UNIT 2 ROLE OF HEALTH IN HUMAN DEVELOPMENT

Structure

2.0 OBJECTIVES

After reading this unit, you will be able to:

- outline the measurement issues of health at the individual level and at the macro level;
- state the components and rationale behind the HDI, 2010;
- show the interdependence between income, healthcare expenditure and health;
- explore the causality between health and poverty;
- discuss the concept of 'equally distributed equivalent achievement' (EDEA) in the context of 'gender adjusted health equality' (GAHE) goals;
- define the concepts of Concentration Curve and Concentration Index (CI); and
- estimate health inequality empirically (at the individual and group level)
- using Concentration Index.

2.1 INTRODUCTION

For long, the principal indicator of the measurement of economic development used to be taken as the growth rate of GDP or per capita GDP. Cross country growth comparisons however suggested that a country having higher level of income need not necessarily have a higher health status or educational level. This meant that income or its growth does not always ensure the well-being of the people. This realisation led to the development of the concept of human development resulting in a distinct shift in the focus of development economics from national income accounting to people-centric indicators like the HDI in the 1990s. Human development came to be defined as a process of enlarging people's choices, particularly in three essential choices viz. (i) by leading a long and healthy life, (ii) with skills acquired by education and (iii) by having access to resources needed for maintaining a decent standard of living. It was recognised that if these choices are not available, many other opportunities would remain inaccessible. For measurement purposes, for each dimension of human development (viz. longevity, educational attainment and access to resources), a relative 'distance' from a 'norm' was calculated, and a value between 0 and 1 assigned to help in its aggregation and serve as a composite indicator. In this unit, we shall specifically focus on the analytical aspects linking health with human development.

2.2 HEALTH AND HUMAN DEVELOPMENT

Health has been a multi-dimensional concept, difficult to define and measure, especially at the individual level. At the individual level, it includes risk of mortality or morbidity, physical limitations caused by injuries, level of pain, chronic health disorder, psychological well-being, etc. In other words, an individual's perception about the ill-being or well-being of health varies widely as it is highly subjective depending up on the above factors. It varies over time and across different age cohorts. In view of this, to assess the health status of an individual, it requires a combination of subjective and objective measures. To deal with this, the issue of measurement has followed the approach of first assessing it at a macro level, using which the individual's health status can then be assessed. For instance, BMI (i.e. body mass index) is tabulated for different regions, gender-wise, on the basis of which an individual can assess for himself, whether he/she is obese or overweight or fit. Similar indicator are available for malnutrition. You have studied about these in Unit 7 of Course 11 (Indian Economy I). Another such indicator about which we shall now study is SAHS i.e. self reported health status. This is computed and used as follows.

At macro level, health status of a community or cohort can be assessed based on the data collected on the performance of a group of individuals (belonging to a specific age cohort). Using Likert scale (i.e. a 5 to 7 point scale used to

allow the individuals to express how much they agree or disagree with a particular statement), a group of individuals belonging to a specific age cohort are asked to report their position 'ordinally' (i.e. in relative terms) on some basic functions (e.g. walking, breathing, digestion, hearing, chronic health disorder, etc.). Once observations on these parameters are recorded for a group of individuals belonging to a specific age cohort, a cardinal number (i.e. a numerical value) can then be assigned (for each ordinal ranking) for each one of the specific functions. An individual can then obtain a score based on his/her self-assessment of his health status. Such a score or index obtained by the individual is known as 'self assessed health status' (SAHS). SAHS is easy to estimate and is shown to be a strong predictor of more subjective measures of health. However, SAHS has some limitations. Besides being subjective, it suffers from cultural bias. It is also influenced by personality, general outlook, social and economic environment.

Health status at the macro level (viz. a country) can be estimated by considering factors like life expectancy at birth (LE), infant mortality rate (IMR), maternal mortality rate, morbidity prevalence rate, etc. Life expectancy at birth (LE) is considered as the best measure of health for cross-country comparison as it is assumed that countries showing higher LE manifest higher health status. However, it may not be always true unless the quality adjusted life years is taken into account.

2.2.1 Human Development Index

The computation of human development index (HDI) has evolved over time since the 1990s. The Human Development Report (2010) used a revised formula to measure the HDI by taking into account a combination of three dimensions as follows:

- a long and healthy life captured by Life expectancy at birth (LE);
- knowledge dimension captured by 'mean years of schooling' and 'expected years of schooling'; and
- access to resources for a decent standard of living captured by gross national income (GNI) per capita (measured in $PPP i.e. purchasing power parity dollars)

a) **Life Expectancy Index (*LEI*)**

$$LEI = \frac{LE - 20}{85 - 20} \qquad (2.1)$$

LEI is 1 when Life expectancy at birth is 85 and 0 when Life expectancy at birth is 20.

b) **Education Index (*EI*)**

$$EI = \frac{MYSI + EYSI}{2} \qquad (2.2)$$

Mean Years of Schooling Index (MYSI) $= \frac{\text{MYS}}{15}$, where 15 years of schooling is taken to yield the value of 1 (the projected maximum to be attained by 2025). Expected Years of Schooling Index (EYSI) $= \frac{\text{EYS}}{18}$, where 18 years of schooling, equivalent to achieving a master's degree in most countries, is kept as the target yielding the full score of 1 on its attainment.

c) **Income Index (II)** $= \frac{\ln \text{ PCGNI} - \ln 100}{\ln 75{,}000 - \ln 100}$ (2.3)

where PCGNI = Per Capita Gross National Income measured in \$PPP. The Income Index (II) is 1 when GNI per capita is \$75,000 and 0 when GNI per capita is \$100.

Finally, the HDI is the geometric mean of the previous three normalised indices:

Human Development Index (*HDI*) = $\left[LEI.EI.II\right]^{\frac{1}{3}}$ (2.4)

Illustration: The values of HDI of a country for the year 2011 and 2016 are 0.82 and 0.89 respectively. The country's educational (EI) and income indices (II) are assumed to be fixed over 2011-2016. The initial life expectancy (for the year 2011) was 60 years. Estimate the value of LE for the year 2016. What is the percentage increase in LE over 2011-16?

Using Equation (2.4), we can write:

HDI for 2011: $0.82 = HI^{1/3}.EI^{1/3}.II^{1/3}$ (2.4_a)

where $HI = \frac{60-20}{65} = 0.6153$

HDI for 2016: $0.89 = (HI*)^{1/3}.EI^{1/3}.II^{1/3}$ (2.4_b)

where $HI* = \frac{LE*-20}{85-20} = \frac{LE*-20}{65}$ assuming $LE*$ to be the life expectancy for the year 2016. Divide Equation (2.4_b) by (2.4_a), we have: $\frac{0.89}{0.82} = \frac{(HI*)^{1/3}.EI^{1/3}.II^{1/3}}{HI^{1/3}.EI^{1/3}.II^{1/3}} = 1.0854.$

Since EI and II are assumed to be the same for the two time points, raising the above to the power 3, we get:

$$\Rightarrow \frac{HI*}{HI} = 1.2785 \Rightarrow HI* = 1.2785 * HI = 1.2785 * 0.6153 = 0.7866$$

$$\Rightarrow \frac{LE*-20}{65} = 0.7866 \Rightarrow LE* = 51.13 + 20 = 71.13$$

Hence, the percentage increase in life expectancy (*LE*) over 2011-2016 is:

$$\frac{LE*(2016) - LE(2011)}{LE(2011)} \times 100 = \frac{11.13}{60} \times 100 = 18.55$$

2.2.2 Health, Income and Healthcare Expenditure: Relationship

Following certain basic assumptions [that: (i) health stock depends on healthcare spending; (ii) healthcare spending depends on income; and (iii) change in income depends on current health status], a simple model to describe the relationship between health, income and healthcare expenditure can be specified as follows:

$$\frac{dY}{dt} = Y_t^{'} = h + \alpha H_t \qquad (2.5)$$

$$\frac{dH}{dt} = H_t^{'} = a + \delta S_t \qquad (2.6)$$

$$S_t = c + \tau Y_t \qquad (2.7)$$

where $0<\tau<1$, change in income i.e. $\frac{dY}{dt}$ is expressed as a function of the current health status H_t, change in health i.e. $\frac{dH}{dt}$ is expressed as a function of the current healthcare spending S_t spending on healthcare S_t is expressed as a function of the current income level Y_t with h, a, c, α, δ and τ all assumed to be non-zero. Substituting the value of S_t in Equation 2.6, we get:

$$\frac{dH}{dt} = H_t^{'} = a + \delta\left(c + \tau Y_t\right) = (a + \delta c) + \delta\tau Y_t = d + \gamma Y_t \qquad (2.8)$$

where, $d = a+\delta c$ and $\gamma = \delta\tau$. Differentiating Equation (2.8) w.r.t time 't' and substituting the value of $Y_t^{'}$ (obtained from Equation 2.5), we get:

$$\frac{d^2H}{dt^2} = H_t^{''} = \gamma\frac{dY_t}{dt} = \gamma\left(h + \alpha H_t\right) = \gamma h + \alpha\gamma H_t \qquad (2.9)$$

Differentiating Equation (2.5) w.r.t time 't' and substituting the value of $H_t^{'}$ obtained in Equation (2.8), we get:

$$\frac{d^2Y}{dt^2} = Y_t^{''} = \alpha H_t^{'} = \alpha\left(d + \gamma Y_t\right) = \alpha d + \alpha\gamma Y_t \qquad (2.10)$$

Equations (2.9) and (2.10) are 2nd order non-homogenous differential equations. Therefore, solution of each equation consists of two parts: a 'particular integral' (PI) and a 'complementary function' (CF).

Let the trial solution of PI of Equation (2.9) be $H_t = k$, so that, $H_t^{'} = H_t^{''} = 0$ and the PI from Equation (2.9) becomes: $PI = k = -\frac{h}{\alpha}$. In order to find the CF, we consider the trial solution as: $H_t = Ae^{rt}$ (i.e. we assume constant compounded growth with respect to time 't') so that $H_t^{'} = Are^{rt}$ and $H_t^{''} = Ar^2e^{rt}$. The homogenous part of Equation (2.9) thus becomes:

$\frac{d^2H}{dt^2} - \alpha\gamma H_t = 0$. Inserting the trial solution of CF, we get:

$Ar^2e^{rt} - \alpha\gamma.Ae^{rt} = 0 \Rightarrow Ae^{rt}\left(r^2 - \alpha\gamma\right) = 0$

$\Rightarrow Ae^{rt} \neq 0, \left(r^2 - \alpha\gamma\right) = 0 \Rightarrow r = \pm\sqrt{\alpha\gamma}$

The general solution of Equation (2.9) becomes: $H_t = Ae^{t\sqrt{\alpha\gamma}} - \frac{h}{\alpha}$ where we ignore the negative root. A is the arbitrary constant determined by the initial condition. Putting, t=0, we have: $H_0 = A - \frac{h}{\alpha} \Rightarrow A = H_0 + \frac{h}{\alpha}$. Therefore, the complete solution of Equation (2.9) becomes:

$$H_t = \left(H_0 + \frac{h}{\alpha}\right)e^{t\sqrt{\alpha\gamma}} - \frac{h}{\alpha} \qquad (2.11)$$

Equation (2.11) is the time path of health H_t. Since it can be assumed that initial health stock (H_0) is determined by initial level of income (Y_0), Equation (2.11) becomes:

$$H_t = \left(Y_0 + \frac{h}{\alpha}\right)e^{t\sqrt{\alpha\gamma}} - \frac{h}{\alpha} \qquad (2.11_a)$$

Similarly, the time path of income can be derived as:

$$Y_t = \left(Y_0 + \frac{d}{\gamma}\right)e^{t\sqrt{\alpha\gamma}} - \frac{d}{\gamma} \qquad (2.12)$$

The time path of income and health is closely related. If we insert the value of $e^{t\sqrt{\alpha\gamma}}$ obtained from Equation (2.11) into the Equation (2.12), we can see that income is determined by health. In the same way, one can easily check that health path is also influenced by level of income. This analytically establishes the interdependence of health with healthcare spending and income.

2.2.3 Causality between Health and Poverty

Health and poverty is jointly determined i.e. the two cannot be separated as poverty cannot be eradicated without considering health issues of the population. In other words, there is a two-way relationship i.e. health affects poverty and poverty affects health. A vicious cycle of poverty is generated in poor countries where low health status plays a major role in causing a low level equilibrium trap. Among the reasons put forward to indicate how poverty affects health are:

a) the poor have low level of material resources and hence they cannot purchase healthcare from the market. As a result, they incur huge medical expenses when they become sick;

b) due to distance of public health centers/hospitals and the transportation/ transaction costs involved, the poor cannot access the public healthcare facilities;

c) in poor countries, public healthcare is poorly organised and managed. Hence, public hospitals cannot manage to provide adequate healthcare to the patients. This leads to deterioration of health of the patients who then need immediate and proper medical intervention. Moreover, poor people reside in remote and rural areas, where public healthcare facility is either inadequate or unavailable;

d) one can avoid some of the diseases by taking preventive measures, but due to lack of income, the poor are unable to take such preventive measures;

e) poor families prefer more number of children since they provide economic incentives to the parents by working instead of going to school. This adversely affects the reproductive health of the mothers and newborn babies; and

f) poverty makes the people more vulnerable to infectious and communicable diseases increasing the probability of their death. Due to lack of income poor people cannot consume nutritious food.

Likewise, following reasons are put forward to indicate how health affects poverty.

a) Malnourished children are less attentive in the class and their performance is poor compared to healthy children. The absenteeism in school is also found to be high among the unhealthy children. Unhealthy children in the long-run are forced to join informal or unorganised sector where wage rate is low and irregular. This aggravates poverty.

a) Mortality is found to be high among the poor. If the principal earner of a family dies at an early age, the whole family falls into poverty. The dependents (viz. children) are forced to join informal jobs to avoid destitution aggravating poverty in the long-run.

b) Catastrophic health expenditure faced by poor people leads to poverty. If a member of a poor family suffers from an incurable disease, the family is forced to borrow to spend on medical care leading to poverty.

b) If the majority of the population of a country suffer from communicable and contagious disease, the foreign direct investment as well as tourism will be adversely affected. As a result, the health status of the poor counties will remain poor.

Check Your Progress 1 [answer within the space given in about 50-100 words]

1) How is the health status of a country measured?

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2) Define Self-Assessed Health Status (SAHS). What are its advantages and disadvantages?

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3) How is Human Development defined? How is it different from economic development?

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4) How does health enter into the human development index (HDI)?

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5) The values of HDI of a country for the year 2011 and 2016 were 0.72 and 0.81 respectively. The country's educational (EI) and income indices (II) are assumed to be fixed over 2011-2016. The initial life expectancy (for the year 2011) was 65 years. How do we estimate the value of LE for the year 2016? What is the percentage increase in LE over 2011-2016?

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6) How does health affect poverty?

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7) How does poverty affect health?

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2.3 HEALTH AND GENDER DEVELOPMENT

Human development index (HDI) is gender insensitive whereas 'gender development index' (GDI) is gender inequality adjusted human development. Gender development plays an important role in the context of inclusive growth and social justice. Gender discrimination directly affects the well-being of women, thus, gender equality is a legitimate policy goal. Discrimination against female is not generally observed in the developed counties but is more acute in the counties in Asia, especially South Asia including China and Korea.

According to Global Gender Gap Report-2016 compiled by World Economic Forum (WEF, 2016), out of four pillars of development (viz. health and survival, work force participation, educational attainment and political empowerment), India's position is almost at the bottom (India is placed at 142nd rank out of 144 countries). India has been progressing in terms of economic growth but such economic growth fails to correct gender imbalance in respect of health and survival.

2.3.1 Gender Adjusted Health Equality (GAHE)

Following the methodology developed by UNDP (1995), we consider X to be the indicator of development, say, the literacy rate with X_f and X_m standing for female and male literacy rate respectively. We further assume that $X_f < X_m$ and N_f and N_m are the female and male population size. The overall or mean literacy ($\overline{X}$) is therefore given by:

$$\overline{X} = \frac{N_f X_f + N_m X_m}{N_f + N_m} \qquad (2.13)$$

(2.13) can be written as: $\overline{X} = P_f X_f + P_m X_m$ where, P_f and P_m are the proportion of female and male population respectively. We want to increase $\overline{X}$ on the one hand and reduce ($X_m - X_f$) on the other. In order to solve this problem, we consider a social valuation function for achievement that is

'additively separable, symmetric and of constant elasticity marginal valuation' as:

$$V(X) = \frac{X^{1-\varepsilon}}{1-\varepsilon} \text{ , for } \varepsilon \geq 0 \text{ but } \varepsilon \neq 1 \quad (2.14a)$$

$$V(X) = \ln X \text{ , for } \varepsilon = 1 \quad (2.14b)$$

where ε stands for inequality aversion parameter with ε ≥ 0 being considered to reflect a preference for equality. For any pair (X_f, X_m) of female and male achievements, we can construct an 'equally distributed equivalent achievement' variable, X_{EDEA} , defined as the level of achievement that, if attained equally by women and men as (X_{EDEA}, X_{EDEA}), would be judged to be exactly as valuable socially as the actually observed achievements (X_f, X_m). We, therefore, have:

$$X_{EDEA} = \left\{P_f X_f^{1-\varepsilon} + P_m X_m^{1-\varepsilon}\right\}^{\frac{1}{1-\varepsilon}} \quad (2.15)$$

where, X_{EDEA}, is formed from (X_f, X_m) by taking what is called as '(1 – ε) average' of X_f and X_m rather than a simple arithmetic average of the female and male achievements. The optimum trade-off between higher achievement and gender equality is achieved through X_{EDEA} for ε > 0. When ε = 0, X_{EDEA} reduces to $\overline{X}$, the simple arithmetic average i.e. there is no concern for equality. But when ε > 0, there is a social preference for equality (or an aversion to inequality) measured by the magnitude of the parameter ε. Thus, ε is interpreted as preference to equality. Equation (2.15) is valid for literacy rate (or work force participation rate) but is not directly applicable to life expectancy. This is because potential life expectancy of female is higher than that of male. Women's higher potential life expectancy is anticipated in demographic projections as well; for the year 2050, for example, life expectancy in industrial countries is projected at 87.5 years for women and 82.5 years for men, averaging to 85 years (UNDP 1993). In considering the disaggregation of the HDI by gender, the UNDP has used separate goal posts for maximum life expectancy for females and males as 87.5 and 82.5 years respectively, reflecting a 5 year gender gap. Minimum life expectancy has been taken to be 27.5 years for females and 22.5 years for males, giving the same range of variation (60 years) for both sexes.

In the disaggregation of the HDI by gender in the UNDP's report, female and male achievements in life expectancy, X_f and X_m, have been assessed through:

$$X_f = \frac{L_f - 27.5}{87.5 - 27.5} = \frac{L_f - 27.5}{60} \quad (2.16)$$

$$X_m = \frac{L_m - 22.5}{85.5 - 25.5} = \frac{L_m - 22.5}{60} \quad (2.17)$$

where L_f and L_m are the actual female and male life expectancies.

The simple arithmetic mean (AM) $\overline{X}$ of X_f and X_m, assuming equal population share of female and male:

$$\overline{X} = \frac{X_f + X_m}{2} = \frac{1}{2}.\left[\frac{L_f - 27.5}{60} + \frac{L_m - 22.5}{60}\right] = \frac{1}{2}.\frac{1}{60}\left[\left(L_f + L_m\right) - 50\right]$$
$$= \frac{1}{60}\left[\left(\frac{(L_f + L_m)}{2} - \frac{50}{2}\right)\right] \qquad (2.18)$$
$$= \frac{1}{60}\left[\overline{L} - 25\right] = \frac{\overline{L} - 25}{60}$$

where, $\overline{L} = \frac{L_f + L_m}{2}$

Thus, the approach to adjusting for gender inequality for life expectancy must first involve a rescaling to take note of the potentially greater longevity of women. Such adjustments are a part of the methodology already under use by UNDP in estimating GDI. Therefore, instead of taking simple AM of X_f and X_m, we take (1 – ε) average (for ε > 0). As before, we form the average X_{EDEA}, for ε ≠ 1 as:

$$X_{EDEA}^{1-\varepsilon} = 0.5 * X_f^{1-\varepsilon} + 0.5 * X_m^{1-\varepsilon} \qquad (2.19)$$

Using Equations (2.15) and (2.18) and inserting the adjusted values of X_f and X_m, and replacing L for life expectancy, we get:

$$\left[\frac{L_{EDEA} - 25}{60}\right]^{1-\varepsilon} = 0.5 * \left[\frac{L_f - 27.5}{60}\right]^{1-\varepsilon} + 0.5 * \left[\frac{L_m - 22.5}{60}\right]^{1-\varepsilon} \qquad (2.20)$$

when $\varepsilon = 0, L_{EDEA} = \overline{L}$, if $\varepsilon > 0, L_{EDEA} < \overline{L}$. Thus, L_{EDEA} is the gender adjusted Life Expectancy.

UNDP (1995) has suggested the value of ε = 2, which is assumed to be moderate inequality aversion parameter in preference to equality.

2.3.2 Empirical Exercise

A numerical exercise will help us to understand the problem of 'equally distributed equivalent achievement' in respect of health variable viz. LE. In order to simplify the problem, let us consider two countries, A and B. The life expectancy of the two countries, for male and female, is given below.

Country	Female Life Expectancy (LE_f)	Male Life Expectancy (LE_m)
A	72	70
B	72	74

From Equation (2.20), we can write:

$$\left[\frac{L_{EDEA}-25}{60}\right]=\left[0.5*\left(\frac{LE_f-27.5}{60}\right)^{1-\varepsilon}+0.5*\left(\frac{LE_m-22.5}{60}\right)^{1-\varepsilon}\right]^{1/1-\varepsilon}$$

L_{EDEA} stands for equally distributed equivalent achievement representing gender adjusted life expectancy at birth. Now, we insert the values of LE_f and LE_m and setting inequality aversion parameter, ε=2 which are assumed to be moderate as suggested by UNDP (1995) for country A:

$$\left[\frac{L_{EDEA}-25}{60}\right]=\left[0.5*\left(\frac{72-27.5}{60}\right)^{1-2}+0.5*\left(\frac{70-22.5}{60}\right)^{1-2}\right]^{1/1-2}$$

$$\text{Or, } \left[\frac{L_{EDEA}-25}{60}\right]=\left[0.5*(0.7416)^{-1}+0.5*(0.7916)^{-1}\right]^{-1}=0.7657$$

$$\Rightarrow L_{EDEA}=60*0.7657+25=70.94$$

In the same way, we can estimate the EDEA of life expectancy for country B as:

$$\left[\frac{L_{EDEA}-25}{60}\right]=\left[0.5*\left(\frac{72-27.5}{60}\right)^{1-2}+0.5*\left(\frac{74-22.5}{60}\right)^{1-2}\right]^{1/1-2}$$

$$\Rightarrow L_{EDEA}=0.7957*60+25=72.74$$

Gender adjusted life expectancy (L_{EDEA}) is socially desirable. It makes some optimum trade-off between overall life expectancy and gender differential in life expectancy.

In the context of focusing on health for optimum human resource development, 'reproductive and child health' (RCH) is kept as the broader goal. RCH has a multidimensional sphere which includes pregnancy, child birth and post partum care, maternal and infant nutrition, breastfeeding, sexual behaviour, STDs and HIV/AIDS and reproductive rights. Under these circumstances, there is an increasing thinking in the scientific community on the need to stress on maternal health in essence of their reproductive health problems. India, at the aggregate level is expected to enjoy the benefit of demographic dividend roughly after 2025 but only the numbers of working age cohort cannot guarantee to generate sufficient income if the health status of the future working population remains poor. Thus, in order to get the real benefit of demographic dividend in near future, we must know about the present health status of the mothers and children so that appropriate measures can be undertaken to improve RCH.

Check Your Progress 2 [answer within the space given in about 50-100 words]

1) Define gender adjusted heath equality.

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2) Define Equally Distributed Equivalent Achievement (EDEA) in respect of life expectancy.

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3) Why re-scaling of LE of both male and female is needed to estimate EDEA of LE?

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4) Assume that female and male life expectancy is 63 and 62 respectively of a country, A. The maximum life expectancy for females and males are 87.5 and 82.5 years respectively, reflecting a 5 year gender gap. The Minimum life expectancy has been taken to be 27.5 years for females and 22.5 years for males, giving the same range of variation (60 years) for both sexes. Find gender adjusted life expectancy (viz. EDEA of LE) of the country A.

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2.4 HEALTH INEQUALITY AND SOCIO-ECONOMIC STATUS

Health and health seeking behaviour of the individuals depends on socio-economic status. The term socio-economic status includes: income, occupation, consumption pattern, education, caste, culture, life style, religion, living conditions, work place environment, residence in rural or urban, etc.

Age of an individual also affects health as children and old-age people are more vulnerable with their probability of death being higher than the youth. Thus, a large number of predictors affect the health of an individual. Health inequality varies between different socio-ethnic and cultural groups. Health inequality also directly varies with the educational status of individuals. Geo-climatic conditions, occupations and income also affect the inequality of health of different communities.

2.4.1 Concentration Curve and Concentration Index (CI)

Health inequality is much more serious than income inequality. Income inequality can be reduced by imposing tax or by other measures but health inequality is structural in nature i.e. there is no automatic mechanism to eliminate health inequality. It requires longer time to bring down health inequality as compared to income inequality as the latter can be reduced even in short term by transferring income from rich to poor. Health inequality may create negative externality. For instance, a domestic helper with TB has a higher chance of affecting others by TB, especially kids, and the old aged.

There are three classes of inequality measures viz. (i) Lorenz class (e.g. Gini coefficient), (ii) Entropy class (e.g. Mean Log Deviation, Theil Index, Coefficient of Variation) and Welfare Based Measure (e.g. Atkinson Index). All these measures, with their own merits and demerits, are used mainly to estimate income, education and health inequality. But Concentration Curve (CC) and Concentration Index (CI) are explicitly used to identify socio-economic inequality i.e. whether it is more pronounced at one point in time than another or in one country than another. But a concentration curve does not give a measure of the magnitude of inequality whereas the concentration index (CI) does it by quantifying the degree of socio-economic inequality with a particular focus on a health variable. It is used to measure and compare the degree of socio-economic inequality in respect of: child mortality, child immunisation, child malnutrition, adult health, health subsidies, healthcare utilisation, etc. In this section, we will first define the CI and its properties. We then describe its estimation procedure for grouped and micro-data.

Concentration Curve (CC) plots the cumulative percentage of health variable against the cumulative percentage of population ranked by socio-economic status. For instance, in Fig. 2.1, horizontally we have measured cumulative percentage of population ranked by income and vertically we have measured the cumulative percentage of ill health. The figure depicts that ill health (bad health) is disproportionately higher among the poor people since the CC lies above the line of equality. In other words, it plots shares of the health variable against the variable for living standards. The CI is defined as twice the area between the CC and the line of equality (i.e. the 45-degree line). Thus, when there is no socio-economic inequality, the CI is zero. The convention is to assign a negative value to CI when the curve lies above the line of equality to indicate disproportionate concentration of ill-health among the poor, and a positive value when it lies below the line of equality. In

particular, if the health variable is a 'bad' like ill health [e.g. infant mortality rate (IMR), malnutrition, anemia], a negative value of CI means ill-health is higher among the poor.

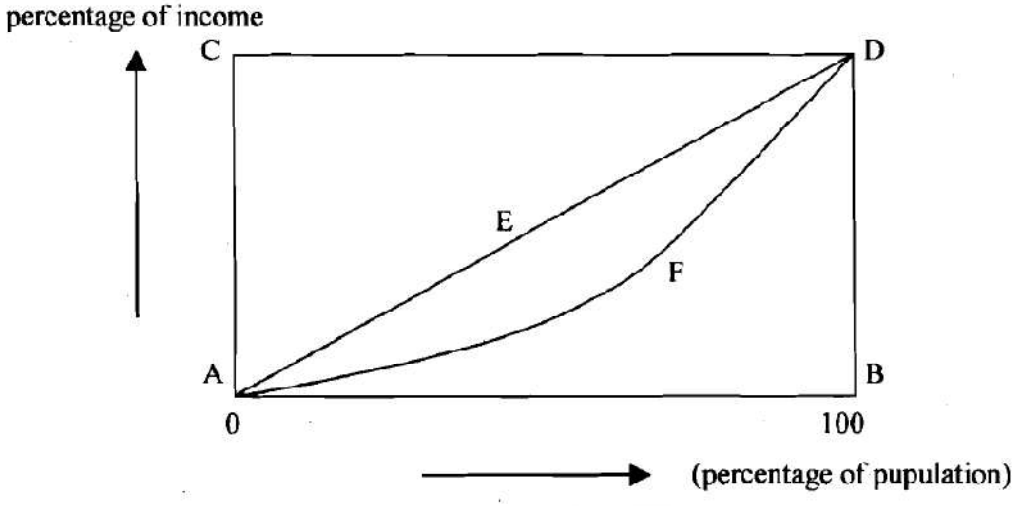

Fig. 2.1: Concentration Curve

Mathematical form of CI: If the health variable is bad and the corresponding cumulative proportion of persons ranked by income) is continuous:

$$CI = 1 - 2\int_0^1 L_h(p)dp \qquad (2.21)$$

where, $\int_0^1 L_h(p)dp$ stands for the area between CC and line of equality.

For a discrete variable of living standards, it is:

$$CI = \frac{2}{N\mu}\sum_{i=1}^{n} h_i r_i - 1 - \frac{1}{N} \qquad (2.22)$$

where h_i is the health sector variable, μ is its mean and $r_i = \frac{i}{N}$ is the fractional rank of individual i in the living standards distribution with i = 1 for the poorest and i = N for the richest. For computational purposes, a more convenient formula for CI, defined in terms of the covariance between the health variable and the fractional rank in the living standards distribution, is given as:

$$CI = \frac{2}{\mu} Cov(h, r) \qquad (2.23)$$

Note that if we expand (2.23), we get (2.22). Hence, there is no difference between Equations (2.22) and (2.23).

In case of grouped data, the CI is estimated by using the formula:

$$CI = (P_1L_2 - P_2L_1) + (P_2L_3 - P_3L_2) + ...(P_{T-1}L_T - P_TL_{T-1}) \qquad (2.24)$$

where P_T is the cumulative proportion of the sample ranked by economic status in group t (t =1,2,3…T), and L_t is the corresponding concentration curve ordinate.

Properties of Concentration Index (CI): The properties of the CI depends on the measurement characteristics of the variable of interest. It is an appropriate measure of socio-economic-related healthcare inequality when healthcare is measured on a ratio scale with non-negative values. The main properties of CI are:

a) CI is invariant to multiplication of the health sector variable of interest by any scalar;

b) CI is not invariant to any linear transformation of the variable of interest. Even adding a constant to the variable will change the value of the concentration index;

c) measurement of health inequality often relies on self-reported indicators of health. A concentration index cannot be computed directly from such categorical data, although the ordinal data can be transformed into some cardinal measure and a concentration index can be computed; and

d) unlike the Gini Coefficient, the CI lies between –1 and +1.

2.4.2 Empirical Illustration of CI

Exercise 1: Hypothetically, the SAHS and income of 10 individuals are recorded as in Table 2.1. Calculate the CI for this individual sample data.

Table 2.1: SAHS Data by Income

Individuals	1	2	3	4	5	6	7	8	9	10
SAHS	19.2	13.6	18.1	13.9	14.5	13.5	39.3	30.3	25.1	38.7
Income('00)	574	609	1470	1885	2320	2529	3431	3654	4413	4529

The income of the individuals are given in ascending order, therefore, we need not arrange these. If income is given in a haphazard order, we have to re-arrange data first in ascending order and proceed. Necessary calculations towards estimation of CI are shown in Table 2.3.

Table 2.2: Computations for Estimation of CI Using Data in Table 2.1

Income ('00)	SAHS (h_i)	Income Rank	Fractional Income (r_i)	$h_i r_i$
574	19.2	1	0.1	1.92
609	13.6	2	0.2	2.72
1470	18.1	3	0.3	5.43

1885	13.9	4	0.4	5.56
2320	14.5	5	0.5	7.25
2529	13.5	6	0.6	8.1
3431	39.3	7	0.7	27.51
3654	30.3	8	0.8	24.24
4413	25.1	9	0.9	22.59
4529	38.7	10	1	38.7
	∑226.2			∑144.02

Inserting the computed values in Equation (2.22) we get:

$$CI = \frac{2}{N\mu}\sum_{i=1}^{n} h_i r_i - 1 - \frac{1}{N} = \frac{2}{10 * 22.62} * 144.02 - 1 - \frac{1}{10} = 0.1733$$

This is positive which means that good health (SAHS) is higher among the richer and the CC will lie below the line of equality.

Exercise 2: Estimate CI for grouped data as given in Table 2.3.

Table 2.3: Estimation of CI for Grouped Data

WG	NB	RPB	CPB (P_T)	U5MR	ND	RPD	CPD (L_T)	CI
Poorest	29939	23	23	154.7	4632	30	30	-0.0007
2nd	28776	22	45	152.9	4400	29	59	-0.0267
Middle	26528	20	66	119.5	3170	21	79	-0.0592
4th	24689	19	85	86.9	2145	14	93	-0.0827
Richest	19739	15	100	54.3	1072	7	100	0.0000
Total/ Mean	129671			118.8	15419			-0.1715

Note: WG=Wealth Group, NB=Number of Births, RPB= Relative % of Births, CPB= Cumulative Percentage of Births, U5MR=Under Five Mortality Rate Per Thousand, ND= No. of Deaths, RPD= Relative Percentage of Deaths, CPD= Cumulative Percentage of Deaths, CI=Concentration Index.

Source: World Bank.

In case of group data, the CI is estimated using formula 2.24. Using Equation (2.24), we get:

CI= (0.23 * 0.59 – 0.45 * 0.30) + (0.45 * 0.79 – 0.66 * 0.59) +

(0.66 * 0.93 – 0.85 * 0.79) + (0.85 * 1 – 1 * 0.93)

= (–0.0007) + (–0.033) + (–0.0578) + (–0.08) = – 0.1715

In Equation 2.29, P_T is the cumulative proportion of the sample ranked by economic status in group t (t =1,2,3…T), and L_t is the corresponding concentration curve ordinate (measured in proportion).

Check Your Progress 3 [answer within the space given in about 50-100 words]

1) What is meant by socio-economic status (SES)? How is health inequality related to SES?

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2) Define Concentration Curve (CC). Under what circumstances CC will lie above and below the Egalitarian line? Can CC coincide with the line of equality?

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3) What is Concentration Index (CI)? What does it capture?

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4) Give the economic meaning of CI if it becomes negative, zero and positive.

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5) State the properties of CI?

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6) Find the CI from the following data

Individuals	1	2	3	4	5	6	7	8	9	10
SAHS	21.3	13.6	18.1	14.9	12.5	13.5	26	30	25	38
Income('00)	500	450	525	1800	1300	1250	900	1400	1150	4500

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7) Find the wealth based health inequality using group CI.

Wealth Group	**Births**	**% of Births**	**Cumulative % of Births**	**U5MR**	**% of Mortality**	**Cumulative (%)of Mortality**
lowest	8331	25.16	25.16	837.27	34.27	34.27
second	7432	22.44	47.60	665.91	27.26	61.53
middle	6518	19.68	67.28	468.65	19.18	80.71
forth	6032	18.22	85.50	308.84	12.64	93.36
highest	4802	14.50	100.00	162.31	6.64	100.00
Total/Mean	33115	100.00		2442.9	100.00	

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2.5 LET US SUM UP

Measuring the health status of an individual is more of a subjective phenomenon. To make it objective, a method like SAHS is used. There is a close linkage between health, healthcare spending and income. The HDI, 2010 is a composite index which takes into account the education and the health attainment for which the 'mean years of schooling' and 'life expectancy at birth' are respectively used. There is a two-way causality between health and poverty. Whereas HDI is gender insensitive, GDI is adjusted for gender inequality. GDI, adjusted for health inequality, is nowadays used by UNDP. These concepts are first explained and then illustrated for empirical computations. Further, to accommodate for varying levels of socio-economic attainment, two measures of health inequality, namely the concentration curve and concentration index are also discussed in the unit.

2.6 KEY WORDS

SAHS : Health status is first ordinally recorded for certain health related functions like walking, breathing, digestion, hearing, chronic health disorder etc. An individual can the self-assess to obtain a pre-specified score as a cardinal number for each of specific health related functions. The score or index so obtained by the individual is known as self assessed or self reported health status (SAHS).

Human Development : Human development is a process of enlarging people's choices – the three essential choices identified as: a long and healthy life, with knowledge or skill acquired by 'years of schooling' and with ability to access resources needed for maintaining a decent standard of living. In Human Development, human beings are both the means and the ends in the development process.

Equally Distributed Equivalent Achievement (EDEA) : An optimum trade-off between higher achievement and gender equality is achieved by an Equally Distributed Equivalent Achievement variable, X_{EDEA} for a positive inequality aversion parameter ε, $\varepsilon > 0$.

Concentration Curve : Concentration Curve (CC) plots the cumulative percentage of health variable against the cumulative percentage of population ranked by socio-economic status.

Concentration Index : The concentration index (CI) is directly related to the concentration curve, and quantifies the degree of socio-economic related inequality in a health variable.

2.7 SOME USEFUL BOOKS AND REFERENCES

1) Grossman, M (1972). 'On the Concept of Health Capital and the Demand for Health', *Journal of Political Economy*, 80 : 223-255.

2) Haldar, S.K., (2008). 'Effect of Health-Human Capital Expenditure on Economic Growth in India: A State-Level Analysis', *Asia-Pacific Social Science Review*, 8 (2), 79-97.

3) Hurd, Michael and Arie Kapteyn (2003). 'Health, Wealth and the Role of Institutions', *Journal of Human Resources*, 38(2), 386-415.

4) United Nations Development Programme, (1990). *Human Development Report*, Oxford University Press, New York.

5) United Nations Development Programme, (2010). *Human Development Report*, Oxford University Press, New York.

6) Wagstaff, A., E. van Doorslaer, and N. Watanabe. (2003). 'On Decomposing the Causes of Health Sector Inequalities, with an Application to Malnutrition Inequalities in Vietnam', *Journal of Econometrics* 112(1): 219–27.

7) World Economic Forum. (2016). '*The Global Gender Gap Report',* World Economic Forum, Geneva.

2.8 ANSWERS/HINTS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) For a country, HDI has come to replace the earlier used PC NI.

2) SAHS is a measure of one's own assessment of health related to pre-recorded 'conditions of health' arrived at for a group of individuals with similar backgrounds. Though it makes the task of assessment of health easier, it suffers from the influence of cultural, social, economic, personality and general outlook factors.

3) Human development is taken to encompass three types of choices, each in the areas of health, education and overall ability to access other resources and opportunities (Sub-section 2.2.1).

4) Health is factored-into HDI through the proxy 'life expectancy'.

5) Follow the same steps indicated in the 'illustration' in the Sub-section 2.2.1.

6) Through malnourishment, mortality and catastrophic health expenditure.

7) Low income, high healthcare cost, transaction/transport cost, inability to take preventive measures, etc.

Check Your Progress 2

1) GAHE is defined as '(1 – ε) average' where ε represents inequality aversion parameter with $\varepsilon \geq 0$ being considered to reflect a preference for equality (Sub-section 2.3.1).

2) EDEA is defined as the level of achievement that, if attained equally by women and men, would be judged to be exactly as valuable socially as the actually observed achievements (Sub-section 2.3.1). The optimum trade-off between higher achievement and gender equality is achieved through X_{EDEA} for $\varepsilon > 0$.

3) This is because potential life expectancy of female is higher than that of male (Sub-section 2.3.1).

4) Follow the steps shown in the illustration in Sub-section 2.3.2.

Check Your Progress 3

1) The term socio-economic status includes: income, occupation, consumption pattern, education, caste, culture, life style, religion, living conditions, work place environment, residence in rural or urban, etc.

2) Concentration Curve (CC) plots the cumulative percentage of health variable against the cumulative percentage of population ranked by socio-economic status (Sub-section 2.4.1).

3) The CI is defined as twice the area between the CC and the line of equality (i.e. the 45-degree line). Concentration index (CI) quantifies the degree of socio-economic inequality with a particular focus on a health variable.

4) When there is no socioeconomic inequality, the CI is zero. A negative value of CI means ill-health (Sub-section 2.4.1).

5) Invariant to multiplication by scalar, non invariant to any linear transformation including addition of a constant, etc. (Sub-section 2.4.1).

6) Follow the steps in exercise 1 of Sub-section 2.4.2.

7) Follow the steps in exercise 2 of Sub-section 2.4.2.