-57	4.05%
58-60	3.23%

The median age of this group (A_{emp}) came to be 37.51 years. Also, the infection rate (I), as seen from data released by ICMR, ranges between 2.5% to 6.6%.

Date	Infection Rate
24-Mar-20	3.05%
25-Mar-20	4.39%
26-Mar-20	5.24%
27-Mar-20	6.66%
28-Mar-20	2.91%
29-Mar-20	3.27%
30-Mar-20	1.88%
31-Mar-20	3.58%
01-Apr-20	3.36%
02-Apr-20	6.10%
03-Apr-20	5.62%
04-Apr-20	5.30%



For the purpose of this study we will take I to be a pessimistic 7%.

Cost of Lockdown

The cost of lockdown is computed by the formula

$$(1 - Q) * P * p_{emp}$$

= (1-0.66)*1.3*10^9*0.4564 = 1.97*10^8 life days.....(1)

This is equal to the loss of quality of living, times the population of the working/homemaking group of individuals aged between 23 to 60.

Cost of No Intervention

This cost of no intervention is computed in three parts:

1. Loss of life days through illness: It is seen that COVID-19 shows mild symptoms in only a share of the individuals aged between 23 to 60. This lasts for typically 4 days, t_{ill} = 4. During this period, we assume

that the individual experiences a life of, highly pessimistic, zero quality. Therefore, the cost is computed by the formula

$$(1 - Q) * P * p_{emp} * I * t_{ill}$$

= (1-0)* 1.3*10^9*0.4564*0.07*4 = 1.66*10^8 life days.....(2)

2. Loss of life through death in the working/homemaking (low risk) group: The COVID-19 infections would lead to deaths in this cohort. Its median fatality rate (F_{emp}) came to be 1.51%.

Cases	Deaths	CFR	Age
98	0	0.00%	23-27
65	0	0.00%	28-32
81	1	1.23%	33-37
81	1	1.23%	38-42
53	2	3.77%	43-47
60	1	1.67%	48-52
62	2	3.23%	53-57
30	1	3.33%	58-60
Median		1.51%	37.51

Death would mean that the remainder of the expected lifespan would be lived at a quality of zero. Average life expectancy of an Indian at 37.51 years (L_{emp}) is 71 years, i.e., another 33.5 years. Therefore, the cost is computed by the formula

$$(1 - Q) * P * p_{emp} * I * F_{emp} * (L_{emp} - A_{emp}) * 365$$

= (1-0)* 1.3*10^9*0.4564*0.07*0.0151*(71-37.51)*365 = 7.66*10^9 life days.....(3)

3. Loss of life through death in the senior citizens (high risk) group: The median fatality rate for this cohort (F_{sen}) came to be 7.22%.

Cases	Deaths	CFR	Age
50	4	8.00%	61-65
31	7	22.58%	66-70
9	1	11.11%	71-75
12	2	16.67%	> 75
Median		7.22%	68.53

The median age for this cohort (A_{sen}) came to be 68.53 years. Therefore, the cost is computed by the formula

$$(1 - Q) * P * p_{sen} * I * F_{sen} * (L_{sen} - A_{sen}) * 365$$

= (1-0)* 1.3*10^9*0.0857*0.07*0.0722*(71-68.53)*365 = 6.16*10^8 life days.....(4)

Thus, the total cost of no intervention comes to (2) + (3) + (4) = (1.66*10^8 + 7.66*10^9 + 6.16*10^8) life days = 8.45*10^9 life days.....(5)

Optimal Duration of Lockdown

The optimal duration of the lockdown would thus be obtained by dividing the cost of no intervention by that of the lockdown, i.e., (5)/(1) = (8.45*10^9/1.97*10^8) life days = 42.83 days.