 CHAPTER 3
MEASURING HEALTH OUTCOMES

“Can you do Addition?” the White Queen asked.
“What’s one and one and one and one and one and one and one and one and one?”
“I don’t know,” said Alice. “I lost count.”

(Carroll, 1872)

3.1 HEALTH STATUS

Before going on to a detailed discussion of measurement of health outcomes, it is important to conceptualise what is being measured. Health status needs to be examined in more detail in order to emphasise the complexity of health outcome measures.

Figure 8 is a simple model of health status showing it as being the result of health determinants and interventions. Health status is defined through these two factors individually and as a result of the interaction between them. Health outcome measures reflect various facets of health status. (Figure 8 is a schematic version of Figure 4 in Chapter 2.)

FIGURE 8: The relationship between health status, determinants and interventions

Source: Lerer 1996 personal communication

Health determinants can be labelled proximal (direct) or distal (indirect). Smoking is an example of a proximal determinant; more distal determinants would be the social,
demographic and economic factors promoting tobacco use. “Distal determinants are mainly in the macro-economic, educational, environmental, demographic and health arenas” (Lerer et al. 1998 P 9). “Distal determinants are considered to be the driving forces of health status” (ibid P 12). “The effects of distal determinants are often, but not invariably, mediated through proximal determinants” (ibid P 9).

Proximal determinants are regarded as direct causes of changes in health status. Many proximal determinants of health status can be prevented “(through health education and promotion) and regulated (through fiscal and legislative measures)” (Lerer et al. 1998 P 15).

The relation between determinants and health status is largely indirect. It is modified by factors such as class, gender, education and socio-economic disparity” (Lerer et al. 1998 P 18).

3.2 MEASUREMENT

It is important to consider measurement, per se, as there have been extensive advances in the development of summary health measures that have not been comprehensively documented. Furthermore, the summary measures of health are not strictly objective and therefore it is necessary to analyse the values and social preferences inherent in them.

The DALY is a relatively new measure that has been used as a measure of global burden of disease and for global comparative assessments in the health sector (WDR 1993; Murray 1994). Furthermore, in terms of health and development, the DALY has been an adjunct tool in determining future research intervention options. (Investing in Health Research and Development. Report of the Ad Hoc Committee 1996). There has also been increasing utilisation by the WHO of summary measures to assess performance of health systems. An example of the latter is Disability Adjusted Life Expectancy (DALE), (The World Health Report 2000).

Measurement is more than the simple act of counting and adding data. There are also no physical devices available to measure constructs in the social and behavioural sciences.
According to the widely quoted WHO definition, health is defined in very broad terms. It is not seen to be simply the absence of disease but a state of well-being at all levels of human existence (Investing in Health Research and Development. Report of the Ad Hoc Committee 1996).

Measures of health status must address the underlying issue of values. The notion of health versus illness or disability is a value judgement. Whatever is used for defining health, be it, biological, psychological, social or cultural criteria, “there are existing values that identify deviation from an acceptable state of being, reflecting peoples’ deepest aspirations and fears” (Patrick and Erickson 1993 P 19). In order to measure health, this conceptual framework needs to be made operational. The measurement of health proceeds by assigning numbers to health states and manipulating these numbers. Indicators of health status define quantities that describe aspects of health. These indicators are considered to be either ‘negative’ or ‘positive’ measures. An example of the former is mortality and an example of the latter is life expectancy. Although the ultimate goal is to promote good health, the primary focus of most health measurements is disease or ill-health, because of the difficulties of measuring health. However, with the current emphasis in public health shifting to health promotion, more attention has been given to positive indicators such as social and mental well-being.

The more usual measures of mortality and morbidity are inadequate for assessing people who are not ill but have some limited function which affects their everyday life. During the last few decades particularly, new health indicators or health outcome measures have been developed to assist in the analysis of the consequences of disease. The concept of morbidity has been extended to incorporate the personal and social consequences of diseases as well as quality of life measures.

The various measures of health outcome will be presented from an historical perspective. In particular, the combined indicator of mortality and non-fatal outcomes, the DALY, will be examined in some detail and compared to other related measures. The intended uses of the measures, whether for assessment, comparison at regional or national level, or planning will be discussed. The usefulness of the DALY to aid health research prioritisation will be highlighted.
3.2.1 MEASURES OF MORTALITY

The measurement of health status dates back to Babylonian times when mortality rates were used to assess the health status of the population.

Life expectancy is an index of mortality. It can be estimated from a life table of the population and reflects both childhood and adult mortality. An expectation of life must always be related to people at a particular age. Life expectancy is usually the measure of the expectation of life at birth.

A crude death rate is the number of deaths in a given time period divided by the population at risk. Adjusted rates are hypothetical summary rates constructed to permit fair comparisons between groups differing in some important characteristic, such as, age. Age-standardized rates are constructed by applying the rates for each age group to a standard population.

Detailed rates for specific groups are needed to analyse epidemiological aspects of disease and population dynamics. For example, the infant mortality rate, the number of infant deaths in a year divided by the number of live births in the year is an important indicator. Child mortality - the probability of a child dying before the age of 5 - is also used as a proxy measure of the health status of the population.

Measures of adult mortality, such as the 45Q15 are also important indicators of population health status. The 45Q15 is the probability of a 15-year-old dying before the age of 60, and describes the level of premature adult mortality. The 35Q15, (the probability of a 15-year old dying before the age of 50), is an important indicator of young adult survival which is changing rapidly due to the AIDS epidemic.

The concept of time lost to mortality, rather than death rates, was introduced in the late 1940s (Dempsey 1947). Subsequently, there have been a wide variety of methods proposed to measure years of life lost. Allied concepts include premature mortality and preventative mortality. An example of a measure that introduces a time dimension to the
evaluation of health is Years of Potential Life Lost (YPLL). Potential years of life lost are calculated by defining a limit to life and determining the years lost due to each death as the limit minus the age at death. The potential limit to life is an arbitrary figure ranging from about 60 to 85 years. YPLL takes account not only of the number of deaths from a disease but also the number of years that people might have continued to live on average compared with their counterparts (Public Health Status and Forecasts P 43).

3.2.2 MEASURES OF MORBIDITY AND NON-FATAL OUTCOMES

Disease-specific measures of morbidity date from the nineteenth century. Two indicators of morbidity are incidence and prevalence.

**Incidence rates** are the number of new disease cases over a period of time divided by the population estimate. Incidence rates are a direct indicator of the risk of a disease.

**Prevalence rates** measure the number of people in a population who have a disease at a given point or period in time divided by the population estimate. Prevalence rates capture both incidence and duration of a disease.

These indicators relate to the etiology of diseases and recently, more attention has been given to the measurement of morbidity and non-fatal health outcomes and the associated quality of life. This shift is in part due to the preponderance of chronic diseases, particularly in the industrialised countries with aging populations. Developing a measure of disability is exceedingly difficult: One reason for this is that, unlike mortality, there are many dimensions to disability such as physical disabilities, pain, discomfort, emotional distress and loss of dignity (Morrow and Bryant 1995).

Three important conceptual frameworks are used for non-fatal health outcomes (Goerdt et al. 1996). According to Murray (1994 P 10), these have developed in isolation as a result of “disciplinary focus, geographical and institutional locus and types of health systems.” The different strands include:

1. The International Classification of Impairment, Disability and Handicaps (ICIDH) classifies three dimensions for the consequences of disease. *Impairment* is defined
at the level of the organ system, disability is the impact on the performance of the individual while handicap includes the overall consequences which depend on the social environment. There are many valid criticisms levelled at the ICIDH. These include its inaccessibility and unnecessary complexity as well as the absence of a recommended assessment schedule. Furthermore, it has been recommended that it be updated (Katzenellenbogen 1991). A revised version of ICIDH-2 (pre-final) has emphasised health and health related domains.

2. The health-related quality of life approach, (HRQL), was developed mainly in North America. The indicators are weighted aggregates of variables measuring physical, mental and social function. They include both objective and subjective measures of functional status and well-being.

A range of instruments for measuring the incidence or prevalence of health states in the community have been developed in the HRQL field. These include generic instruments that provide a profile of health status relevant to quality of life (QOL) such as the WHOQOL (WHO 1993) and the EuroQol (EuroQol Group 1990). More recently, the Evidence Cluster of WHO has developed a tool which is being piloted.

The theoretical bases for defining health and quality of life states are the theories of positive well-being and quality of life from psychology and functionalist theory from sociology and anthropology (Patrick and Erickson, 1993 P 60).

3. An utilitarian framework underlies most of the work on health economics. In this theory, non-fatal health outcomes are important only to the extent to which they alter an individual’s utility. Utility in economics is synonymous with the satisfaction of individual preferences. The focus is on the measurement of preferences rather than on the measurement of characteristics of health that individuals’ value. The analysis of utility includes measures such as PYLLs, DALYs or QALYs, which “explicitly introduce one or more subjective parameters in order to value outcome” (Musgrove 2000 P 110).
3.3 SUMMARY MEASURES COMBINING MORTALITY AND NON-FATAL OUTCOMES

Extensive research has been carried out to develop more general measures of non-fatal health outcomes that are commensurate with time lost due to premature mortality. Since Sullivan’s (1971) proposal in the late 1960’s of a composite index of health status that incorporates mortality and morbidity, there has been much debate on the value of these single indicators (Murray 1994). However, there are no comprehensive overviews of these measures. This section attempts to provide such.

Composite measures of health are invaluable for comparing different health conditions and for monitoring health services and research. It is difficult to compare different health conditions directly as each has different ill-effects, with the resulting problem of comparing ‘like with true like’. As a result there has been a number of attempts to create composite measures which assign values to different combinations of health states such as, death, pain and disability.

Early work on composite health status indicators was that of the Ghana Health Assessment Project Team (1981). This work was a first attempt to evaluate the burden of disease due to disability and premature mortality by cause for an entire population. The measure, healthy days of life lost (YHLL), was used with the assumption that days lost to death, being permanently disabled or temporarily disabled should be valued equally. This composite indicator combines morbidity and mortality to provide quantitative measures of losses from particular diseases and gains from particular interventions.

3.3.1 QALY: QUALITY ADJUSTED LIFE YEAR

Torrance et al. (1972) developed a measure in which health states between perfect health and death are weighted by the utility to the individual of time spent in each of these states. Zeckhauser and Shephard (1976) were the first to label such a measure of utility or preference-weighted time as QALYs. The term QALY refers to a time-based measure which includes life expectancy and non-fatal health outcomes where time spent with non-fatal outcomes is adjusted by a preference weight. QALY is a rubric for a family of such measures; there is no standard method for calculating QALYs.
The QALY measures years of survival weighted for the quality of life, which people may be expected to have in the context of different states of illness. Attempts to quantify the quality of life have been conducted in some cases by experts and in others by communities (Barker and Green 1996). QALYs have been used extensively in cost-effectiveness studies but have had limited use in describing the comparative burden of different conditions.

3.3.2 DALY: DISABILITY ADJUSTED LIFE YEAR

The 1993 World Bank Development Report and the Ad Hoc report (1996) make extensive use of the DALY as a composite measure of disease burden. William Foege (1994) sees the DALY as a major public health development of the past century. He states that the DALY concept has the potential to revolutionise the way in which we measure the impact of disease. The DALY combines years of healthy life lost from disability with those lost from premature death. DALYs were calculated for over one hundred specific diseases for eight demographic regions worldwide.

The DALY is calculated by adding Years of Life Lost (YLL) and the Years Lived with Disability (YLD). The YLL is determined using the West model life-table to determine age- and sex-specific life expectancies. This is one of four key values or social preferences that are incorporated in the DALY.

The YLD is calculated on the basis of the incidence and duration of conditions resulting in non-fatal outcomes and are weighted according to the severity of the disability of the sequelae. In this way, another explicit value is attached to the time lived with a disability to make it comparable to time lost due to premature mortality.

In contrast to the Ghana study (1981), the DALY calculations for the measurement of disability use a standardised method for defining, measuring and weighting disability. Health professionals from around the world were asked to evaluate the disability for the average individual with the condition described, taking into account the average social response or milieu and using the person trade-off methodology. Individuals were asked to choose between curing a certain number of individuals in one health state and another.
number in a different health state. The methodology elicits the point at which the individual is indifferent to the two choices being offered. At this point the outcomes are equivalent and a weight is derived (Murray 1994). Based on the results from the person trade-off protocol, the spectrum from perfect health (0) to death (1) was divided into six arbitrary classes. Highly consistent results were obtained from the various groups that participated for the disability severity weights for the 22 indicator conditions. Each class is exclusively defined by the range of disability weights and contains two or three indicator disorders, that act as benchmarks for the definition of each class.

The third explicitly social preference incorporated in the DALY, is the value of time lived at different ages. This is shown in Figure 9, which depicts the age–weight function. The middle age group, 9-54 years, is weighted more than the extremes.

**FIGURE 9: Age-weight function**

![Age-weight function](image)

Source: Murray (1994)

The fourth social value incorporated in the DALY relates to time preference and involves, the choice of a discount rate for future loss. Discounting implies a greater preference for time lived now than at some time in the future. This is particularly important in the context of cost-effectiveness assessments where future costs are discounted.

The general underlying concepts and specific values as well as the justification of certain assumptions used in the formulation of this measure are made explicit.
3.3.3 HeaLY: HEALTHY LIFE YEARS

Another new composite measure is the Healthy Life Years (HeaLY), which is a measure of healthy life-years lost, reformulated from the Ghana Health Assessment study data. Details are given in Appendix 2.

It is defined as “a composite measure that combines the amount of healthy life lost due to morbidity with that attributable to premature mortality” (Hyder et al. 1998 P 196). The defining characteristic of the HeaLy is that it is based on the incidence pattern within the conceptual framework of the natural history of disease rather than the juxtaposition of current mortality and the current incidence patterns.

3.3.4 DFLE: DISABILITY FREE LIFE EXPECTANCY

The principle of the calculation of Disability-Free Life Expectancy was postulated in the early 1960s. However, the first method of calculation of such a measure was proposed by Sullivan in 1971. The institutionalisation rate (generally from a recent census) and the prevalence of various states of functional disability (from national health or disability surveys) are incorporated with the years lived at various ages by the population of a life table. The period life expectancy for the modified table is calculated in the traditional manner yielding the value of Disability-Free Life Expectancy. The advantage of Sullivan’s method of calculating health expectancy is that mortality and disability data are treated separately and the data necessary for the calculations are available. The problem with this method is that it approximates the period prevalence by the observed prevalence within the population; it is not really a period indicator (Goerdt et al. 1996).

3.3.5 DALE: DISABILITY ADJUSTED LIFE EXPECTANCY

The DALE is calculated using a weighted number of years lived with disability added to the years of healthy life lived at a specific age.
3.4 COMPARISONS OF COMPOSITE MEASURES

3.4.1 QALY AND DALY

The QALY can be considered to be a precursor of the DALY. The DALY like the QALY allows both fatal and non-fatal outcomes to be combined in a single indicator. However, the QALY is a measure of health rather than ill-health. Marrow and Bryant (1995) point out that with the QALY, the focus is on assessing individual preference for different non-fatal health outcomes that might result from a specific intervention and that the DALY was developed primarily to compare relative burdens among different diseases and among different populations.

The DALY is considered to be a simpler and more ‘objective’ measure than the QALY as it is concerned with the severity of disability rather than the quality of life.

3.4.2 HeaLY AND DALY

The HeaLY differs from the DALY in that no differential is given to the value of life according to the age at which life is lived. Another difference is that discounting is integrated into the DALY formula, whereas with the HeaLY, discounting is done separately.

The major purpose of the HeaLY formulation is the assessment of the effects of health interventions and not attributing loss to specific diseases. This is facilitated by the HeaLY formulation being based on life lost to disability and death for all disease with onset in a given year. The effectiveness of interventions are considered on the basis of current incidence patterns. For the DALY measure, mortality and disability are considered for all deaths in the current year regardless of when the onset of diseases occurred.

3.4.3 DALY AND DALE

The DALY is a measure of the health gap whereas the DALE is a summary measure of health. The health gap is the difference between the actual health of a population and some reference status. DALYs are preferable to the DALE, the life expectancy in
different classes of disability when the burden of non-fatal outcomes and premature mortality needs to be broken down into the burden attributable to various diseases, injuries or exposures. This situation is analogous to cause specific death rates versus the relative utility of life-expectancy (Murray and Lopez 1997[b] P 1352).

3.4.4 DFLE AND DALE
Disability-Free Life Expectancy, (DFLE) and Disability-adjusted life expectancy, (DALE), are two measures of health expectancy. DFLE is a calculation of expected length of life without disability. The DALE is calculated in the same way as the DFLE at birth, with the DFLE, the number of years lived at a specific age is obtained from a life table. The DFLE measure attributes zero weights to estimates of life expectancy in different health states. DALE calculations are estimates of life expectancy for different health states adjusted for the GBD disability severity weights (Life Expectancy minus the DALE equals the severity-adjusted expectation of disability). Both are useful ways to summarise the health status of a population. Further examples include, Impairment Free Life Expectancy (IFLE) and Handicap Free Life Expectancy (HFLE) and are considered to be positive health indicators.

International comparisons of DFLE and other health expectancy measures have been hampered by differences in calculation and definition. However, the new WHO Report 2000 which incorporates estimates of DALE for each country is likely to create a standard approach that will overcome this problem (WHO 2000).

3.5 COMPARISON OF DALE VERSUS LIFE EXPECTANCY
The World Health Report 2000 has focussed on evaluating the performance of health systems. Data from this report for DALEs and Life Expectancy for males and females for the 191 WHO Member States was analysed, using regression analysis. DALEs were regressed on Life Expectancy. The results, as expected, are very highly correlated. This can clearly be seen in Figures 10 and 11.

Based on the regression model, the DALE is on average 10 years less than the Life Expectancy.
FIGURE 10: Graph of disability adjusted life expectancy against life expectancy: Males

WHO Member States
Males

$R^2 = 0.99$
$p < 0.0001$
FIGURE 11: Graph of disability adjusted life expectancy against life expectancy: Females

\[ R^2 = 0.99 \]
\[ p < 0.0001 \]
3.6 COMPARISON OF DALY VERSUS MORTALITY

Roughly two thirds of the global burden of disease measured by DALYs, is due to premature death and one third is due to disability (Jamison et al. 1995). The morbidity component of the DALY is generally more difficult to quantify than mortality due to the number of parameters and limited data. Hence it is important to understand what gets added by the morbidity component, (YLD), of the DALY over and above the mortality component, (YLL). The use of the DALY as opposed to mortality data only for the setting of health priorities is explored in the following section; this is integral to the question as to whether one needs dally with the DALY.

Some medical classifications have only a mortality component, for example suicide, whereas others have negligible excess mortality and a large non-fatal component such as some psychological disorders. A whole spectrum of differing mortality/morbidity ratios for different diseases and injuries lie between these two extremes. The relationship between mortality and non-fatal burden is investigated by means of linear regression analysis. In addition, in order to examine mortality and the DALY, YLLs were expressed as a percentage of DALYs for all diseases for SSA that were included in the regression analysis.

3.6.1 DATA

Estimates from the Global Burden of Disease study for Sub Saharan Africa for DALY and YLD values for each disease are used (Murray and Lopez (1994). The YLL values could readily be obtained by subtraction from the reported DALYs. Table 3 below shows the 14 diseases or injuries that were excluded from the analysis as they had either a negligible mortality component or a negligible non-fatal component. These conditions clearly do not have a relationship between the YLDs and YLLs.
Table 3: Sub-Saharan African diseases and injuries which have either YLDs or YLLs less than 1000

<table>
<thead>
<tr>
<th>DISEASE OR INJURY (ICD 9 CODE)</th>
<th>BOD Category</th>
<th>YLD (1000)</th>
<th>YLL (1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conditions with mortality but little morbidity or disability</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Hypertension complicating pregnancy, childbirth and puerperium (642 MINUS 642.4-642.6)</td>
<td>I</td>
<td>-</td>
<td>204</td>
</tr>
<tr>
<td>2 Other Neoplasm (210-239)</td>
<td>II</td>
<td>-</td>
<td>453</td>
</tr>
<tr>
<td>3 Skin disease (680-709)</td>
<td>II</td>
<td>-</td>
<td>113</td>
</tr>
<tr>
<td>4 Drowning (E910)</td>
<td>III</td>
<td>-</td>
<td>1554</td>
</tr>
<tr>
<td>5 Self-inflicted (E950-950)</td>
<td>III</td>
<td>-</td>
<td>1686</td>
</tr>
<tr>
<td><strong>Conditions with morbidity and disability but little mortality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Trachoma (076)</td>
<td>I</td>
<td>901</td>
<td>-</td>
</tr>
<tr>
<td>2 Major affective disorder (-----)</td>
<td>II</td>
<td>1647</td>
<td>-</td>
</tr>
<tr>
<td>3 Post traumatic stress disorder (-----)</td>
<td>II</td>
<td>505</td>
<td>-</td>
</tr>
<tr>
<td>4 Glaucoma related blindness (365)</td>
<td>II</td>
<td>171</td>
<td>-</td>
</tr>
<tr>
<td>5 Cataract related blindness (715)</td>
<td>II</td>
<td>1130</td>
<td>-</td>
</tr>
<tr>
<td>6 Osteoarthritis (521.0)</td>
<td>II</td>
<td>223</td>
<td>-</td>
</tr>
<tr>
<td>7 Dental carries (523)</td>
<td>II</td>
<td>436</td>
<td>-</td>
</tr>
<tr>
<td>8 Periodontal disease (520)</td>
<td>II</td>
<td>417</td>
<td>-</td>
</tr>
<tr>
<td>9 Edentulism</td>
<td>II</td>
<td>41</td>
<td>-</td>
</tr>
</tbody>
</table>

(Source: Murray and Lopez 1994)  
I Communicable, maternal and perinatal  
II Noncommunicable  
III Injuries  
- indicates less than 1000 YLDs or YLLs

3.6.2 METHODS

The four graphs and the statistics were obtained using the Advanced Regression programme of the spreadsheet Quattro Pro (Version 6 1997). The graphs have the YLD as the dependent variable and the YLL as the independent variable. Both measures have
been transformed using a natural logarithmic scale of the measure plus one, so as to have a more meaningful spread of the data that was more normally distributed. This was necessary as there were some outlying values. Linear regression lines were fitted with log (YLD +1) as a function of log(YLL+1) for All diseases and the three sub-groups of: Communicable and Maternal, Non-Communicable and Injuries. These correspond Figures 12, 13, 14 and 15 respectively. There are 68 observations with 20 observations for Communicable and Maternal, 41 observations for Non-Communicable diseases and 7 observations for Injuries. The correlation coefficient (R²) was used to describe the extent of the relationship between the transformed DALY and YLL. The significance of the correlation is assessed using the p-value.
FIGURE 12: Graph of years lived with disability against years of life lost:
All Diseases

all diseases
SSA

log(yld + 1)

1 3 5 7 9 11

log(yll + 1)

R² = 0.2409
p < 0.0001

FIGURE 13: Graph of years lived with disability against years of life lost:
Communicable Diseases

communicable diseases
SSA

log(yld + 1)

1 3 5 7 9 11

log(yll + 1)

R² = 0.2554
p = 0.023
FIGURE 14: Graph of years lived with disability against years of life lost: Non-Communicable Diseases

non-communicable diseases
SSA

![Graph showing the relationship between log(yld + 1) and log(yll + 1) for non-communicable diseases with R² = 0.0975 and p = 0.0469.]

FIGURE 15: Graph of years lived with disability against years of life lost: Injuries

injuries
SSA

![Graph showing the relationship between log(yld + 1) and log(yll + 1) for injuries with R² = 0.2099 and p = 0.3012.]

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3.6.3 RESULTS

For the DALY versus YLLs, for All Diseases, the correlation for YLDs regressed on YLLs is, $R^2 = 0.2409$. The correlation is highest for Communicable Diseases with $R^2 = 0.2554$. The lowest correlation, $R^2 = 0.0975$, is for Non-Communicable diseases. The correlation is 0.2099 for Injuries. The probability values (p values), range from $p < 0.0001$ for All Diseases, to $p = 0.3012$ for Injuries. At the chosen probability level (95%), there are 3 statistically significant results, i.e. they cannot be attributed to chance. The probability value for Injuries is not less than 0.05. It should also be noted that Injuries is the smallest sub-group, with only 7 values.

However there is considerable variation and the average percentage value for YLL/DALY is 63.1%, mortality accounts for only 1.8% of the total burden for affective disorders while it accounts for 98.1%, for poisoning. While the diseases and injuries at both the extremes of the distribution of the YLL/DALY percentages, can be reasonably well identified, there is a wide range of values which cannot be easily identified with accurate predictions of the corresponding values.

These results suggest that mortality cannot be used to predict morbidity. Hence, the morbidity or non-fatal component would be most a useful additional health outcome measure especially for Non-Communicable diseases.

Although mortality is an important component for examining the burden of disease, morbidity cannot be ignored as it constitutes a relatively large portion of the burden of disease. Based on the calculation, on average up to 36% of the total burden can be attributed to morbidity.

3.7 CONCLUSION

The above analyses show that it is important to measure non-fatal health outcomes when considering burden of disease or health gap, as they constitute a large proportion of the burden of disease.
For the comparison of the DALE versus Life Expectancy, both correlation values approach unity, which represents perfect correlation. Thus, in the case of an overall summary of health, it would appear that life expectancy could be used as a proxy for DALE.

In the case of prioritising health research through the identification of health problems, it is important to analyse the health gap. It is therefore clear that it is important to take non-fatal outcomes into account and that mortality is not an adequate proxy measure.